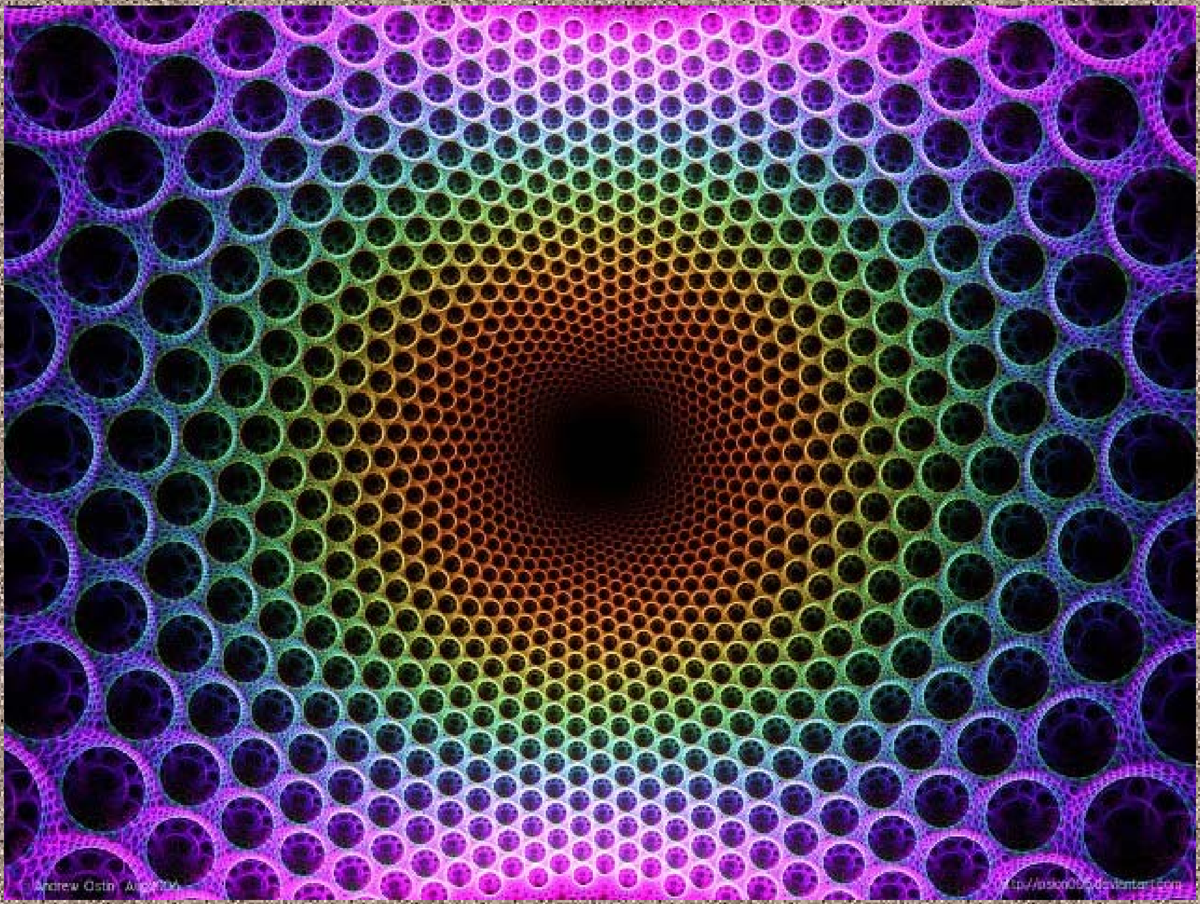
Soil Classification

Newsletter No. 3

Spring 2012



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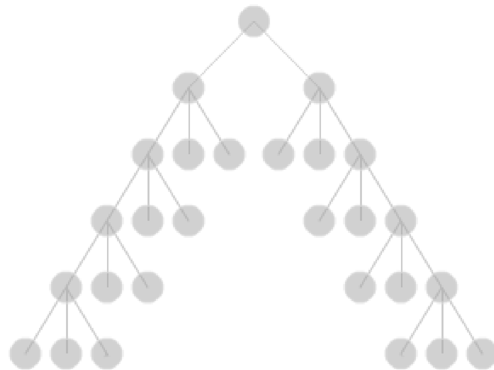
Front cover: Abstract digital art gallery / fractal: Psytrip, by psion005 (http://www.abstractdigitalartgallery.com/)

Please visit our site http://clic.cses.vt.edu/IUSS1.4/ for the hottest news on soil classification.

Abbreviations: United States Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS), National Soil Survey Center (NSSC), Virginia Polytechnic Institute and State University (Virginia Tech).



Top down (triangular)

Message from the Chair

I am pleased to introduce the 3rd Soil Classification newsletter from IUSS Commission 1.4. The left image represents the connectivity or lack of connectivity of taxa in a hierarchy classification system, usually represented by a triangle form from highest to lowest levels.[1]

For presenting information, a hierarchy can be thought of as a set of taxa in which:

1. No element is superior to itself, and
2. One element, the *hierarch*, is superior to all of the other elements in the set.

The first requirement is also interpreted to mean that a hierarchy can have no circular relationships; the association between two objects is always transitive. The second requirement asserts that a hierarchy must have a leader or root that is common to all of the objects. If the human mind can comprehend 20-30 items in short-term virtual memory and 6-10 complex items in intermediate-term working memory, then the maximum taxa in the highest level of a hierarchy should be 20-30 and the number of subcategories at each level should be 6-10. Is this still true when we have numerical classification algorithms and portable electronic devices available?

The image of the hand(s) is a metaphor for the tasks facing the Universal Soil Classification Working Group. The image is like a hierarchy, the format voted for by the Working Group. The number of taxa (fingers/thumb) divides as the triangle in the first image. There are challenges for each level. Looking at the smallest hands, the unique number of taxa must be identified and defined with properties that have similarity with little overlap, based on cluster analysis of data assembled for each base level taxa. The base level taxa will probably be based on existing concepts proven over centuries of practical soil science application. Is one hand really different than the other? Are the fingers/thumb on separate hands more similar to each other than they are to other fingers/thumb on the same hand? Once allocated to a taxon, the soils in separate taxa (fingers or thumb) cannot be joined again. This causes redevelopment of the entire system. Classification system development is bound to be iterative. The challenge is complex showing only three levels with only one taxa at the highest level, with only five new taxa added at each major subsequent level. The challenge of classification of natural objects continues to evolve.

[1] Dawkins, R. (1976). "Hierarchical organization: a candidate principle for ethology". In Bateson, Paul Patrick Gordon; Hinde, Robert A. *Growing points in ethology: based on a conference sponsored by St. John's College and King's College,* Cambridge, England: Cambridge Univ. Press. pp. 7–54.

Report on the 4th Conference for Soil Classification, – Lincoln, NE USA June 12, 2012

Regular conferences of the Commission 1.4. "Soil Classification" started from the meeting in Gődőlö, Hungary, organized by the initiative of Erika Michéli, followed by the events in Petrozavodsk, Russia (2004) and Satiago, Chile (2008). This is the 4th conference on the topic, which was followed by a field workshop and a business meeting of the Universal Soil Classification Working Group.

Meeting attendance: 46 conference attendees from 19 countries, six continents. The IUSS officers present were Karl Stahr (Division 1 Chair), John Galbraith (Commission 1.4 "Soil Classification" Chair), Zhang Ganlin (Commission 1.3 "Soil Genesis" Chair), Pavel Krasilnikov (Vice-Chair of the Commission 1.4), Peter Schad and Cornie van Huysteen (the Chair and Vice-Chair of the WRB Working Group, correspondingly), and Jon Hempel and Erika Michéli (the Chair and Vice-Chair of the USC Working Group, respectively). Both working groups are part of Comm. 1.4.

The conference included eight sessions, six symposia, 32 speakers plus 16 posters.

Sponsors: University of Nebraska-Lincoln, USDA-NRCS, Virginia Tech, Nebraska Society of Professional Soil Scientists, International Union of Soil Science, and Soil Science Society of America.

Called to order by Cameron Loerch, *National Leader Soil Standards, NRCS-NSSC, NSSC*.

Program:

Day 1 – Monday, June 11, 2012

1. Convenor: Cameron Loerch. Welcome Speeches by Ron Yoder, Assoc. Vice-Chancellor of Univ. Nebraska-Lincoln (UNL). Then Karl Stahr, IUSS Div. 1 Chair, John Galbraith, Comm. 1.4 Chair, Pavel-Krasilinikov, Comm. 1.4 Vice-Chair, and Jon Hempel, Director of USDA-NRCS Nat. Soil Survey Center.
2. Dr. Mark Kuzila of UNL gave a lecture on the geology and soils of Nebraska. This was followed by a group photo outside.
3. The Guy Smith Medal was awarded to Dr. Hari Eswaran, retired USDA-NRCS Director of World Soil Resources in Washington (see below the report).
4. Moderator: Session 1 - John Galbraith. Soil Classification
5. Moderator: Ben Harms - Session 2 – Towards a Universal Soil Classification

Day 2: Tuesday, June 12, 2012

1. Moderator: Peter Schad - Meeting Session 3 – Worldwide classifications: their improvement, correlation and harmonization

   Poster session
2. Moderator: Juan Comerma - Meeting Session 4 – Marginal Soils: Strongly transformed and subaqueous soils
3. Poster session

Day 3: Wednesday, June 13

1. Moderator: Lúcia Helena Anjos - Meeting Session 5 – Case Studies: examples from (sub)tropical areas
2. Moderator: Pavel Krasilnikov - Meeting Session 6 – Novel methods and approaches in soil classification

Poster session

3. Field Trip – with tour guide
4. Banquet
5. Entertainment – Native Dancers – Winnebago and Lakota Tribes
6. Keynote speakers - Robert & Anne Diffendall "Travels of Lewis & Clark through Nebraska"

Day 4: Thursday, June 14, 2012

1. Field Trip
2. Lunch
3. Social and Barbeque Buffet
4. Scenic Overlook
5. Closing Remarks and Adjournment

The Commission Chair John Galbraith in a soil pit during the Field Workshop. The soil is Monona Series (Fine-silt, mixed, superactive, mesic Typic Hapludoll) near Hitchcock Nature Center, Idaho

Please consult the conference site for details:
http://clic.cses.vt.edu/IUSS1.4/Conf_Soil_Classification_2012/IUSS_Conf_Soil_Classification_2012_A1.html

John Galbraith

International Union of Soil Science Societies

4th Conference for Soil Classification

Lincoln, NE, USA

June 12, 2012

BOOK OF ABSTRACTS

Edited by Cameron Loerch, Jon Hempel and John Galbraith

Note:

Abstracts and contacts for all meeting participants are planned for publication on the IUSS Comm. 1.4 web site.

MEETING SESSION 1

Towards a Universal Soil Classification System

Jonathan Hempel, *Director, USDA-NRCS, NSSC*
Erika Michéli, *Szent Istvan University, Gődőllő, Hungary*
Phillip Owens, *Assoc. Professor, Purdue University, West Lafayette, Indiana, USA*
John M. Galbraith, *Assoc. Professor, Virginia Tech, Blacksburg, Virginia, USA*

During the 2010 World Congress of Soil Sciences in Brisbane, Australia, the IUSS Council unanimously accepted the "Gődőllö Resolution" and formally accepted the proposal for a new Working Group to carry out the proposed investigations and development of common standards, methods and terminology in soil observations and investigations and a universal soil classification system. The working group is established and is functioning to research and develop the IUSS council recommendations.

