Toward Development of A Global Soil Classification Correlation Matrix (GSCCM)

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Abstract

Increased demand for effective communication of global soil resource inventories requires continued development of correlation matrices for cross-reference of international and national soil classification systems. Although the World Reference Base for Soil Resources was originally conceived as "a basis, or framework for better correlation between national systems," questions still arise when making comparisons of field research and agrotechnology transfer among countries with varying national soil classification systems.

The objectives of this project are development of a prototype global soil classification system correlation matrix using published information for international and national systems. Sets of GSCCM correlation tables were developed to cross-reference soil taxonomic classes from USDA Soil Taxonomy, 1998; World Reference Base for Soil Resources, 2007; FAO, 1990, 1974; Soil Map of Russia, Soil Map of Vietnam and other countries.

Global Soil Regions

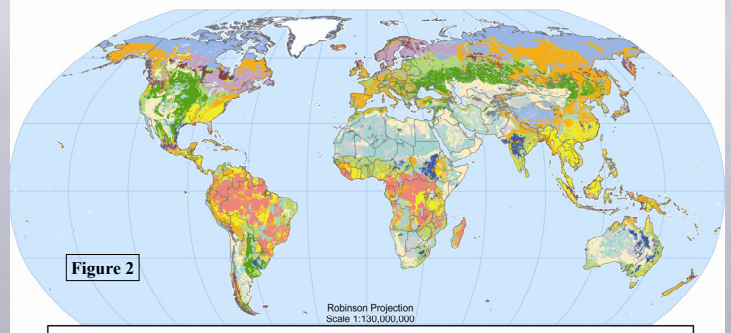


Figure 2

Soil Orders

Alfisols	Entisols	Inceptisols	Spodosols	Rocky Land
Andisols	Gelisols	Mollisols	Ultisols	Shifting Sand
Aridisols	Histosols	Oxisols	Vertisols	Ice/Glacier

Methods

We assembled publicly-available geospatial data [Table 2] and applied GIS tools to examine the various published data from international and national soil classification systems and to extract information on cross-system correlations.

We studied soil correlations among the various systems using four different sources or techniques –

1. FAO Soil Map of the World poster (1987) [see Table 1];
2. published data in journals and reports [see Table 3];
3. GIS overlays of soil climate regimes with the FAO Digital Soil Map of the World, 2003 [see Table 4]; and
4. attribute data from GIS geospatial data (e.g., Russia, 2002) [see Table 5].

We compiled published information on soil classification systems to develop tables of cross-correlation, where feasible, and illustrated soil correlation examples with geospatial output (maps, tables) from selected areas.

DOMINANT SOILS OF THE WORLD

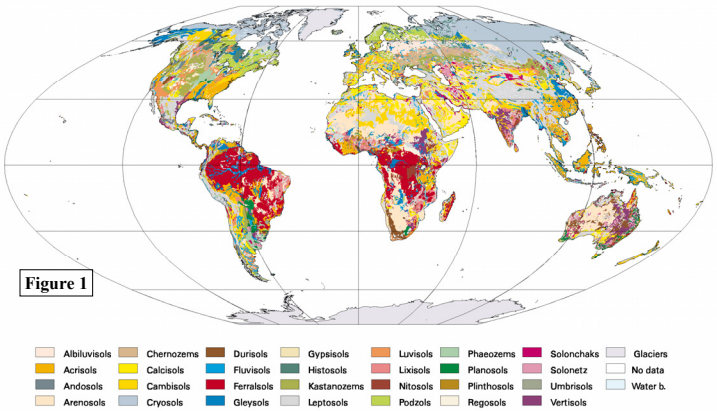


Figure 1

Albiluvisols, Acrisols, Andosols, Arenosols, Chernozems, Calcisols, Cambisols, Cryosols, Durisols, Fluvisols, Ferralsols, Gleysols, Gypsisols, Histosols, Kastanozems, Leptosols, Luvisols, Lixisols, Nitosols, Podzols, Phaeozems, Planosols, Plinthosols, Regosols, Solonchaks, Solonetz, Umbrisols, Vertisols, Glaciers, No data, Water b.

