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Experience of the teaching of soil classification systems to students at different stages of education (Faculty of Soil Science, LMSU, Russia)

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Tatiana V. Prokof'eva

Lomonosov Moscow State University, Russia

* **Correspondence:** Soil Science Faculty, Lomonosov Moscow State University, Russia. E-mail: tatianaprokofieva@yandex.ru

Abstract. Soil classification systems provide a common language for scientific communication, represent the diversity of soils and create a scientific basis for soil management, monitoring and conservation. There are several soil classifications currently in use in Russia. Teaching soil systematics to students at the Faculty of Soil Science of the LMSU has developed over the years to meet specific requirements at different stages of education. Students learn to use and correlate different classification systems. Bachelor's students study classifications to enable professional communication and describing soil diversity. Master's students further learn the key principles of soil formation, historical and current trends in the development of soil science and the international terminology of soil science. Studying different aspects of the theory and practice of soil classification at different stages of education gives our students a solid base for systematising their knowledge and acquiring skills in scientific research.

Key words:
WRB classification system,
Soil Classification of Russia,
Soil Judging Contest,
education in soil science,
field work course

Introduction

The human mind continuously systematises and ranks different items and phenomena to enable it to successfully process large volumes of information. We try to classify everything around us, define a place for each and every item, and establish interactions and sequences of phenomena; that is, we systematise, and such systematising is a part of our thinking process. The development of any scientific discipline requires us to organise all the existing knowledge on the subject. As a rule, knowledge is organised according to its existing level, principles and paradigms to provide a unified language for communication and knowledge transfer, which is necessary for a science to progress (Krasilnikov et al. 2009).

The aim of soil classification is to create a unified language for scientific communication, to represent the diversity of soil with interspecific and intraspecific relationships between soil varieties (their similarities and differences) and to establish a scientific basis for the monitoring, use and conservation of soil resources. Every country needs a well-developed and unified soil classification for efficient farming, environmental monitoring and land management.

The teaching of the theoretical basis of soil systematics and the practical use of specific classification systems is designed to achieve different goals at different stages of student education. The main

purpose of the article is to show how it is possible to make the teaching of classifications a framework for soil education and an assistant in environmental education.

Methodology

Student education on soil systematics and classifications at the Faculty of Soil Science of the Lomonosov Moscow State University (LMSU) focuses on studying the genetic classifications of soils based on considering the soil profile as a product of the interaction of soil-forming factors.

The main problem at the current stage of soil science development in Russia is the absence of a unified national classification of soils. Several classification systems are currently in use in Russia, and education in soil science therefore requires that students learn to use and correlate different classification systems. Primarily, these systems include the Classification and diagnostics of soils of the USSR (Egorov et al. 1977) and the Classification and diagnostics of soils of Russia (Shishov et al. 2004), which are taught to students starting from the first academic year.

Studies on global soil diversity are based on classification systems that reflect the world-wide diversity of soils. The increasing globalisation of world science dictates the necessity for more active information exchange and, therefore, a need for greater understanding and application of international classification systems that are recognised by the global scientific community: FAO-UNESCO World Reference Base for Soil Resources (IUSS Working Group WRB 2015) and USDA Soil Taxonomy (Soil Survey Staff 1999).

Problems of the coexistence of several classification systems are aggravated by the general lack of taxonomic consistency between Russian soil scientists. Education courses and textbooks often contain modified or personally developed versions of classifications that can cause serious complications for our students. We intend to gradually overcome the methodological contradictions and 'feudal division' problems that arise from such taxonomic inconsistencies. Teaching one or another classification system to students at different stages of education at the Faculty of Soil Science of the LMSU involves a general introduction to each system (its type, structure, definitions, principles of diagnostics and soil horizon designations) and acquaintance with its taxonomic units. The degree of detail in presenting such information depends on the purpose of each specific course.

As a result of more than 15 years' work, the teaching staff of our Faculty has developed a basis for creating a more-or-less complete system in the area of soil systematics.