Developing and submitting proposals to amend Soil Taxonomy

J. Cameron Loerch, *National Leader Soil Standards, NRCS-NSSC, NSSC*
Joseph V. Chiaretti, *Soil Scientist, Soil Standards, NRCS-NSSC, NSSC*

The US Soil Taxonomy has been developed over a span of 60 years. This dynamic system has been amended and improved to add newly found soils and soil properties around the world into a common system. The National Cooperative Soil Survey (NCSS) has an infrastructure of National, State, local, and private soil scientists who have helped build the system. There have been 10 international committees assembled to improve Soil Taxonomy since 1975.It's currently used in over 140 countries as its primary or secondary classification system. Soil Taxonomy has always been intended as a universally accepted system of soil classification that is open to amendment. It's important for all soil scientists to understand the process for proposing changes to Soil Taxonomy. The USDA Soil Survey Division is responsible for maintaining Soil Taxonomy. Staff at the National Soil Survey Center are assigned to accept proposals and facilitate review prior to decisions resulting in acceptance, acceptance with change, or rejection. The process currently includes a cooperative effort of review throughout the NCSS program. It would be beneficial to have representation within IUSS as part of the review process, especially for proposals addressing soils outside of the United States. A review of the process to amend Soil Taxonomy is presented to illustrate opportunities the International soils community has to submit proposals and participate in improvement of Soil Taxonomy to meet their needs.

The Place of the Laboratory in Soil Classification

Larry T. West, *National Leader, Soil Survey Research and Laboratory, NRCS-NSSC, NSSC*
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S.E. Monteith, *Supervisory Soil Scientist, Kellogg Soil Survey Lab, NRCS-NSSC, NSSC*
R.R. Ferguson, *Supervisor, Analytical Chemist, Kellogg Soil Survey Lab, NRCS-NSSC, NSSC*

The results of laboratory examinations of soil samples are commonly considered to be an essential part of soil research, and certain soil properties important to soil classification and behavior cannot be directly observed in the field. Representative laboratory data are essential for answering important questions about soil morphology, genesis, classification and behavior, and many soil classification systems including Soil Taxonomy and the WRB rely on laboratory data for separation of certain taxa. To be fully effective, laboratory data used for classification must 1) be preceded by and accompanied by field evaluations, and 2) address properties that will result in meaningful separations of soils that cannot be made from morphological observations. The morphology and landscape characteristics that are observed and described in the field must guide our collection of soil samples and, in turn, must be used to extend laboratory data from a limited number of sampled pedons to broad regions. With combined field and laboratory studies, field-observable accessory characteristics can be identified and associated with the differentiating lab-determined characteristics. These accessory characteristics can then be used to guide separation of soils lacking measured values for the laboratory based differentiating characteristics. This paper will discuss these and similar concepts and present successful examples of field and laboratory collaboration.

MEETING SESSION 2

WRB: State of the art and next steps

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Erika Michéli, *Szent István University, Gödöllö, Hungary*

The 2nd edition 2006 (update 2007) of the international soil classification system WRB (World Reference Base for Soil Resources) is focused on pedon classification. WRB has 2 hierarchical levels with 32 Reference Soil Groups (RSG) at the upper level. At the lower level, adjectives called qualifiers are added to the RSG name. To classify a pedon, all applicable qualifiers have to be added. Their sequence is fixed following practical reasons without hierarchy. In 2010 "Guidelines for constructing small-scale map legends using the WRB" were published electronically. Without changing definitions, the order of the qualifiers was arranged differently. For every RSG, a small number was selected as Main Map Unit Qualifiers and ranked. All others are Optional Map Unit Qualifiers and listed alphabetically. The number of qualifiers in the map unit depends on scale. At very small scales, only the RSGs are shown. If the scale is larger, the first applying qualifier of the main list is added, at the next larger scale the first two, etc. All main qualifiers are placed before the RSG. At every scale, additional qualifiers may be added in brackets behind the RSG. They may stem from the main list (not yet used for that map unit) or from the optional list. At the IUSS Congress 2014 in Korea, the 3rd edition of WRB will be presented. There are 4 major topics to work on:

1. Unify the rules for qualifiers sequences for pedon classification and map unit definition. The unified rules will be closer to those for map units.
2. Modify definitions where needed.
3. Write the definitions more didactically.
4. Add a family level.

The editions of WRB are issued in an 8 year cycle: 1998, 2006, 2014. Whether there will be a 4th edition 2022 will depend on the quality of the outcome of the USC Working Group.

Universal Soil Classification system and problems of classification of cold soils

Sergey Goryachkin, *Institute of Geography, Moscow, Russia*
Megan Balks, *University of Waikato, Hamilton, New Zealand*
James Bockheim, *Wisconsin State University, Madison, Wisconsin, USA*
Chien-Lu Ping, *University of Alaska-Fairbanks, Fairbanks, Alaska, USA*
Cezary Kabala, *University of Life and Environmental Sciences, Wroclaw, Poland*
Dmitri Konyushkov, *Dokuchaev Soil Science Institute, Moscow, Russia*

Permafrost-affected soils are recognized as very important ones in several classification systems of the world. In the Canadian system and in the US Soil Taxonomy soils of the world are divided into those with permafrost and other soils. In WRB system permafrost-affected soils are also very high. In Chinese and Russian classification systems the permafrost are recognized only on the 3rd-4th taxonomical levels. However since that time when all these classification systems came into being community of soil scientists got new challenges for the classification of cold soils in a wider sense than just permafrost-affected ones. It is very important for the Universal Classification System. 1. The problem of shallow soils of cold climates, whether we can accept them as Gelisols, as they theoretically have permafrost within 1 or 2 m of solid rock, or they should be classified as Gelorthents as nobody can see permafrost in the profile because of shallow lithic contact. 2. The contrary problem on the classification of soils in loose materials which have permafrost below 2 m, but this permafrost results in cryoturbation and salinity of soil horizons because of impermeability of the deep permafrost. 3. The problem of soils with well-pronounced cryoturbation but without permafrost. 4. The problem of soils of highly continental climates – they may be very productive but with low MAST. 5. The problem of Antarctic soils – they may have same names as tundra soils but they are microsoils.

Development of Various Soil Classification Systems: Contribution to Universal Soil Classification from Indonesian experiences

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Universal soil classification faces great and serious challenges in grouping and naming the soils (considering diagnostic horizons, properties and nomenclatures) to accommodate various national soil classification systems in order to allow correlation and harmonization of communication, usage and management of soils worldwide. In Indonesia, the study of soils was initiated since 1905, followed by several proposals of soil classification. Briefly, Mohr in 1916 proposed soil classification based on parent materials and weathering, then followed by Szemian in1927 by taking into account four soil forming factors: climate, weathering stage, parent materials, and mineralogical composition. In 1930, J.T. White proposed a more basic classification based on soil characteristics. In 1936, Te Riele confirmed the introduction of classification based on soil properties. Dudal and Soepraptohardjo in 1957 proposed soil classification system based on morphogenetic properties. This system was used until 1981. In 1981-1983, research staff of Soil Research Institute (Pusat Penelitian Tanah, PPT) established the soil classification by modifying soil classification introduced by Dudal and Soepraptohardjo (e.g., Organosol, Grumusol, Kambisols, Latosol, Podsolik, Okisol, Mediteran, Planosol). The modified classification was based on morphogenetic and adoptions of some soil properties from FAO-UNESCO (1970, 1974) and USDA soil taxonomy (1975). The adopted soil properties were simplified and adjusted according to tropical conditions. The national classification system (PPT, 1983) was used nationally and accompanied by FAO (1974) and USDA soil taxonomy (1975) until 1992. In 1992, the technical meeting for standardization of soil classification and survey methods was made in Bakosurtanal, Bogor (29-31 August 1992) and by consensus, it was officially decided to use USDA soil taxonomy for national soil classification and mapping activities.

Indonesian experiences of 95 years (from 1916 to 2011) showed soil classification needs continuing modification to accommodate changes in soil usage due to human civilization (e.g., intensive soil use, urbanization and mining residue), various technology achievements (e.g., instruments for measurements and analyses, soil fertilizers and amendments) and knowledge accumulation in pedology. Various classification approaches have been performed to build up the national classification system. Evaluation of various approaches showed that classification based on morphogenetic, given simple name in common languages and significantly convey soil properties are rapidly acceptable. For examples, soil names for Indonesian national classification system are Gleisol Molik, Andosol Melanik, Podsolik Plintik, Mediteran Kalsik, Oksisol Plintik. Currently, we are at the advanced knowledge of soil formation, processes and properties to figure out the behavior of soils in response to their use and management. Hence, the universal soil classification system should be based on morphogenetic and given simple and common names to make it easy to disseminate, understand and remember. Morphogenetic is the soil features (measurable and observable) characterized by diagnostic horizons and associated properties. Measured and observed properties should take mainly into account the use of soil for agriculture (supporting food security), conservation and environmental protection. Therefore, standard properties of soil diagnostic horizons should be defined clearly and that standard soil description is easy to follow.

A Proposal for a Universal Framework of Enhanced A-Horizon Lowercase Suffixes for Addressing Dynamic Soil Change in Topsoils

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The A horizon is one of the most important soil layers in the topsoil subject to both environmental stressors such as climate change and anthropogenic impacts from urbanization and industrial applications which leads to dynamic changes in soil properties and genetic development. Currently many soil descriptive systems of taxonomic protocols for A horizon description rely either on process designators (i.e. Ap, Ah, Ae) or a numbering system of A horizons with predefined criteria for field description (i.e. A1, A2, A3). At detailed scale of application of field description for tracking change and impact of management practices within experimental field plots, fields and landscapes to watershed studies, a more detailed level of scale will be essential to address and monitor dynamic change in soil properties. For example with current systems using process designators, all agricultural fields would be identified only as Ap horizons no matter what major changes occurred in morphology or soil properties as a result of implementation of beneficial management or remediation practices. There would be no way to differentiate in the horizon designation soil change. We have developed a Framework of enhanced A horizon designators to enable tracking and monitoring of specific subtle soil changes. Criteria on soil properties subject to dynamic change were designed into the Framework. Intensive workshops and field evaluations were carried out in Canada and Germany to determine the soil properties and assess their relevance to distinguishing A horizon properties. A four-level framework was defined for lower case suffix designators for soil processes (i.e. genetic, physical, chemical and biological), soil structure, organic carbon, pH, and in addition a system of coding to include specific optional detailed soil attributes. By applying the new four-level designators, for example, an enhanced Ah horizon designator is “Ah[gr](h){n}” where *h* – humus accumulation; [*gr*] – granular structure; (*h*) – high organic carbon, and {*n*}– neutral pH. The Framework of enhanced horizon designators now provides a means for undertaking detailed field assessment and using the codes for analyses of change. The horizon designator becomes a “soil fingerprint” for assessing soil change and tracking and mapping of variation across fields and landscapes in the topsoil. The Framework makes full use of soil data and field soil descriptions to provide an enhanced A-horizon designation built on definitions brought together from different international soil field description systems. It has much universal potential for use in field monitoring of change in topsoils and providing detailed differentiation of A horizons. The new enhanced A horizon Framework of lowercase suffixes and its potential for topsoil characterization and soil monitoring will be discussed.

Gypsiferous Soils and the Universal Soil Taxonomic System.

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Lynn Loomis, *USDA-NRCS, Marfa, Texas, USA*

There are two components to all taxonomic systems. The first deals with the philosophy of the system and the second deals with the everyday functionality of the system, sometimes referred to as the nuts and bolts of the system. One of the distinguishing characteristics of Soil Taxonomy is the philosophy upon which it is based. All of the eight attributes to soil taxonomy are important to the soil classification system. I believe that there are a few that that should define an international soil taxonomic system. The first of those from Soil Taxonomy is that the definition of each taxon should carry nearly as possible the same meaning to each user. The major use of Soil Taxonomy is communication, especially communication among soils scientists. The use of Soil Taxonomy has proven to be the international language of, not only soil classification, but the language for all soil science. Soil Taxonomy provides for all soils that are known and can be amended to accommodate all new soils. Any universal system must be able to do likewise.

Secondly, an international system must be structured in a manner that field soil scientists, especially soil mappers and classifiers, can systematically classify the soils. Gypseous soils must be recognized at a higher level than the family. For example, the Pokorny soil described and mapped in Texas is classified as Fine-gypseous, hypergypsic, thermic, shallow, Ustic Petrogypsids. The one distinguishing characteristic is that it is hypergypsic and the soil contains more than 90 percent gypsum throughout the 1.8 meter thick hypergypsic horizon. There are more than 500K ha of these soils in the United States and on a similar surface in Mexico. These soils are much like the Andisols in that they have characteristics that are totally different from other mineral soils. Terms used in lieu of particle size cases applied to gypseous materials should be developed that are connotative of their characteristic rather than using gypseous or gypsic. Based upon existing documents, terms will be proposed that are derived from easy field observations.