Polar Quartic Projection — FAO-GIS, August 1999

Introduction

Soil classification serves as a method to organize our knowledge of soil geography and associated soil characteristics, both spatial and temporal. Soil classification also aids in the identification and prediction of soil behavior or its response to natural and human-induced stresses. The evolution of soil classification systems involves constant review and revision of both the scientific and technical systems for classifying soils in response to technological advances and political needs (Buol, 2003).

In recent years the capability for conducting global to regional scale natural resource assessments has substantially increased because multi-scaled soil resource inventories for continental, regional, national and sub-national areas are now publicly-available in a digital format. In response to questions regarding cross-correlations among the various international and national soil classification systems, we performed an inventory to collect publicly-available digital soil resource information that could be assembled in a GIS-based data visualization tool.

Table 1. Soil Correlation Matrix for FAO-UNESCO (1974) and USDA Soil Taxonomy (1975)

FAO Major Soil	FAO Soil Unit	USDA-ST Great Group	FAO Major Soil	FAO Soil Unit	USDA-ST Great Group
Acrisols	Ferric Acrisols	Haploxerults	Luvisols	Albic Luvisols	Cryoboralfs
	Gleyic Acrisols	Ochraqualfs		Calcic Luvisols	Rhodoxeralfs
	Humic Acrisols	Palehumults		Chromic Luvisols	Rhodoxeralfs
	Orthic Acrisols	Haplustults		Ferric Luvisols	Haploxeralf
	Plinthic Acrisols	Paleaquults		Gleyic Luvisols	Ochraqualfs
Andosols	Humic Andosols	Dystrandrepts		Orthic Luvisols	Hapludalfs
	Mollic Andosols	Eutrandepts		Plinthic Luvisols	Plinthustalfs
	Ochric Andosols	Dystrandrepts		Vertic Luvisols	Palexeralfs
	Vitric Andosols	Vitrandepts	Nitosols	Dystric Nitosols	Paleudults
Arenosols	Albic Arenosols	Quartzipsamments		Eutric Nitosols	Palustults
	Cambic Arenosols	Ustipsamments		Humic Nitosols	Paleustalfs
	Ferralic Arenosols	Ustipsamments	Phaeozems	Calcaric Phaeozem	Haploborolls
	Luvic Arenosols	Cryopsamments		Gleyic Phaeozem	Argiaquolls
Cambisols	Calcic Cambisols	Xerochrepts		Haplic Phaeozem	Hapludolls
	Chromic Cambisols	Xerochrepts		Luvic Phaeozem	Argiudolls
	Dystric Cambisols	Dystrochrepts	Planosols	Dystric Planosols	Albaquults