MEETING SESSION 3

Proposals of Soil Classification from Venezuela

Juan A. Comerma, *Retired Soil Scientist from National Centre of Agriculture Research (CENIAP) of Venezuela. Maracay, Venezuela. Email: fliacomermas@cantv.net*

From past experiences, when applying Soil Classification in Venezuela, mainly Soil Taxonomy at various past periods and recently the World Reference Base (WRB), we present cases that are considered pertinent for new criteria that may be useful to a Universal Soil Classification. The first case deals with the mollic epipedon: here the main doubt was the poor relationship observed between the required levels of Organic Matter (>1%) and the color requirements. After an analysis of over 100 profiles in young alluvial soils that qualified for a mollic for all items, except half of them for color, it was found that increasing the requirement to 4 % or more, the relationship was drastically improved. The second case refers to the cambic horizon when applied to the case of poorly drain morphology. This case, that was eliminated in the definition of cambic of the WRB, is considered very significant for our extensive alluvial plains, as it represents a very good relationship between a given landscape position and soil characteristics or a classification class. Consequently we would encourage maintaining it. The third case refers to the soils in which the endopedon is dominated by low activity clays. In soil taxonomy this refers to the oxic horizon (< than 16 CEC), but also to the kandic (< than 24 CEC). We support the criteria that mineralogical features should prevail over morphological, as is the clay increase with depth. Consequently we prefer the concept of the ferralic of the WRB which includes soils with low CEC indifferently if there is a clay increase or not with depth, as in Ferralsols or a modified Oxisol and, at a lower categorical level separate them. The fourth case is with Vertisols, in which the classical case is clay rich soils with high bases that swell and shrink significantly. But there are important areas with soils that meet these criteria but that are acid. They occur, at least in our country, in two situations, derived from clay rich acid parent materials, and those from back swamp alluvial deposits where flooding occurs for several months of the year. In the last case extreme leaching occurs, moving bases as well as clay to the subsoil, resulting in acid upper soils and sometimes neutral subsoils, but retaining typical morphological features of Vertisols. This situation is recognized in Soil Taxonomy, but not in the WRB. The fifth case is with the temperature regimens in tropical areas. Here we tested the relationship between the limits established in Soil Taxonomy and elevation, which is the factor in tropical areas for changes in temperature. The results showed elevations which were not related to ecological or agro ecological changes, so we proposed new limits of soil temperatures (10, 14, 18, and 22) adapted to typical crops of the tropics and /or ecological regions, and a new regime at 28 degrees called megathermic adapted to lowland tropical crops.

Converting the soil map of Belgium into the World Reference Base for Soil Resources: strength and constraints of WRB for international soil correlation and as a map legend

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Antoine Bouhon, Xavier Legrain, Karen Vancampenhout, Geert Baert, Carole Ampe, Nathalie Cools, Roger Langohr, Eric Van Ranst, Jean Chapelle, Jozef Deckers, *Katholieke Universiteit Leuven*

There is a general interest within the European Union to prepare joint soil maps at a 1:250,000 scale in order to harmonise agricultural and environmental policies. Towards this aim, the World Reference Base for Soil Resources (WRB) has been adopted as the common soil classification system. As soil surveys in most member states were conducted independently, the challenge is now to convert the national legends into a common WRB legend. In Belgium, soils were mapped between 1947 and 1991 and published at a 1:20000 scale. These maps have proven useful in e.g. land consolidation projects and for assessing soils' vulnerability to erosion and pollution. The legend of the soil map of Belgium is based on field properties such as texture, drainage status and profile development. The WRB classification is based on diagnostic features defined by morphological, physical and chemical properties. A key and a software programme, have been developed to convert the Belgian units into WRB units. However, as many Belgian soil units could not unequivocally be translated into WRB units, additional guidelines had to be derived based on soil profile data which were classified according to WRB. The data show that principles of the legend shifted over time or were interpreted differently to take regional specificities into account. To overcome resulting ambiguities a national database of reference soil profiles is being established. By using WRB Reference Soil Groups with one or two main qualifiers, the principal soil information of the original 1:20000 scale soil map of Belgium can be represented. Inevitably the conversion to WRB leads to some loss of information as details on soil texture, drainage and substratum get generalised into broader categories in WRB. This generalisation however can be neatly presented on 1:50000 scale maps. Being less complex than the original maps, these maps have the advantage to provide a wider insight into the regional soil geography. These maps have also proven to provide a good base for deriving maps at a 1:250000 scale. Whereas, overall WRB is satisfactory for classifying soils at national level, the experience also shows that some WRB concepts may benefit from revisions to facilitate its correlation with national soil survey data.

Origin and classification of extremely skeletal Podzols in WRB and Soil Taxonomy

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The slopes in the Sudetes Mountains (Central Europe) were a subject of the strong cryogenic processes (frost weathering, stone sorting, mass movement etc.) under a periglacial climate of the late Pleistocene, which led to an extensive formation of the rocky or loamy-skeletal surface covers. Then, the covers were partially denuded (by the scouring or subsurface "suffosion"), or secondary displaced ("debris flow") during the Holocene period. Currently, the surface covers on the mountain slopes at an altitude of 1100-1400 m asl are dominated by angular rock fragments (gravel- to boulder-size), have a thickness of 30-100 cm (or more), and gradually or rapidly change into a loamy-skeletal material (originated mostly from the periglacial solifluction). Loose skeletal covers contain less than 2-5% (by volume) of mineral fine-earths, that are light colored, low in iron, aluminum and organic matter, and meet the criteria for the loamy sand or sandy loam texture classes. The extremely skeletal layers meet the requirements of an *albic* horizon (according to WRB 2006/2007). The lower, loamy-skeletal layers are compact or very compact (fine earths and fine gravel fill all the interstices between rock fragments), but the total content of the fine earths (coarse sandy loam) does not exceed the 20-30% of soil volume. In the most cases, the well developed illuvial layers that meet - in fine earths - the criteria of *spodic* horizon (both morphological and chemical), occur at the contact of the loose skeletal and the compact, loamy-skeletal materials. The upper limit of a *spodic* horizon is at a variable depth of 30 to 90 cm. These soils are usually classified as Hyperskeletic (Folic) Albic Podzols (WRB 2006/2007), although it is unclear whether the requirements for the Leptosols group exclude the occurrence of a *spodic* horizon to a "control depth" for this group only (25 or 75 cm) or deeper (up to 200 cm). Soil Taxonomy (Keys, 11th

Edition) classifies the discussed soils mostly as Spodosols. However, when the upper limit of the *spodic* horizon is deeper than 50 cm below the soil surface, and the particle-size class of the soil over the spodic horizon is "fragmental" (not a sandy or sandy-skeletal), then the soils are likely to be classified as Entisols (when the soil temperature regime is frigid). Loose skeletal covers, very poor in the fine earths and extremely well-drained, create a specific environment and are slowly colonised by vegetation. Thus, such "loose" skeletal materials should be distinguished in the classification from the other "compact" extremely skeletal materials (sandy-skeletal or loamy-skeletal). It is postulated, therefore, to introduce a new qualifier "Rubblic" or "Skeletalic" (from: "skeletal" and "talus"), to define extremely skeletal materials, where the interstices between rock fragments are not filled or only in part filled with fine materials (other criteria the same as for Hyperskeletic qualifier). The proposed qualifier is applicable mainly to the Leptosols on the slope materials exposed on frost weathering and mass movement under a periglacial climate and on taluses below the rocky cliffs at different latitudes, as well as to the Podzols, that have developed on the stable ("fossilized") stratified cover-beds.

Automated WRB classification – software tool and initial experience with its application

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Peter Schad, *TUM Weihenstephan, Germany*
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Soils are described and classified using national guidelines and taxonomies in many countries of the world. For international exchange, the use of an international soil classification system is necessary. The World Reference Base for Soil Resources (WRB) has been adopted by the International Union of Soil Science and by the European Union as a reference system to enable communication on soils. Direct translations from the German soil classification system to WRB failed for about half of the German categories. Due to the high number of already described soil profiles in various German soil information systems, a software application was designed to automate the procedure of assigning profiles to the WRB reference soil groups (RSG) and adding the appropriate qualifiers.

We reformulated the diagnostic criteria of WRB 2006 (update 2007) in a way that they relate directly to data fields of the German Soil Mapping Guideline. For each diagnostic horizon, material, or property, qualifier and RSG, a graphical algorithm shows criteria for data fields. We included proxies for parameters that are assumed to miss in many datasets.

The algorithms have been coded as a MS Access based application. Initial experience with German and Swiss soil data regarding performance and quality of results is evaluated.

Issues pertaining to the classification of Australian soils

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Australia's unique geomorphic history has seen the evolution of unique soil landscapes. The two currently used international systems of soil classification – World Reference Base and Soil Taxonomy – are not commonly used in Australia. They are perceived to be 'unnecessarily complex' and lacking in relevance – mainly because of difficulties in correlation with the Australian Soil Classification (ASC). This paper addresses the particular features of Australian soils that make them challenging for international classification systems and offers suggestions on how the diagnostics employed in such systems might be enhanced to more efficiently address soil form and function as well as diversity in soil landscapes.

Discussion will include the following issues:

- Texture-contrast soils. A key conceptual understanding that underpins the Australian definition of strong texture-contrast is the functioning of the soil individual in terms of permeability and drainage. The argic/argillic horizon concept does not adequately facilitate this.
- Pedogenesis: There is often considerable uncertainty in recognising and attributing the genetic significance of a particular soil property. The identification of an 'illuvial' B horizon is not a diagnostic criterion in the ASC.
- Sodic soils. It is generally accepted in Australia that a lower limit of exchangeable sodium percentage at 15 for a natric horizon is too high.
- Wet (aquic) soils. Reducing conditions may not always be present during periods of saturation and may be difficult to identify.
- Base saturation and cation exchange capacity (CEC). Many low CEC soils in Australia are fully base saturated, but cannot be considered rich in bases.
- Analytical data requirements.

Evolution of the Brazilian Soil Classification System - SiBCS

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Development of the Brazilian Soil Classification System (SiBCS) resulted from the need of soil surveys, at a scale compatible with Brazil's large territory, variation of tropical, dry and subtropical environments, soil forming processes in old and new landscapes, and vast areas of soils unmapped. The classification systems, such as the Soil Taxonomy (United States) and the FAO soil map legend (Rome), were not adequate to represent the highly weathered tropical soils in the old landscapes of cerrado region, or the soils formed on newest hydromorphic conditions such as in the Amazon Basin and Pantanal region. The first soil surveys in Brazil were in Rio de Janeiro (1958) and São Paulo (1960) States. For these surveys, the soil classes defined in Baldwin, Kellog & Thorp (Yearbook of Agriculture for 1938), and Thorp & Smith (Soil Science, 67, 1949) publications were used as a reference base. But they showed many limitations as the work in other states progressed. In 1964, the first attempt of a national soil classification was presented by pedologists Marcelo Camargo (Embrapa Soils) and Jacob Bennema (FAO adviser), but information on Brazilian soils was still limited. In 1975, the Soil Taxonomy was first published, and a field workshop was held in Brazil, but the system was not accepted by scientists, one main limitation was the usage of climate as a suborder main attribute, and also the lack of hydromorphic soils as an order. In 1978, the first national soil field correlation was held with the goal of developing the Brazilian system. It was followed by many other meetings. In 1980, a work group was created with EMBRAPA pedologists, subsequently including participants of different Brazilian institutions and universities, generating four approximations of the system. In 1999, the first edition of the SiBCS was released, and in 2006 a second one was published, which incorporated changes resulting from the field validation. The SiBCS is a hierarchic system, based on morphogenetic soil attributes, with 6 categorical levels, order, suborder, great group, subgroup, family, and series. It has 13 soil orders, and it is structured as a key down to the subgroup level. The family and series levels are still in development. So far, 43, 192, and 812 soil classes, respectively for the levels from suborder to subgroup, were identified in Brazilian territory using the SiBCS. Many soil attributes used in the system are based on concepts adopted by the Soil Taxonomy (United States) and the World Reference Bases (WRB - FAO), with differences on some quantitative limits, such as the clay ratio of B/A horizons for argillic (textural) and oxic (latossólico) horizons, limits of organic matter for Histosols and organic soil materials, methods for estimating clay activity and measuring cation exchange capacity, subdivision of classes based on iron content in the soils, to mention a few.

Evaluating the US Soil Taxonomy Soil Moisture Regimes: Applications across scales and continents

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Soil moisture is a dynamic soil property that greatly impacts soil function which is incorporated at the suborder level in US Soil Taxonomy. Historically, the soil moisture regimes were determined at the pedon scale Newhall soil moisture model. Combined with soil data and measurement, the soil moisture regimes lines were determined for the US in 1994 by interpolation through expert knowledge. For this research, the Newhall model was applied spatially using PRISM weather data across the United States and Brazil. The results indicate a close approximation with the 1994 US soil map created through manual interpretations; however, areas were identified that could be misclassified at the suborder level. Additionally, the soil moisture map of Brazil indicated very little spatial variability across the country.

MEETING SESSION 4

Proposed changes to U.S. Soil Taxonomy regarding human-altered and human-transported soils

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ICOMANTH (International Committee for Anthropogenic Soils) was commissioned by USDA in 1988 to introduce differentiae and taxa for classification, identification and survey of observed human-altered and human-transported (HAHT) soils. The HAHT soils form through profound, intentional alteration or transportation of materials by humans, and do not include soils altered unintentionally or by production agriculture practices. Earlier circular letters introduced new terms, new horizon nomenclature, and new property descriptions into USDA databases that complimented existing technical standards. Major new changes include redefinitions of buried soils, epipedons, and new diagnostic materials. All HAHT soils will now be recognized at Subgroup, family and series levels using a standard set of subgroup modifiers. HAHT soils can now be allocated into any soil order except Mollisols, and soils with irregular decrease in carbon will no longer default to Cumulic or Fluventic Subgroups or Fluvent Suborders. A new family class is proposed to further separate HAHT soils when 50 cm or more human-altered and human-transported material is present. These changes are being made to facilitate mapping of highly-altered landscapes, allow meaningful interpretations for unique materials and soils, and ease establishment and correlation of new soil series. These proposals must be tested to see if they support a system for making and interpreting soil surveys.

Altered Soils Due to Urban Development & Construction of Vernal Pools Case Study in the Sacramento Valley, California

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In the Sacramento Valley, California, naturally occurring vernal pools are typically found on 30,000 to more than 500,000 year old terraces with restricting claypans and/or duripans (hardpans). The terraces have depressional seasonal wetlands, which are regulated by the Clean Water Act. Urban development often occurs on these landscapes, which results in destruction of wetlands that requires mitigation replacement. The conversion of natural landscapes into economically profitable leveled agricultural fields and urban development has resulted in loss of many habitat types, including vernal pool complexes. Since restoration to an exact pre-disturbance condition is usually not feasible for many leveled agricultural sites due to the drastic changes to the landscape and underlying hydrological processes, mitigation efforts in these areas typically focus on landscape-level restoration to achieve an optimal mix of uplands and wetlands . One method to mitigate for the loss of these wetlands is to construct new vernal pools that replicate natural functions. Identifying appropriate soil types and their respective landscapes, especially in soils leveled for agriculture, are critical to successfully constructing or restoring vernal pools. These soil factors are instrumental in the design process, development of vernal pool construction plans, and the implementation of such plans. This presentation details an example of landscape characteristics and soil properties of pre-construction soil pits used to guide the conceptual design of constructed vernal pools, as well as implementation. Final habitat design is based upon shallow subsurface soil investigations of water restricting horizons -- i.e., claypans and/or duripans (hardpans) -- and analysis of existing vernal pools shapes and sizes. An example of one case study illustrates the construction of 327 vernal pools on about 80 hectares of irrigated pasture in southeastern Sacramento County, CA. Models depicting natural and altered soils and landscapes at the mitigation site are provided to illustrate the relationships of the depth of restricting layers to constructed vernal pools. Establishment of the proper relationship between the vernal pool bottom and the restricting layer is a critical step in successfully restoring this at-risk wetland habitat. This presentation provides results from several landscape and geomorphic analyses that demonstrate how the restoration objectives were achieved and the resulting alteration of the landscape.

Anthroscapes and other anthropogenic features: How should human-modified features fit into geomorphic descriptions?

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Human caused alteration of the Earth's surface is becoming accepted as a significant and permanent part of Geomorphology. Human-modified or created surface features are increasingly pervasive across the Earth's surface, not only as individual features but also as extensive land-surface mosaics. The ability to identify, describe, and manage anthropogenic features and assemblages differs from, yet shares common challenges with, conventional geomorphology (natural landforms. These challenges include identifying range of composition, stratigraphic arrangement, and lateral extent. As with natural landforms, the ability to consistently partition the landscape into meaningful subsets facilitates recognition of anthropogenic soil geography and empowers land management decisions for those lands. As the variety, complexity, and sheer number of anthropogenic features increase it becomes imperative to develop a language to recognize, delimit, and ultimately to manage them. A framework is proposed for arranging anthropogenic features. Initial terms and definitions for Anthroscapes, Anthropogenic Landforms, and Anthropogenic Microfeatures are presented. Examples are drawn from geomorphic descriptions for urban soils in actual soil surveys and recent work by the International Committee on Anthropogenic Soils ICOMANTH).

The reclamation effects should be considered for saline soil criteria in soil classification system

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The criteria for classifying soil as saline taxon are different in different soil classification systems. In Chinese Soil Taxonomy (CST), soils that have a salic horizon starting within 30 cm from the soil surface are named as Orthic Halosols. In the World Reference Base for the Soil Resources (WRB)soils that have a salic horizon starting within 50 cm from the soil surface are named as Solonchaks. In the US Soil Taxonomy (ST), soils that have a salic horizon starting within 100 cm from the soil surface are named as Salids. In China, a large area of saline soils was reclaimed for crop production. This paper describes some soil profiles that were classified into saline taxon in CST, WRB and ST before they are reclaimed, to see if these soils, after a long history of irrigation, are still classified into saline taxon in the three soil classification systems. The results showed that the salts were leached into certain depth, the salic horizons were observed at different depth from the surface, many profiles could not be classified as Orthic Halosols as identified earlier, some of them could not be classified as Solonchaks, few of them even could not be classified as Salids. With a long irrigation

history, the depth of salic horizon is related to the amount of irrigation water and irrigation models. When more water was used for irrigation each time, the salts were found at deeper layers. Relatively the surface irrigation leached the salts deeper than the drip irrigation. According to the present study, we suggest that the criteria of ST should be taken for keeping reclaimed saline soils in the saline taxon, i.e. soil classification should not be changed by irrigation. We also suggest that more soil survey should be taken for discovering how much water should be used in normal irrigation models and how deep the salts were leached under such normal irrigation models. Through analyzing large amount of data, especially those data coming from reclaimed saline soils, the depth and index for salic horizon should be re-defined for keeping the reclaimed saline soils in the saline taxon of soil classification systems. In this paper, we examined the criteria of saline soil classification and made some suggestions to saline soil classification by citing other scholar's research results published in the scientific literature.

Fen Histosols: Subaqueous or terrestrial?

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Fens occur at slope discharge sites along late Wisconsin moraines in eastern South Dakota. These fens form under a landscape-controlled hydrology with a constant upward, carbonate-laden water discharge. This hydrology produces Histosols of unique pedological and ecological character. The Histosols often have two intermittent surface "crusts". The upper crust is a carbonate precipitate that mimics and engulfs organic debris. Beneath the carbonate is a Fe/Mn-rich zone. The Histosols are fibric at the surface, but become sapric and/or hemic with depth. In the Eleventh Keys to Soil Taxonomy, which added criteria for "subaqueous" soils, fen Histosols classify as Wassists. The Wassists' criterion states "Histosols that have a positive water potential at the soil surface for more than 21 hours of each day in all years." In the Histosol Key to Suborders, Foilists key out first followed by Wassists, and then other Suborders. Fen Histosols occur adjacent to terrestrial mineral soils, and are never submerged. The classification intent for "subaqueous soils" was to create a Suborder for submerged, tidal soils. The criterion, however, also encompasses soils at permanent discharge sites. The World Reference Base uses subaquatic as a second level formative element with a criterion of "being permanently submerged under water not deeper than 200 cm." A similar criterion in Soil Taxonomy would class Fen Histosols as Fibrists, Saprists, or Hemists, which matches their terrestrial nature.

Marginal soils: if they require a special classification?

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The definition of soil and thus the scope of soil classification was always a topic of an endless discussion among pedologists. Initially scientific classifications covered only soils formed in loose sediments and used in agriculture or in forestry. However, later demand for environmental soil assessment has led to a certain amplification of the soil concept. Actually many classifications include in soil classifications such objects as man-transported materials, urban soils (including those covered with asphalt), soils under shallow water, bare rock etc. We analyzed 32 national and international classifications, and found that 14 classifications recognize urban soils as specific taxa, 16 recognize man-transported materials as soils, 4 recognize bare rock, and 6 – subaquatic soils. In the World Reference Base practically all the marginal soil bodies are recognized as specific soil taxa, the USDA Soil Taxonomy gradually aggregates them in the classification structure. The scope of soil classification strongly depends on the concept of soil. There are two main conceptual models, the genetic and the conceptual one; both models permit including a very broad range of objects in soil classifications. The genetic model considers all the zone of the contact of lithosphere with atmosphere as a soil cover (the concept allows including even extraterrestrial soils in the classification). The other concept considers all the objects, which perform the functions of soils, as "ecosoils", thus extending the definition to pots and hydroponic solutions. We believe that an excessive amplification of soil classification is a mistake, because the criteria for classifying many soil-like bodies are too different from those we use for soils (it is like including robots in biological classifications). We suggest using separate taxonomic systems for "mainstream" soils and marginal soil/like bodies.

Pedogenesis and Classification Of Alluvial Soils With Surficial Deposition Of Anthropogenic Mine Sediments; Coeur d'Alene River, Idaho

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Alluvial soils along rivers that transect surface mining areas are subject to deposition of mine waste. Along the Coeur d'Alene River in northern Idaho, mine sediments produced from Ag, Pb, and Zn mining from the past 100 years have been identified. This study, conducted along 37 km of the river, examined properties of soils composed of metal-enriched sediments overlying native alluvium. The objectives were to (a) characterize soil property differences of these two parent materials and (b) evaluate the impact of these anthropogenic sediments on soil classification in Soil Taxonomy (ST) and World Reference Base (WRB). The ten pedons sampled had metal-enriched sediments that varied in depth from 20 to 104 cm. Pedons classified by ST as Aquepts, Fluvents, Orthent, or Dystrudepts and as Fluvisols or Gleysols according to WRB. Only four pedons meet the criteria for surface mantle in ST, and none meet the ST criteria for buried soils. The mean pH was 5.7 and 5.5 for horizons from mine sediments and native alluvium, respectively. Similarity in particle size resulted in similar water retention, bulk density, and cation exchange capacity between the two materials. Geochemistry of mine sediments was distinctly different from underlying native alluvial materials. Surficial sediments were characterized by high Fe, Mn, Ag, Pb, Zn, Cu, Cd, and Hg, vertically redistributed from redox conditions in these seasonally wet soils.