	Eutric Cambisols	Cryochrepts		Eutric Planosols	Albaqualfs
	Ferralic Cambisols	Dystropepts		Gelic Planosols	Cryoboralfs
	Gelic Cambisols	Cryaquepts		Humic Planosols	Paleustalfs
	Gleyic Cambisols	Dystrochrepts		Mollic Planosols	Argialbolls
	Humic Cambisols	Haplumbrepts		Solodic Planosols	Natrustalfs
	Vertic Cambisols	Xerochrepts	Podzols	Ferric Podzols	Ferrods
Chernozems	Calcic Chernozem	Vermustolls		Gleyic Podzols	Cryaquods
	Glossic Chernozem	Cryoborolls		Humic Podzols	Tropohumods
	Haplic Chernozem	Vermustolls		Leptic Podzols	Haplorthids
	Luvic Chernozem	Argiudolls		Orthic Podzols	Haplorthids
Ferrosols	Acric Ferrosols	Acrorthox		Placic Podzols	Placohumods
	Humic Ferrosols	Haplustox	Podzoluvisols	Dystric Podzoluvisols	Glossudalfs
	Orthic Ferrosols	Haplustox		Eutric Podzoluvisols	Cryoboralfs
	Plinthic Ferrosols	Haplorthox		Gleyic Podzoluvisols	Glossaqualfs
	Rhodic Ferrosols	Orthox	Ranker	Ranker	Haplumbrepts
	Xanthic Ferrosols	Haplustox	Regosols	Calcaric Regosol	Orthents
Fluvisols	Calcaric Fluvisol	Fluvents		Dystric Regosol	Udipsamments
	Dystric Fluvisol	Fluvaquents		Eutric Regosol	Orthents
	Eutric Fluvisol	Fluvaquents		Gelic Regosol	Cryaquepts
	Thionic Fluvisol	Tropaquepts	Rendzina	Rendzina	Rendolls
Gleysols	Calcaric Gleysol	Haplaquepts	Solonchaks	Gleyic Solonchak	Halaquepts
	Dystric Gleysol	Humaquepts		Mollic Solonchak	Haplustolls
	Eutric Gleysol	Haplaquepts		Orthic Solonchak	Salorthids
	Gelic Gleysol	Cryaquepts		Takyric Solonchak	Gypsiorthids
	Humic Gleysol	Humaquepts	Solonetz	Gleyic Solonetz	Natraqualfs
	Mollic Gleysol	Haplaquolls		Mollic Solonetz	Natrustolls
	Plinthic Gleysol	Plinthaquepts		Orthic Solonetz	Natrustalfs
Greyzems	Gleyic Greyzems	Argiaquolls	Vertisols	Chromic Vertisol	Chromoxererts
	Orthic Greyzems	Argiborolls		Pellic Vertisol	Pelloxererts
Histosols	Dystric Histosols	Fibrists	Xerosols	Calcic Xerosols	Calciorthids
	Eutric Histosols	Borosaprists		Gypsic Xerosols	Gypsiorthids
	Gelic Histosols	Cryohemists		Haplic Xerosols	Camborthids
Kastanozems	Calcic Kastanozem	Vermiborolls		Luvic Xerosols	Haplargids
	Haplic Kastanozem	Haplustolls	Yermosols	Calcic Yermosol	Calciorthids
	Luvic Kastanozem	Argiustolls		Gypsic Yermosol	Gypsiorthids
Lithosols	Lithosol	nonsoil?		Haplic Yermosol	Camborthids
				Luvic Yermosol	Haplargids
				Takyric Yermosol	Camborthids

(Source: Elsevier ISRIC poster, 1987)

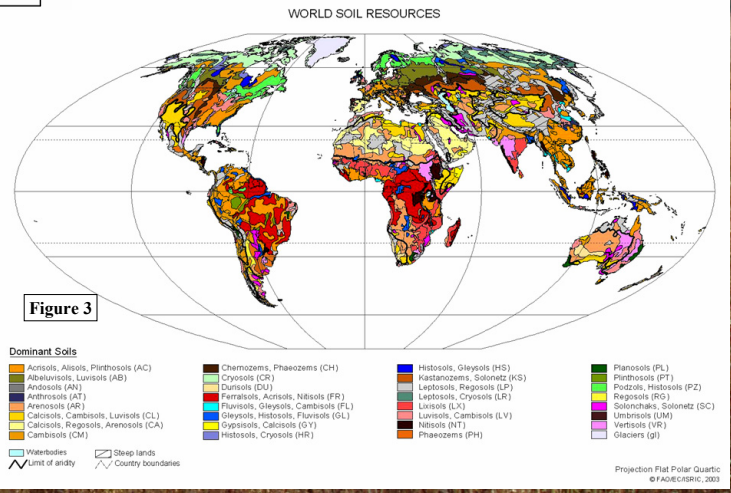


Figure 3

Table 2. Geospatial Data Sources

Title	Abbreviation	Year	Scale
Digital Soil Map of the World (Fig. 1)	DSMW_v3.5	1995, 2003	1:5,000,000
Global Soil Orders and Suborders (Fig. 2)	WSR	2005	1:5,000,000
Harmonized World Soil Database (Fig. 3)	HWSD_v1.0	2008	Ranges from 1:5,000,000 to 1:1,000,000
Land Resources of Russia	LRR_v1.0	2002	1:5,000,000
Soil Geographical Database of Eurasia	ESDB_v4_beta	2001	1:1,000,000
Soil Map of Brazil	---	1981	1:5,000,000
Principal Soil Types/Associations of Ghana	---	1998	1:250,000
U.S. General Soil Map	STATSGO2	2009	1:250,000
U.S. Soil Survey Geographic Database	SSURGO	2009	1:12,000 to 1:63,360

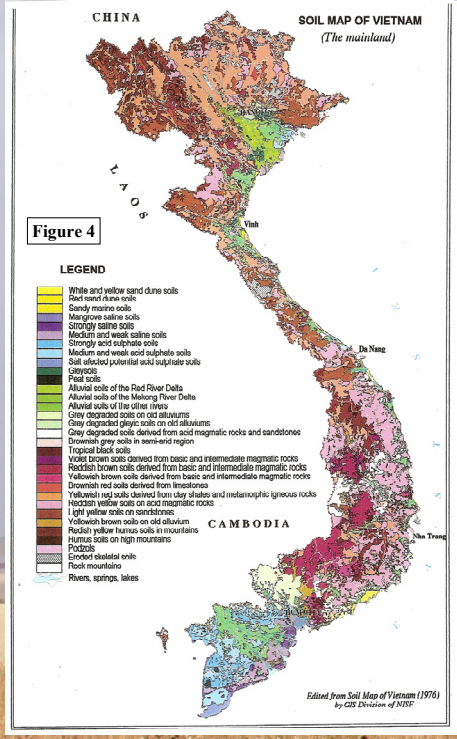
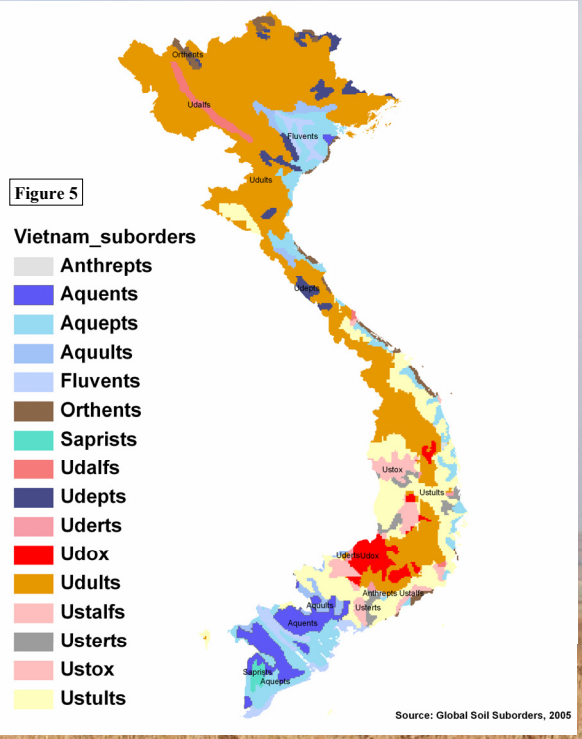


Figure 4



Figures 4 and 5 show the Soil Subunits of the Soil Map of Vietnam (1976, scanned image) and the USDA Suborders for Vietnam derived from the USDA Global Soil Suborders Map (2005). Table 3 is a proposed soil classification correlation matrix showing the Vietnam Soil Units and Subunits (MARD, 2002) with comparable soil taxa from the FAO World Reference Base (1998) and USDA Soil Taxonomy (1999).