Attributes to classify strongly weathered soils in the Brazilian and Australian Soil Classification Systems

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National soil classification systems have developed to cater for a specific range of soil types, particularly in relation to their use and management. Commonly, there are deficiencies in the application of ‘international’ systems (e.g. Soil Taxonomy and World Reference Base) to the narrower range of soils encountered within a particular geographical region. The classification of strongly weathered soils is particularly important for countries with significant tropical and subtropical areas such as Brazil and Australia. The Brazilian Soil Classification System (SiBCS) developed to better classify the strongly weathered tropical soils in old landscapes such as the Cerrado. The attributes used in Soil Taxonomy (ST) to differentiate Oxisols and Ultisols, although tested with soils outside United States, are not able to account for the variations of pedogenesis influenced by long time periods and different climatic regimes. At the suborder level, the ST emphasizes the soil moisture regime, an attribute that is less important for the tropical soils. The SiBCS is a hierarchic system, based on morphogenetic soil attributes, with 6 categorical levels, order, suborder, great group, subgroup, family, and series, structured as a key down to 4th level. It has 13 orders, and strongly weathered soils are mainly included in the Latosols, Nitosols, and Argisols, which are somewhat correlated to Ferrasols, Nitisols, and Lixisols, Alisols or Acrisols (WRB). For the suborder, attributes such as color, related to parent material and type and amount of iron oxide, are frequently used; and at great group, iron content, aluminum content and saturation, cation exchange capacity and base saturation. For subgroup, texture or type of surface horizon, plinthite, and intergrades characteristics are used. These attributes have proved to be good indicators of soil limitations and agricultural potential. For example, a soil classified as *LATOSSOLO VERMELHO-AMARELO Acriférrico típico* will be strongly limiting for crops, since it has: iron oxides and kaolinite in clay fraction, very low cation exchange capacity, high iron content (180 - 360 g Fe_2O_3 per kg of soil), high phosphate fixation, and anion exchange capacity. In the Australian Soil Classification System (ASC) strongly weathered, highly leached soils are generally classified as Kurosols, Kandosols or Ferrosols. None of these soil orders correlate neatly with a particular soil order of Soil Taxonomy or a reference soil group of the WRB. Kurosols are strongly acid soils with a clear to abrupt textural change between the A and B horizons. Kandosols lack a strong textural change although they have a clay content in the B2 horizon of more than 15%. Ferrosols also lack a strong texture contrast but are defined in terms of their significant free iron oxide content and are found almost exclusively on basalt landscapes. Color alone defines the suborders for each of these groups. Great groups are defined in terms of base status and the presence of segregations or indurated layers and/or hardpans.

MEETING SESSION 5

Texture-contrast and sodicity: a soil taxonomic elephant and wombat in the Australian room

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The age and stability of land surfaces on the Australian continent has lead to the widespread formation of pedologically well-developed soil profiles, often with strongly texturally-differentiated A and B horizons. In arid and semi-arid climatic zones, the stability of the landscape and climate has allowed extensive accumulation of exchangeable sodium in soil profiles. To discriminate these well-developed texture-contrast soils, and sodic soils showing dispersive behaviour and sodic morphologies, the Australian Soil Classification (ASC) scheme uses a *Clear or abrupt textural B horizon* concept, and a *Sodic B horizon* concept, respectively. These concepts are more-or-less equivalent to the argic/argillic horizon concept of the World Reference Base for Soil Resources (WRB) and Soil Taxonomy (ST), and the natric horizon concept of the WRB and ST, although in the case of the clear or abrupt textural B horizon there are no requirements to demonstrate the presence of illuvial features. However, the seemingly straightforward correlation of these concepts between the ASC and the WRB and ST is muddied by the quite contrasting cut-off values for the main diagnostic criteria; in the ASC, a clay content increase of at least 20% across the A/B boundary is required to qualify a soil as texture contrast (cf. 3-8% in WRB, ST), while an ESP of only 6 is required to qualify a subsoil as being sodic (cf. 15 in WRB, ST). Were the WRB and ST cut-offs to be used routinely in Australia, much taxonomic utility would be lost; 'texture-contrast soils' would become very widespread and incorporate a great range of soil types currently allocated across various ASC orders, and the extent of identified sodic soils would shrink. Although it is clear that the cut-offs were developed to reflect local conditions and observed effects of clay content increase and exchangeable sodium concentration on other management-related soil properties, from an Australian viewpoint the texture contrast and sodicity concepts remain the elephant and wombat in the room as we move towards a universal soil classification scheme.

Some soils of the derived savanna of southwest Nigeria: Clay mineralogy and comparative adaptive soil classification for soil mapping

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The Derived Savanna (Savanna-Forest Ecotone) is important for two major reasons:as a breadbasket of the nation, and the most degraded landscape representative of the agroecological zone of the humid/subhumid West Africa. As an offshoot of an inventory exercise for sustainability studies, the objectives were to characterise the soils in terms of its clay mineralogy and do comparative classification using the aUSDA-Soil Taxonomy, bFAO-Unesco Mapping Legend, and the cWRB systems with the local system of classification (series level) as the dependent variable. The area of study was close to Ilero (08.05N/03.22E) with a bimodal annual rainfall of 1105mm. The parent rock lithology is commonly granitic gneiss, igneous and ultrabasic. The soil pattern is adapted to the toposequence and/or lithosequence concepts and soil-landscape typically consists of soils on the crest, shoulder and/or upper slope, middle slope, lower slope, fringe and/or valley bottom positions. The crest/upper slope positions contain soils with gravels/stones/cobbles(quartz rubbles) at various depths including concretions, nodules, iron pans and stone lines. Middle to lower slope positions contain poorly to imperfectly drained soils and soils with iron pan at shallow depths. Valley bottoms are mostly U-shaped and eroding. Soil texture of pedons vary from a predominant

loamy topsoil to sandy, sandy clay/clay subsoils. The surface horizons are slightly acid (pH6.1-pH6.5) to neutral (pH6.6-pH7.8) while the subsoils are slightly acid (pH6.1-pH6.5) to strongly acid (pH5.1-pH5.5) with increasing depth. Exchangeable Al has a dominating influence on soil acidity. The base saturation is moderate to low. Ten soil series with equivalent classifications in USDA/FAO-Unesco/WRB sytems repectively were identified: SHABE [Typic Kandiustults/ Haplic Acrisols/ Haplic Acrisols (Rhodic)], AMODU[Rhodic Kandiustults/Rhodic Nitisols or Haplic Acrisols/ Nitic Acrisols (Rhodic)],IWO[Kandic Paleustalfs/Rudi-Haplic Alisols/ Cutanic Alisols (Chromic –skeletic)],OGBORO [Ustoxic Dystropepts/Dystric Cambisols/ Ferralic Cambisols (skeletic)], IWAJI [Oxic Dystropepts or Lithic Dystropepts/ Dystric Cambisols Petroferric phase/Petroplinthic Cambisols (skeletic)], TEDE [Lithic Dystropepts/ Rudi-Chromic Cambisols/ Haplic Cambisols (colluvic)], SHANTE/APOMU [Ustic Quartzipsamments-Aquic Quartzipsamments/ Haplic Arenosols- Gleyic-Arenosols/ Haplic Arenosols (Dystric)], DEJO [Plinthaquepts/ Plinthic-Gleyic Cambisols/ Endogleyic Cambisols (colluvic)], GAMBARI [Lithic Ruptic-Ultic Dystroochrepts/ Ferralic Cambisols, Petrofferic phase/ Petroplinthic Arenosols (Eutro)], ADIO [Aquic Udifluvents / Gleyi-Dystric Fluvisols/ Gleyic Fluvisols (colluvic)]. The dominant clay mineralogy of (the subsoils) are kaolinite and illite (mica). Traces of montmorillonite and/or mixed layer/vermiculite occur in most pedons except in Amodu series. WRB seems to give the best information of the pedon morphology without recourse to the full profile description . It clearly indicates eroded phase (colluvic) and gravelly phase (skeletic) land qualities important in soil management.

MEETING SESSION 6

Phenetic versus phylogenetic: Deriving meaning from soil classification

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For centuries, perhaps millennia, humans have placed objects into groups and given those groups classification names. Today there are classifications for animals, plants, microorganisms, rocks, climates, landforms, organic chemicals, languages, and medical diseases, to name but a few. These classification schemes, in turn, can be placed into two groups: (1) *phenetic classifications*, in which objects are grouped according to observable similarities, or (2) *phylogenetic classifications*, in which objects are grouped based on evolutionary development. The USDA Soil Taxonomy system has elements of both. The Aridisol order, for example, is phenetic, grouping together dryland soils in which pedogenic horizons have formed. The Inceptisol order, on the other hand, is phylogenetic, grouping together soils that have developed from Entisols and are developing into Alfisols or other soil orders.

The important task for either a phenetic or phylogenetic scheme is to maximize *meaning*; that is, to convey significant ideas about a group of objects. Prerequisite to maximizing meaning, however, is the need to identify the audience for which the meaning is intended. Assuming these assumptions are valid, several questions arise. First, who is the audience for the Universal Soil Classification? Is it international soil taxonomists, all soil scientists (e.g., soil physicists, chemists, microbiologists, etc.), scientist in general dealing with land (e.g., agronomists, ecologists, foresters, geologists, archaeologists, etc.), or a more general audience (e.g., farmers, developers, policy makers, etc.)? Taking Soil Taxonomy as an analogy, did it have a clearly identified audience at its development? Who is the audience now and does it convey meaning to that audience? Finally, can a meaningful soil classification system evolve without being embedded within an organization like the USDA which has supported over an century of work and thousands of career soil scientists? These are questions that may help us understand our endeavor to move “Towards a Universal Soil Classification System.”

A generalized algorithm for determining pair-wise dissimilarity between soil profiles.

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Development of a generalized, quantitative metric of dissimilarity between soil profiles is hindered by the complexity of soil data (a suite of site and horizon-level attributes), sampling style (depth-intervals vs. genetic horizons), and subtle differences in horizons designation (through time, regionally, and even among co-workers). Our objective was to develop a set of data structures (classes) and associated algorithms (methods) that would support data-driven, quantitative evaluation of between-profile dissimilarity regardless of differences in horizon designation, thickness, or sampling style. Specialized data structures and methods were implemented in the R language, as part of the 'aqp' package (open-source). Pair-wise dissimilarities (between soil profiles) are evaluated along regular depth-slices using Gower's distance metric, using any combination of continuous, categorical, or boolean attributes. Total pair-wise dissimilarity is computed by taking the sum of slice-wise dissimilarities, to a user-defined depth. Variation in profile depth is accounted for by assigning maximum slice-wise dissimilarity to comparisons between soil (i.e. Bt horizon) and

non-soil (i.e. R horizon). The resulting dissimilarity matrix can be used to assist with topics ranging from initial mapping ("similar/dissimilar" soils), comparisons below family-level Soil Taxonomy, soil series correlation, map unit harmonization, and correlation between different taxonomic systems.

Toward a Global Soil Series Warehouse

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The soil series is the lowest category of the U.S. national soil taxonomy system. The soil series facilitates public communication about soils. More than 20,000 soil series are currently recognized in the United States and other areas served by the USDA-NRCS. The soil series definition and format are described in Soil Taxonomy and the U.S. National Soil Survey Handbook, part 614.06. The standard text format includes these items: location line, status of soil series (tentative or established), initials of authors, name of soil series, introductory paragraph, taxonomic class, typical pedon, type location, range in characteristics, competing series, geographic setting, geographically associated soils, drainage and saturated hydraulic conductivity, use and vegetation, distribution and extent, MLRA office responsible, series proposed or established, remarks on diagnostic horizons and features recognized in the pedon, and additional data (if available). An electronic warehouse exists to store and distribute the soil series descriptions in text format. The evaluation and management of the series in a geographic area is the responsibility of MLRA office. The MLRA office responsibilities include proposing and naming a soil series, establish an official soil series description and revising existing series descriptions. Extending this warehouse to include global soil series will facilitate the sharing of soil attributes and properties among nations. In order to expand the warehouse, global standards are needed including defining roles and responsibilities for managing the creating and revision of official series descriptions.

UNSORTED ABSTRACTS

The genesis and classification of Andisols derived from andesitic an basaltic volcanic ash on several agroclimatic zones in West Java-Indonesia

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The characteristic of Andisols are affected by their formation factors that arrange and control the entire pedogenesis processes. The main soil formation factors of Andisols are climate and parent material. Besides, the age of eruption of volcanic materials also has an important role in controlling the degree of soil development. Based on these reasons, the research was conducted at tea plantation area in West Java, Indonesia. The objective of this research was to study the pedogenesis and classification of Andisols developed in different agroclimatic zones, the age of volcanic material eruption, and the characteristic of different parent materials. Soil samples were taken for physical, chemical, and mineralogical analysis from 18 pedons at Ciater, Sinumbra, and Sedep in Bandung District. The soil classification was based on The Soil Taxonomy, FAO-UNESCO, and CSR-National systems. The results showed that the agroclimatic zones and the age of parent materials (Pleistocene and Holocene) showed a clearly influence on the different processes of pedogenesis and the stage weathering of pedons, hence the Andisols had various clay mineralogical, chemical and physical properties. However, andesitic and basaltic parent materials did not show clearly differences on those properties. The Soil Taxonomy had a better ability to reflect a variation of Andisols properties compared to the FAO/UNESCO and CSR-National systems. The first system could classify those 18 pedons into 9 subgroups while the second and the third systems could classify only into two and three equivalent soil taxa, respectively.

An adequate hierarchycal system for soil classification users

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A pedological classification must foresee its application with an easy and simple interpretation of map legends by soil surveyors and planning users. It must improve mainly morphological attributes at higher levels of an hierarchycal system. I. First Level (Order?) - established by the soil development degree and their horizons covered: A) *Weakly developed soils* – A-R (Lithosols), A-C-R (Regosols), I-II-III… (Fluvisols or unconsolidated materials); other ones would be recognized by the dominant characters of the soils surfaces: Histosols, Organosols, Andisols *etc.* B) *Moderately developed soils* – A-(B)-C-R, with the followed (B) types: (B)i (Cambisols), (B)g (Gleisols), (B)ca (Calcisols), (B)v (Vertisols) etc. C) *Highly developed soils* – A-B-C or A-E-B-C profiles with a Bs (Spodosols), Bw (Ferralsols, Latosols, Oxisols), Bt (Argiluvisols, substituting the Ultisols and Alfisols – USA, or the Argisols and Luvisols – Brazil), Bni (Nitisols) and a Bq (quartzic) for the thick weathered soils inappropriately considered a weakly developed one (Arenosols, Entisols, Neosols…).The amount of clay fraction (15% or 150 g/kg1- is not a reasonable criterion for a soil development degree, as well the structure does. They must be substituted by the predominant *horizonation* character in the pedon - an *argiluvic organization* (profiles Bs, Bt, and Bni) or an *haploidic* one – a *latosolic organization* (profiles Bw and Bq). II. Second Level (SubOrder?) – The names of soils would be preceded by their colours and textural classes (Red clayey Nitisol, Red-Yellow sand/loamy Argiluvisol, Yellow sandy Ferralsol or Yellow Arenosol). III. Third Level - The *eutrophic* or *distrophic* characters in the A, I, (B) or B layers will be refered at the list of the taxonomic designations and provide their respective correlations with soils of different world regions, as in the RSGs of FAO

system. The non specialist on soil taxonomy will be capable to use a classification of such nature, including interpretations for agricultural finalities or environment practices. It would be also interesting provide explanations about special attention on the latosolic or argiluvic organization and their relationships with the water circulation into the profiles and toposequences. The more detailed inferior levels would attend mainly scientific studies like pedogenesis or the continuous and necessary actualization of the classification system.

Thick tropical Arenosols must be considered highly developed soils
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Extensive continental tropical areas are covered by thick weathered sandy soils (clay fraction = 80-150 g.kg-1), usually associated to old smooth geomorphic surfaces of senile uplands. Their designations in soil taxonomies usually point out to a weak evolution degree, as Entisols (Quartzpsamment – USA) or *Neossolos* (*Neossolos Quartzarênicos* – Brazil). In reality, they are highly developed *psammoferralitic soils,* as recognized in Africa by French, Belgian and Portuguese researchers. They are practically absents in weathering minerals and have low values of silt fraction and silt/clay ratio, usually submitted to intensive agricultural uses on smooth surfaces (especially sugar cane and pasture). The allegation for their small development degree is a massive or a very weak granular structure - an inadequate criterion for highly old weathered soils with subsurface horizons that goes to 4-5 meters, improperly described as a *C horizon.* They show correspondences to *latosolic* (*oxic*) profiles, but the clay granulometric fraction is below the exigence for a B horizon – an improper and arbitrary criterion wich would be reviewed They were also refered as Sandy Latosols, Psammoferralitic soils, *Regosols intergrades to Latosols* or Quartzic Sands - *Areias Quartzosas*, now substituted by *Neossolos Quartzarênicos* in Brazil. If the granulometric exigence remains, these soils would constitute an individual class at the high levels - the Arenosols, going out the weakly developed soils as the Lithosols and Fluvisols (Neossols). The more appropriate would create three classes of those soils: Clayey, Loamy and Sandy - Ferralsols, Latosols or Oxisols, by suppressing the granulometric limit.

Learnable hyperspectral measures
Abdulrahman Galal, Hesham Hasan, Ibrahim F. Imam

Hyperspectral measures are used to capture the similarity degree between two spectra. Spectral Angle Mapper (SAM) is an example of such measures. SAM similarity values range from 0 to 1. These values do not indicate whether the two spectra are similar or not. A static similarity threshold is imposed to determine similar and dissimilar spectra. Adjusting static thresholds requires extensive expert intervention. The proposed approach aims to develop learnable hyperspectral measures.
This is done through using hyperspectral measures values as similarity patterns and employing a classifier. The classifier acts as an adaptive similarity threshold. The derived similarity patterns are flexible. As they are able to capture the specific notion of similarity that is appropriate for each spectral region. Two similarity patterns are proposed. The first pattern is the cosine similarity vector for the second spectral derivative pair.
The second pattern is a composite vector of different similarity measures values. The proposed approach is applied on full hyperspectral space and subspaces. Experimental results of the proposed approach are statistically significant. This implies using simple learnable measures overcomes complex and manually tuned techniques used in classification tasks.

Proposed changes to U.S. Soil Taxonomy epipedon criteria

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ICOMANTH (International Committee for Anthropogenic Soils) is a committee commissioned by USDA-NRCS to introduce differentiae and taxa for soils that form through profound, intentional alteration or transportation of materials by humans. Not included are soils altered unintentionally or altered from chemical treatment of standard production agricultural practices. Commonly, epipedons of soils developed from human-altered or human-transported (HAHT) materials are pale and thin. Two exceptions are the anthropic and plaggen epipedons. Historically, and in other classification systems, high amounts of phosphorus (P) have been used as differentiae to separate anthropic from other epipedons. However, lab data does not support the use of P as definitive criteria to separate epipedons. Anthropic epipedons may be high in carbon, P, and calcium, may contain artifacts or have anthraquic saturation. Yet the current Soil Taxonomic criteria for anthropic epipedons did not exclude them from qualifying as other epipedons. Also, other epipedons were not prevented from being recognized in HAHT materials. A new proposal removes the P limits on all epipedons, relies on the presence of artifacts or anthraquic (paddy flooding) conditions to identify anthropic epipedons, and excludes all except anthropic and plaggen epipedons from forming in HAHT materials. Proposed modifications to epipedons criteria will be discussed.

Removing the “Sliding Scale” Thickness of the Mantle in Soil Taxonomy

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Soil horizons (other than C or R) are identified as “buried” by the letter of “b” in the horizon name. However, a buried soil must have a mantle of new material of minimum thickness. The minimum mantle thickness is 50 cm or more, or a mantle from 30 to 49 cm thick that is at least half of the thickness of preserved diagnostic horizons below. The presence of a buried soil affects the reference for depths to differentiae and which properties are considered for placement in taxa above the family level (with an exception for “Thapto-Histic” subgroups). A recent proposal was made to set the minimum mantle thickness to a constant 50 cm. The effect of such a proposal was tested on the typifying pedons of 1491 soil series of the Fluvents suborder, Fluvaquents great groups, Fluventic and Fluvaquentic subgroups. About 19 percent of the series had a mantle, mainly Fluvents. Only 8 (~0.5%) series had a mantle between 30 and 49 cm thick that met the minimum thickness criteria, and only one (Forney series) would change in classification if the minimum mantle thickness were raised to 50 cm. The Forney series would become an Inceptisol, and it is very unlikely that the series would be split by the change, based on the range in characteristics. Therefore, eliminating the rule fragment that allows a thin mantle 30-49 cm thick would have minimal effect (if any) on existing soil series, soil surveys, or interpretations. The proposed change would have a positive effect to simplify Soil Taxonomy.

Determining soil moisture and temperature regimes with the Java Newhall simulation model for the Albania Soil Survey.

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Albania is a small mountainous country covering an area of 28,748 km2. The terrain is complex and steep and is ideal for mappings soils based on terrain attributes. Determining soil climate regimes is a useful tool to divide large regions for preliminary mapping purposes. The objective of this project was to produce an Albanian soil moisture and temperature regime map in a raster based on the World Soil Climate database using the Java Newhall Simulation Model. According to the climatic indicators, Albania is characterized by three major soil temperature and moisture regimes. The dominant temperature regimes are Mesic (52%) on the mountainous eastern part of the county, followed by Thermic (38%) in the intermountain valleys and flatter part in the east. The Cryic (10%) temperature regime was associated with the higher elevations. It was determined from the model that the Udic soil moisture regime covered the majority of the country (67%), followed by Ustic(28%) and some Xeric (5%) areas. The Java Newhall Simulation Model was found to be useful for establishing soil climate regions for preliminary mapping.

2012 National Cooperative Soil Survey Work Planning Conferences – national collaborative research agenda for emerging issues

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The US National Cooperative Soil Survey (NCSS) National Conferences convene to discuss and develop solutions to issues of national concern to the National Cooperative Soil Survey. Participants of the NCSS include representatives from USDA NRCS, USDA NIFA, USDA ARS, USFS, BLM, BIA, EPA, NPS, USFWS, SSSA, the US university experiment stations, and tribal colleges. Other interested foreign and domestic groups such as lead scientists from Canada, Mexico and other cooperative countries are invited to participate. Committees convene each year at the regional and national meetings to establish a collaborative work plan to address grassroots issues as well as national priorities under the national umbrella of the NCSS. The Research Agenda Committee has established a collaborative work plan to address emerging issues. Priorities are divided into 3 categories: Short-Term Priorities, Global Priorities and National Applications. Short-Term Priorities are focused on soil change, new technology, ecological site descriptions, subaqueous soils, landscape hydraulic function and hydropedology, gypseous and salt-affected soils and NCSS database harmonization. Global Priorities are focused on scaling/extrapolation, landscape-scale carbon processes and accounting, integration of soil organic carbon and land use, adaptation and prediction of soil CO_2 sequestration, soil ecosystem services, soil function, and development and testing of decision support tools. The final category of Application of Soil Survey Data includes the integration of carbon and land use data into conservation planning and related activities, data validation and urban/suburban interpretations. This poster briefly overviews highlights of the 2012 NCSS research agenda with specific examples.

Application of Comprehensive Soil Classification System of Japan. First Approximation to major Japanese soils

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In the previous report, we proposed the *Comprehensive Soil Classification System of Japan-First Approximation*, a more practical system that enables the nationwide classification of soils. In this study, we applied this new classification system to several major Japanese soils, which were collected as soil monoliths at National Institute for Agro-Environmental Sciences. And, we compared

this new classification system with international classification system, such as Soil Taxonomy (USDA, 2010) and WRB (2006). Soil monolith No.76 was collected from Kyusyu district, southwestern Japan, and derived from volcanic ash. This soil has thick humus-rich horizon (7.5YR2/1), whose thickness is more than 50 cm. According to Japanese new classification system, it is classified as *high-humic Cumulic Allophanic Andosols*, which corresponds to Pachic Melaudands (Soil Taxonomy) or Melanic Silandic Andosols (WRB). Soil monolith No.45 is used for paddy rice cultivation and located in Shikoku district, western part of Japan. This soil has a reducto-morphic feature (iron and manganese accumulation) below the plow layer by irrigation water. It is classified as *coarse-textured Albic Lowland Paddy soils*, which corresponds to Anthraquic Eutrudepts or Fluvic Hydragric Anthrosols.
Soil monolith No.40 is so called as *Red soils* in previous classification system and located in central Japan. The soil has an argillic horizon, whose color is 2.5YR4/8. It is classified as *fine-textured Reddish Argic Red-Yellow soils*, which corresponds to Typic Hapludults or Haplic Acrisols (Chromic).
Soil monolith No.62 is called as *Brown Forest soils* (Inceptisols or Cambisols) according to the classification of forest soil in Japan (1975). These soils are widely distributed in northeastern part of Japan under the deciduous broad-leaved forest and soil color of B horizon is brown (7.5YR4/6). This soil has andic properties; therefore, it is classified as *low-humic Haplic Non-allophanic Andosols,* which corresponds to Alic Hapludands or Aluandic Andosols. In this case, we need a pay attention to update the soil map using new soil classification system.