Table 4. Example Soil Correlations for FAO (1981) Soil Units and USDA Soil Taxonomy (1975) Great Groups

FAO (1981)	USDA-ST (1975)					
Major Unit	**Aquic**	**Perudic**	**Udic**	**Ustic**	**Xeric**	**Aridic**
Ferric Acrisols	Kandiaquults	Kandihumults	Kandiudults	Kandiustults	Palexerults	none
Humic Acrisols	Umbraquults	Sombrihumults	Sombrihumults	Paleustults	Palexerults	none
Dystric Cambisols	Endoaquepts	Dystrudepts	Dystrudepts	Dystrustepts	Dystroxerepts	none
Dystric Fluvisols	none	Udifluvents	Udifluvents	Ustifluvents	Xerofluvents	Torrifluvents
Eutric Fluvisols	none	Udifluvents	Udifluvents	Ustifluvents	Xerofluvents	Torrifluvents
Ferric Luvisols	Plinthaqualfs	Ferrudalfs	Ferrudalfs	Kandiustalfs	Kandixeralfs	Paleargids
Haplic Luvisols	Endoaqualfs	Hapludalfs	Hapludalfs	Haplustalfs	Haploxeralfs	Haplargids
Eutric Vertisols	Salaquerts	Hapluderts	Hapluderts	Salusterts	Haploxererts	Salitorrerts

Table 4 illustrates soil correlation between FAO Major Soil Units and USDA Soil Taxonomy Great Groups using the results of a GIS raster-based method which overlays soil climate (soil moisture and temperature regimes) on the FAO Digital Soil Map of the World (Eswaran and Reich, 2005).

Table 5. Selected Correlations of USDA-Russia-FAO-WRB

USDA, 1999	Russia, 1988	FAO, 1988	WRB, 1998
Aqualfs	Podzolics deep-gleyic and gley	Dystric Podzoluvisols	Albeluvisols Gleyic
Aqualfs	Podzolics surfacely-gleyic	Stagnic Podzoluvisols	Albeluvisols Stagnic
Aquic Dystrochrepts	Brownzems raw-humic gley	Gleyic Cambisols	Cambisols Gleyic
Aquic Eutrochrepts	Brownzems gleyic and gley	Gleyic Cambisols	Cambisols Gleyic
Aquic Glossoboralfs	Sod-podzolic-gleys	Gleyic Podzoluvisols	Albeluvisols Gleyic
Aquic Glossoboralfs	Sod-podzolic-gleys with the second humic horizon	Gleyic Podzoluvisols	Albeluvisols Gleyic
Aquic Glossoboralfs	Sod-podzolics deep-gley and gleyic	Gleyic Podzoluvisols	Albeluvisols Gleyic
Aquic Glossoboralfs	Sod-podzolics surfacely-gleyic	Stagnic Podzoluvisols	Albeluvisols Stagnic
Aquods	Gley-podzolics	Gleyic Podzoluvisols	Albeluvisols Gleyic
Aquods	Gley-podzolics with the second bleached horizon	Gleyic Podzoluvisols	Albeluvisols Gleyic
Aquods	Podzols gleyic	Gleyic Podzols	Podzols Gleyic
Aquolls	Greys forest gleyic and gley	Gleyic Greyzems	Phaeozems Gleyic
Argiaquolls	Meadow-chernozem-likes "Amur prairie"	Gleyic Phaeozems	Phaeozems Gleyic

Source: IIASA and RAS, 2002

Table 5 is an example of selected Russian soil classes with comparable soil taxa from the FAO World Reference Base and USDA Soil Taxonomy. This table was extracted from the attribute database provided on the Land Resources of Russia CD (IIASA and RAS, 2002).