Documenting bulk density and electrical conductivity sampling methods for subaqueous soil classification and description

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Demand for resource inventories in freshwater and coastal zone areas is on the increase and soil survey information is commonly unavailable. Two methods to aid classification and description of subaqueous soils, Soil Core Bulk Density and 1:5 Aqueous Mixture by Volume for Subaqueous Soils (EC1:5vol), were documented and archived for consistent use in soil survey. The soil core method for collecting bulk density samples was adapted to measure satiated bulk density in subaqueous soils. Subaqueous soil samples typically have very low bulk density because they contain a large percentage of water causing the samples to have high fluidity class. The Soil EC1:5vol method is used in the Keys to Soil Taxonomy (11th edition) at the great group level to distinguish freshwater subaqueous soils (Frasiwassents and Frasiwassists) from saltwater and brackish water subaqueous soils. This method is used for fresh, field wet samples or those that have been refrigerated or even frozen because sulfides may oxidize during drying, forming sulfate salts, which increase the EC1:5vol value. Bulk density and EC1:5vol methods were documented as addenda to the Soil Survey Field and Laboratory Methods Manual in 2011 and made available online. Documenting methods for classification and description of subaqueous soils ensures consistency in the development of soil surveys.

Suggestions for the Universal Soil Classification System

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Presently, two soil classification systems compete for global acceptance, Soil Taxonomy (ST) and WRB. Notwithstanding many harmonization intents, both systems are so different, particularly in their structure, that next step in order to have a unique universally accepted soil classification system is to develop a new one that fulfils this necessary condition. Following is a non exhaustive exercise on what should be kept and avoided from the existing systems on developing the new one, based on the experience of utilizing in the Pampean Region of Argentina a system developed in USA since more than 40 years ago as well as having the opportunity to participate in an international working group involved in the development of WRB.

It is advised to keep:

- A strong basis on soil forming factors subsequently followed by soil forming processes, both evidenced by soil morphology.
- A hierarchical system as in ST with an open lowest level with precise and concise definitions as in WRB qualifiers with clear rules of utilization.
- Standards for soil site and profile description as well as analytical methods both for field and laboratory use.

It is suggested to avoid:

- Soil climate as defined today in ST, in many places the available information is not enough to define soil moisture and temperature regimes, which in fact are estimated.
- A closed system as in ST which conceptually means that any soil can be classified with its keys, but implicitly results in that some soils get a name that does not show their actual origin or properties, and the eventual official actualization of the system, if achieved, takes too much time.
- Criteria strongly based on properties that cannot be ascertained in the field (complicated laboratory data, technological instruments dependency) for the higher categories.
- Implications for soil use and management which should be the basis for utilitarian land classifications.
- Criteria based on polygenetic soil profiles and all other sets of features which may lead to non unanimous interpretations of soil profiles.

The resulting universal soil classification system should have such a structure that actualizations becomes unnecessary, possibly with a basic hierarchical structure for the higher levels and a lower open level comprising codes with precise rules of utilization. The development of a universal soil classification is an enormous task, it will take a very long time and it must involve participants experienced in as many regions of the world as possible.

Conflict between traditional concept of soil classification and diagnostics defined in WRB

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Soil scientists often connect soil units to typical geographic regions that represent soil forming factors leading to prevailing soil forming processes, e.g. calcic soil in arid and semiarid climate. Diagnostics based on soil morphology and properties, as set in WRB, proved to be essential in harmonizing global soil data. However, settings and limits of soil diagnostics can, in some cases, radically change the traditional interpretation of soil units, e.g. Calcisols (in WRB) occurrence in temperate humid regions. Such deviation from commonly applied soil concept leads to a mistrust of the soil science community and unwillingness to accept and use such classification.

The study is based on analysis of soil national database of Czech Republic. The correlation between the national classification system and WRB was based on profiles analytical data. Several cases, when soils were classified as WRB units that normally occur in different environmental conditions, were found. These cases include: 1) classification of eroded soils on loess as Calcisols and some mollic soils as Kastanozems, both typically connected to arid and semiarid climate; 2) dystric soils with increased clay content in mountain areas as Alisols (WRB), that are connected to tropical, subtropical and warm-temperate regions.

Based on the analysis, a questionnaire survey was run for conflicting soil units. A detail soil profile description and analytical data accompanied by profile photographs were sent to 20 soil surveyors familiar with soil classification with demand to classify the soil in both national and WRB classification. The results showed significant discrepancies between agreement on classifications. The classification of each profile showed high consistency in national classification while classification in WRB varied significantly.
The main role of WRB is harmonization of soil classification world-wide. The study shows that the use of WRB by common soil scientist with their stereotypes, in some cases fails. The question is whether we should, in these cases, change the WRB criteria or we have to resign from traditional concepts in our mind?

Plinthite in Southeastern U.S. coastal plain soils

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Plinthite is commonly found in southeastern U.S. Coastal Plain soils. More than 50 soil series in this region classify in plinthic subgroups (> 5% plinthite) as per USDA Soil Taxonomy, while many more soils contain lesser amounts of plinthite. Globally, soils containing plinthite are found on five continents, and Plinthosols are estimated to occupy more than 60 million hectares (WRB). A plinthic diagnostic horizon exists in the WRB system, while plinthite is considered a diagnostic soil characteristic in Soil Taxonomy. Although plinthite is defined in these systems, its criteria are sometimes interpreted (at least in the U.S.) as more of a concept than a rigid diagnostic feature. Considering its importance, consistent identification and interpretation of effects on soil properties is warranted on a global basis. Many inconsistencies are due to: 1) plinthite's existence within the continuum of laterite and its corresponding variable cementation, morphological forms, and continuity within a soil, 2) problems in identifying Fe-enriched soil material that irreversibly hardens, and 3) its complex relationship with contemporary soil formation and hydromorphology. Recent advancements in its definition (Keys to Soil Taxonomy, 11th ed.) and quantification (standardized slaking technique) have increased our understanding of plinthite. This presentation will address certain aspects of plinthite and related soils in the U.S. Coastal Plain region (e.g. formation, hydraulic properties, hydromorphology). The goal is to emphasize knowledge gaps and ideally promote increased global discussion on this important soil feature.

Description, classification and mapping of soils with potential for agricultural development in the Chilean Patagonia

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The Aysén Region of the Chilean Patagonia is one of the most extensive of the country and most recently colonized by settlers. Although the region includes zones of forests, ranching, and crop production, basic information of soils is fragmented, coming from previous studies of separate areas. Therefore, the project objective is to describe, classify and map soils in valleys of the region, and to determine their potential for agricultural development. Satellite images and available soil information of the southern zone of the region were input into a geographic information system, followed by detailed soil descriptions in the field, and laboratory analyses of soil samples. Soils of the southern zone formed in glacial till, volcanic ash, fluvial and lacustrine sediments, under a climatic gradient ranging from perudic to xeric. The principal soil groups included Andisols (Andosols), Entisols (Arenosols, Fluvisols), Inceptisols (Cambisols, Gleysols), Histisols (Histosols), and Spodosols (Podzols) in humid areas, and Mollisols (Phaeozems) in the drier steppes. Land capability classifications ranged from IIIws to VIe. Soil characterizations will continue in the central and northern zones of the region which will be used to unify and update preexisting soil maps, and diagnose the potential agricultural productivity of the soils.

Soil Survey investigations of freshwater subaqueous soils

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USDA Natural Resources Conservation Service soil scientists have been involved with the mapping, classification, and interpretation of subaqueous soils in saltwater ecosystems since 1996. Over the last few years, comparable work has been started on freshwater ecosystems. Minimal observations of freshwater ponds were used to establish the classes of Frassiwassents and Frassiwassists at the great group level in Soil Taxonomy. A freshwater soil survey project completed in 2012 has provided valuable data, documentation, and recommendations. It has helped fill in the gaps in our knowledge of subaqueous soils and further tested the development of Soil Taxonomy. Current data suggests that additional subgroups are needed and expansion of the classification of subaqueous soils into other soil orders or development of subaqueous soils as a separate, new order in Soil Taxonomy is needed.

Development of a tool to predict soil moisture and temperature

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Soil moisture and temperature are key variables for evaluating soil suitability for plant growth and are factors for understanding soil genesis. Soil Taxonomy placed considerable emphasis on these variables, and soil moisture regime is used as the differentiating criterion for Suborders of most Orders. Developing a tool that will simulate soil moisture and temperature at different soil depths as well as identify soil moisture and temperature regimes will provide useful information that supports natural resource assessments and conservation activities. The USDA-NRCS National Soil Survey Center and Texas AgriLife Research Center have developed a modification of the Environmental Policy Integrated Climate (EPIC) model to simulate soil moisture and temperature at different depths, calculate the soil moisture control section, and assign soil moisture and temperature regimes based on Soil Taxonomy criteria. EPIC is a cropping systems model developed to evaluate the impact of soil erosion on soil productivity. Soil moisture and temperature were simulated at four depths and annual soil temperature and moisture regimes predicted from 30-years of daily climate data from weather stations for 19 locations across the U.S. Predictions were evaluated by comparison with measured soil moisture and temperature from these stations. The paper will discuss the validation of the EPIC tool in predicting soil moisture and temperature regimes.

Using Soil Taxonomy and official series descriptions to score and sort soils for expected SOC stocks

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There is a high level of international interest in systematically measuring, modeling and predicting soil organic carbon (SOC) stocks. Many current approaches rely on legacy data to create coverage of national scale areas; they do not allow for an SOC stock estimate at one given point in time. A current snapshot of US SOC stocks would require a sampling scheme that represented the entire country. The objective of this paper is to outline a process to create soil-based strata for sample selection to inventory SOC stocks on a national scale in three steps: 1) Official series descriptions were used to compile comprehensive soil information, 2) an ordinal scoring system was developed and applied to link soil properties to likely SOC stocks, and 3) hierarchical clustering was applied to the property scores to cluster soils into groups for sampling. The scores and groups were tested using pedon data from MLRA regional office area 5 (Salina, KS) was used to illustrate the process and results. The 12 resulting groups were significantly different in pedon SOC stocks. The groups can be used to stratify SOC stock sampling in the region. A similar process could be applied to any soil property information to create strata for distributing samples.

Problems in correlation of Czech national soil classification and World Reference Base 2006

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The use of legacy data in international soil mapping projects entails the demand for the harmonisation of soil data. Accurate correlation between national and international soil classification units is an important prerequisite in global soil mapping and acquisition of harmonised soil data usable in environmental applications. The correlation of soil units at different taxonomic levels was undertaken to relate the Czech national soil classification system with the World Reference Base (WRB) and evaluate the effectiveness of a semantic approach (analogical soil units provided by expert knowledge), and quantitative approach in the correlation. For the quantitative approach, a set of 433 soil profiles randomly selected from the Large-scale mapping of agricultural soils in Czechoslovakia was classified according to WRB using available analytical and morphological soil data. The study showed the necessity for an analytical approach and quantitative data use for reliable correlation between the two classification schemes. The general level of correlation at the higher taxonomic level can be considered as high (88%), whilst there is a significant variability of correlation accuracy between soil types. Conversion of some soil units, e.g. Rankers, Rendzinas, Pararendzinas, Černice, Černozems, Podzols or Luvizems requires analytical and morphological data of corresponding profiles. Relatively low correlation is caused by various factors. Different concepts of the soil unit and different setting of the criteria of the diagnostic soil properties are the most important. Some units such as Glejs, Fluvizems or Hnědozems can be correlated with a high probability of accurate assignment. High incompatibility was shown at the lower taxonomic level. Correlation of lower taxonomic units should be subject to analytical processing.