Table 3. Proposed Soil Correlations for Vietnam Soils, WRB Major Soils and the Great Groups of USDA Soil Taxonomy

Soils of Vietnam	source: The Basic Information of Main Soil Units of Vietnam, 2002			
Vietnamese System		**FAO-WRB**		**ST, 1999**
Vietnam_soil_units	**Vietnam_soil_subunits**	**WRB_1**	**WRB_2**	**ST_1**
Sandy soils	Yellow and white sand dune soils	Haplic Arenosols		Ustipsamments
	Red sand dune soils	Rhodic Arenosols		Ustipsamments
	Sandy marine soils	Haplic Arenosols		Udipsamments
Saline soils	Mangrove saline soils	Salic Fluvisols		Epiaquents
	Strongly saline soils	Salic Fluvisols		Hydraquents
	Medium and weak saline soils	Salic Fluvisols		Udifluvents
	Alkaline saline soils	Sodic Solonchaks		Aquicambids
Acid sulphate soils	Potential acid suplate soils	Protothionic Gleysols		Sulfaquents
	Actual acid sulfate soils	Orthithionic Fluvisols		Sulfaquepts
Swampy soils and peat soils	Gleyic soils	Fluvic Gleysols		Udifluvaquents
	Peat soils [1976]; Peat potential acid sulphate soils [1996]	Protothionic Gleysols		Sulfohemists
Alluvial soils	Alluvial soils of the Red River Delta	Eutric Fluvisols		Udifluvents
	Alluvial soil of the Mekong Delta	Eutric Fluvisols	Cambic Fluvisols	Ustifluvents
	Alluvial soils of other river system; Dystric Fluvisols [1996]	Cambic Fluvisols	Dystric Fluvisols	Udifluvents?
Grey degraded soils	Grey degraded soils on old alluviums	Plinthic Acrisols		Plinthaquults
	Grey degraded gleyic soils on old alluviums	Gleyic Acrisols??		Endoaquults??
	Grey degraded soils derived from acid magmatic rocks and sandstones	Haplic Acrisols		Hapludults
Brownish Grey soils in semi-arid region	Brownish Grey soils in semi-arid region	Chromic Lixisols		Paleargids
Tropical Black soils	Carbonates black soils	Calcic Luvisols		Paleustalfs
	Black soils on basaltic deposit; Gleyic Black soils [1996]	Gleyic Luvisols		Haplustolls
	Black soils on basaltic tuff	Vertisols?		Vertisols?
Ferralitic soils	Violet brown soils derived from basic and intermediate magmatic rocks	Rhodic Nitisols		Haplustolls
	Reddish brown soils derived from basic and intermediate magmatic rocks	Rhodic Ferralsols		Hapludox
	Yellowish brown soils derived from basic and intermediate magmatic rocks	Xanthic Ferralsols	Haplic Acrisols	Hapludox
	Brownish red soils derived from limestones	Haplic Ferralsols	Xanthic Ferralsols	Hapludox
	Yellowish red soils derived from clay shales and metamorphic igneous rocks	Haplic Acrisols		Hapludults
	Violet brown soils on clay shales	Haplic Nitisols		Kandiudults
	Reddish yellow soils on acid magmatic rocks	Haplic Acrisols	Arenic Acrisols	Kanhapludults
	Light yellow soils on conglomerate	Skeletic Acrisols		Kanhapludults
	Light yellow soils on sandstones	Arenic Acrisols		Kanhaplustults
	Yellowish brown soils on old alluvium	Haplic Acrisols		Hapludults
Reddish yellow humus soils on the mountains	Reddish yellow humus soils on the mountains	Humic Acrisols		Haplohumults
Humus soils on the high mountains	Humus soils on the high mountains	Haplic Alisols		Haplohemists
Podzols	Podzols	Histic Podzols		Haplorthods
Eroded skeletal soils	Eroded skeletal soils	Haplic Leptosols		Udorthents

Summary

Examples of international and national soil correlations were presented to illustrate preliminary results. Information on examples of correlation among the various international and national soil classification systems is being compiled to complement development of a prototype multi-scaled global soil resources information system. Further research is necessary to identify, correlate and incorporate additional regional and national to sub-national soil data sets. A prototype global soil information system is envisioned that can display, analyze and integrate soil resources information at various scales.

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