Guy Smith Medal awarded to Hari Eswaran

This time the ceremony of the award was honored by the presence of the family of Guy Smith. D.C. Arthur Smith, Guy's son, Amy and Curtis Smith, his grandchildren gave a video and powerpoint documentary of their father's life as an Army videographer during WW II in Burma, building the Lido Road. They discussed his personal life and habits, and answered many questions. Please visit the web site created by Ms. Amy Smith in commemoration of her grandfather: http://www.guyswar.com/Links.html

From left to right: The Chair of the Division 1 "Soils in Time and Space" of the IUSS Karl Stahr and the Chair of corresponding Division of Dokuchaev (Russian) Soil Science Society Sergey Goryachkin with Guy Smith's family: his son Colonel Arthur R. Smith, grandson Curtis Smith and granddaughter Amy E. Smith with her fiancé

As we announced earlier, the Guy Smith medal has to be awarded for the second time to an extraordinary personality who devoted a lot of effort to the development and improvement of soil classification.

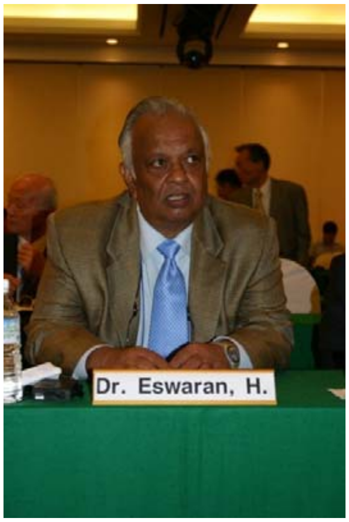
The ceremony of the award took place during the Soil Classification Conference in Lincoln, Nebraska on 11 of June 2012.

The Guy Smith Medal was awarded to Dr. Hari Eswaran, retired USDA-NRCS Director of World Soil Resources in Washington. Terry Cook, Consulting Soil Scientist from CA accepted the award on behalf of Hari, who is seriously ill. Lúcia Anjos of Brasil, a member of the Awards Committee, presented the Laudation.

Laudation for Dr. Hari Eswaran

By Prof. Jozef (Seppe) Deckers

Chair of the Selection Committee of the IUSS Guy Smith Award



Distinguished delegates, Mr. President of the IUSS, Mr. Chairman of the IUSS Division of Soil in Space and Time, it is a real honor for me to provide this laudation for Dr. Hari Eswaran at the occasion of the handing over of the second Guy Smith medal for soil classification.

Let me start by providing some background on **Hari Eswaran's personal history and professional career**. He was born on January 28, 1941 in Kluang, Johore, Malaysia. He obtained his M.Sc in Soil Survey in 1967 at the University of Ghent, Belgium where he also graduated with a PhD in 1970 under the guidance of the renown Prof. Dr. R. Tavernier, a personal friend of Guy Smith. Hari stayed on in Belgium at the International Training Centre (ICT-Ghent) as lecturer and scientific collaborator till 1976.

In the early eighties Hari Eswaran went to Honolulu at the University of Hawaii for leading an USAID project on Soil Management Support Services (SMSS). The idea of the SMMS project was to provide assistance to developing countries to come to grips with Soil Taxonomy for mapping and classifying soils. Within this programme Hari reached many young soil scientists from all over the world during the field training sessions. Some 90 countries benefitted from this project. 12 international committees were established bringing some 1200 soils scientists under one roof, reflecting on soil genesis and classification. The project received honors and awards from different countries (Van Ranst, 2011). In 1986 Hari was elected Vice-Chairman of Commission V of the ISSS and in that capacity he shaped the Benchmark Soils Project. As of 1989 till 2009 Hari was the National Leader of the World Soil Resources Centre of the USDA Natural Resources Conservation Service. He developed a program and coordinated activities of international technical exchange and assistance in areas of soil resource assessment, monitoring and management (Van Ranst, 2011). The result of this work culminated in the production of the 1:30 million map of the 'Soil Regions of the World'. He also developed a global soil database which has been used world-wide for assessing soil qualities and impact of land degradation. Last but not least he was one of the fore-runners in designing 'Sustainable agriculture' by soil type and spearheaded studies on 'Global change and desertification'. Hari has published numerous scientific journal papers, served as reviewer of some seven scientific journals.

Let me now further elaborate upon **Hari's major contributions to soil classification**.

Prof. Van Ranst (2011) wrote: 'Dr. Eswaran's greatest contribution has been the improvement, understanding, and use of 'Soil Taxonomy' globally. He led the creation of several international committees (e.g. ICOMOX, ICOMID, ICOMAND,...), open-ended groups that brought the world's leading soil experts together to improve aspects of Soil Taxonomy. Under his leadership, these committees provided recommendations that led to a series of universally accepted updates, including the establishment of two new orders, the Andisols and Gelisols, and the publication of periodic issues of "Keys to Soil Taxonomy"'.

As ex-chairman of the IUSS World Reference Base for Soil Resources (WRB) working Group I have witnessed Hari's true love for soils. He joined us wherever WRB would take him, China, Vietnam, Italy, Germany etc... In the profile pit he is a master to open the pit like a book, meticulously unfolding its pages and explaining its true content to all young scientists clustering around him. Thanks to Hari the WRB working group developed a rationale for the WRB system, and in doing so we realised that a simple system of two categorical levels with great flexibility of the qualifiers would make an easy, useful and true classification system ready for international soil correlation and mapping. He also favoured congruence between Soil Taxonomy and WRB so as to improve the scope for international soil correlation.

Upon the launching of the call for the second Guy Smith Prize, the selection committee received numerous nominations. After a thorough scrutiny of the submissions Dr. Hary Eswaran came out as the strongest candidate.

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Chair, IUSS Guy Smith Prize Selection Comittee
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Acknowledgement: for this laudation I gratefully used factual information on Hari Eswaran drawn from the article in PEDON No 22, January 2011 (Newsletter of ICT-Ghent, Belgium) with kind permission of its author Prof. Dr. Eric Van Ranst

On the history of soil classification:
Vladimir Fridland and Russian Soil Classification

Maria Gerasimova

This paper is part of presentation made by its author in the Dokuchaev Soil Science Institute, Moscow, at the jubilee session in commemoration of V.M. Fridland (1919-1983) in April, 2010.

Professor Vladimir Fridland is well known among soil scientists in Russia for his contribution to soil geography and soil mapping: he analyzed the laws of zonality, and the vertical zonality, in particular; he published a monograph on soils of Vietnam, he developed the theory of soil mapping and was co-editor of the last (1988) small-scale map (1:2.5M) of Russian Federation, and until now the map serves a main source of information for developing databases of Russian soils (Program of the Map of Russian Federation, scale 1:2.5M, 1972).

Worldwide, Professor Fridland is recognized as author of the theory of the soil cover pattern (Fridland, 1965, 1974); his monograph on the subject (1972) was translated in 1976 into English and is being frequently cited in publications concerning soil cover, soil mapping (and DSM), pedon concepts and hierarchy of the soil spatial units. In the field of soil classification, Fridland is weakly known to European and American pedologists, maybe except for his participation in early IRB (WRB) conferences in Bulgaria in early 1980s.

The system of soil classification proposed by V.M. Fridland is presented in a poorly published small book (150 pages) named "The main principles and elements of the basic soil classification and program of the work for its development", Moscow, 1982; his friends and followers used a shorter name: "White Book".

The book starts with the definition of soil as "*the surficial layer of the earth's crust resulting from the interaction of the atmosphere and biosphere with the lithosphere; this interaction produces different genetically interrelated horizons, which are basically parallel the earth's surface; the layer has the property of fertility"*. This definition enabled Fridland to extend the field of *objects to be classified*. Along with common soils, the bottom sediments of shallow-water bodies and the "parasoils" – artificial substrates or human-made soil-like bodies functioning as soils, are referred to the objects of soil classification. The arguments to be included into soil classification for the former is their capacity to support green plants, while for the latter, it is their transient nature: soon they are expected to become soils. As for subaquatic soils, V. Fridland mentions the same approach of B. Polynov (1933), W. Kubiëna (1953) and Soil Taxonomy (1999); whereas addressing the "parasoils" was rather a new experience. It's worth reminding that in the new Russian system the "Technogenic Surface Formations" are introduced, but they are ranked separately from soils (2004, 2008).

Soil classification is regarded by Fridland as an open, hierarchical system, and it should be updated every 10-15 years. Its principles permit to include "new soils", its hierarchy comprises 7 levels with the central one – genetic soil type, which is traditional in Russian soil science although identified in accordance with the new properties-oriented rules.

The vital and disputable problem of priority of soil-forming agents or soil properties for soil classification was skillfully solved in the White Book by introducing three *components* of soil classification: profile-genetic (and this is what all soil scientists mean as soil classification), mineralogical-textural and hydrothermal regimes. The soil should be classified separately in accordance with the rules and qualifiers for each component, so that the full name of the soil comprises three blocks.

Here is an example. Profile-genetic component: southern chernozems, loamy on loess; mineralogical-textural component: silty loamy soil with clay-illuvial profile and illite minerals in the clay fraction; regime component: seasonally freezing soils with non-percolative water regime.

This discriminative approach was also proposed in the version of 2004 of the new system, and in a more simplified and general way, in the version of 2008, however, it was not required by users. The profile-genetic component remains the main one, and the further discussion refers to it.

The *priority of soil properties*, which should be chosen, defined and ranked under the control of pedogenic processes, is implemented most obviously in the criteria for identifying soil types. The definition given by Fridland is the following: "Soil types have similar characteristics of the soil profiles that are composed of the sets of genetic horizons having certain properties that were formed by main processes, which depend on soil forming agents". Still more categorically the same principle has been formulated in the new Russian system: genetic soil types are identified by the combinations of diagnostic horizons; these combinations are termed as profile formulas.

The highest *taxonomic level* – trunk – in the new Russian system has been directly inherited from Fridland's system, and identified by the ratio between lithogenesis and pedogenesis in a broad sense. It was his proposal, as well as names for trunks: organo-mineral synlithogenic, organomineral postlithogenic, organic synlithogenic, organic postlithogenic. Between trunks and types there are 2 categories in Fridland's system: orders and suborders, their numbers are 28 and 54, respectively; both were identified by common trends in the profile composition owing to similar sets of pedogenic processes manifested in all soils of the (sub)order. The suborder category was omitted in the new system, whereas the criteria and most of the names of orders were preserved. Fridland's system was designed as a world one, and the number of orders, hence, their volume, seems now insufficient. At the same time, the orders were genetically and geographically related to the units of the legend of the Soil map of the world compiled by M.A. Glazovskaya and V.M. Fridland (scale 1:15M), which is popular in Russia and published also in 1982.

To qualify soils at the type level groups of *genetic horizons* were proposed (together with M. Glazovskaya, I. Sokolov, and V. Targulian). They were not as numerous as in other classifications (21 versus 32 in WRB, or 51 in the new Russian system), and their definitions were not so extensive (exhaustive), but this was the first experience in this country, and a step forwards from the old Russian system (1987) with its indefinite, if not vague, horizons.

For the next – subtype – level, the modifications of major horizons by superimposed processes were regarded as criteria, and implemented in the set of “small indices” for them. In case of intergrades, the major process had to be revealed as responsible for formation of the horizon, and the superimposed process(es) received small indices. In the new Russian system, this idea was also preserved, developed, and the number of genetic features – analogues of “small indices” increased (54 versus 34). Finally, it is worth to note that Fridland compiled a key (the first soil key in Russia) for trunks and orders.

The brief overview of the aspects of soil classification discussed in the White Book of V.M. Fridland reveals his great contribution to the formation of the new Russian system, and this is written as a dedication in its first edition of 1997. The contribution embraces: the principles and structure, objects to classify, diagnostic elements and their preliminary inventory. Presumably, the international experience exerted a strong influence on his proposals, and this is clear when comparing the White Book with Soil Taxonomy-1975; the FAO/IRB/WRB system was in progress in those years. Meanwhile, the Fridland’s system has some particular features. (i) It comprises three components in order to conciliate “factor-properties” conflict; (ii) it includes non-traditional objects – “parasoils” and aquatic soils; (iii) being based on soil properties it puts emphasis on pedogenic processes; (iv) it is the first national classification with the key and strict definitions of horizons and features.

Followers of V.M.Fridland hope to continue the updating and developing the Russian classification system within the same conceptual framework assimilating new data on soils and using new methodological facilities.

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