Classifications learned by students at different stages of education

Bachelor of Sciences (BSc) course

The BSc students have their first introduction to soil classification during the course of lectures on main 'central images' (i.e., classical examples) of soils (the 1st academic year – the 'Introduction to Soil Science' course). This course is focused on the two most commonly used Russian classifications (Egorov et al. 1977; Shishov et al. 2004). The Classification and diagnostics of soils of the USSR (CSS) was officially recognised at the national level soon after its publication and its terminology is now compliant with the State Standard of 'Soils. Terms and definitions' (GOST 27593-88). This is an agriculturally oriented classification, where soil diagnostics are based on soil properties as well as soil-forming factors. The classification and diagnostics of soils of Russia (CRS) are based on morphological diagnostics of soils and provide the most complete characterisation of soil diversity within the Russian Federation, which makes them more convenient for applications in scientific research and nature conservation. Its original version was edited several times at the turn of the century and since then have remained unrevised for the last 10 years. Ideas and suggestions on possible further amendments are regularly presented in scientific publications (e.g., Gerasimova et al. 2013; Prokof'eva et al. 2014). Interested readers use these suggested amendments in their scientific work and publications, but no formal recognition of these changes has been gained so far.

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During the 1st academic year, international soil classifications are only briefly mentioned to our bachelor's students at a theoretical level.

The 1st-year students acquire practical skills in identifying soils according to the CSS and CRS during summer seminars and a field work course at the Agrobiological Research Station near Moscow.

The 2nd-year students attend the 'Soil Geography' course of lectures, which is currently being reorganised. We hope that after improvements it will become more balanced in respect to the use of different classification systems.

The main sites for training in soil identification for students at the end of their 2nd year of studies at the Soil Science Faculty (all educational profiles) are located along a route across the Eastern European Plain. They are explored during a summer field work course on 'Soils and flora of the natural zones' (also called the 'zonal practice'). The main aim of this course is to give our students some practical experience in understanding soil-forming factors and processes and relationships between soils and vegetation cover in different natural zones. The students are taught to identify taxonomic positions of soils in different classification systems using methods of soil diagnostics in the field. In total around 22–24 soil pits are studied on the route of the zonal practice. During field excursions and theoretical classes, the students are taught how to use different soil classification systems, i.e., both Russian systems and also the World Reference Base for Soil Resources. Due to the fact that our 2nd-year students can only use Russian-language materials, the older version of WRB (Targulian, Gerasimova 2007) was used until very recently, but now the latest version of WRB (2014–15) is also available in Russian.

To make the education process more interesting for the students, we have organised a competition during the Zonal practice – the Soil Judging Contest (Mikhailova and Post 2014; Official Handbook Inaugural International Soil Judging Contest 2014; Csorba et al. 2015). The contest guidelines were designed to fit into the education plan of the zonal practice and the Russian system for the teaching the Russian system of soil morphology (Prokof'eva and Buivolova 2017). During the contest, the students learn to use the international system of soil description (Guidelines for Soil Description 2006) and independently studied an unfamiliar soil profile, which they identified according to the CSR and the WRB, and won prizes. The teachers benefited from that competition too, which further helped to advertise the Faculty of Soil Science on Instagram and find new opportunities for training our post-graduate students and young teachers. Moreover, the contest revealed the degree of readiness of our students to work independently in the field and how we could improve their training and the educational plan of the zonal practice.

It should be mentioned that, in addition to soil science students, students specialising in 'Ecology and environmental management' also took part in the Soil Judging Contest, as their 'Biogeographical practice' joined the 'zonal practice'. The ecology students showed better aptitudes in understanding soil classifications, especially the WRB, despite having less general knowledge of soil genesis than soil science students.

The 2rd-year students of the Soil Science Faculty also undertake the 'soil mapping practice' in the field, which unfortunately only lasts for a short period. However, it gives the students a chance to apply their soil identification skills to compiling legends for large-scale soil maps.

By the 4th academic year, the students follow different courses according to their educational profiles. Only the students of the 'Soil resources and soil functioning' specialisation (Departments of General Soil Science and Soil Geography) have the opportunity to more deeply understand the WRB system within the framework of the 'Soils of the world' course, which is designed to describe the diversity of soils using the Soil Reference Groups of WRB.

Master of Sciences (MSc) course

During the first term of the MSc course at the Faculty of Soil Science of the LMSU, within the framework of a theoretical course on the 'History and methodology of soil science', the master's students can refresh their knowledge on the history of development and the state of the art in internationally recognised soil classification systems – the USDA Soil Taxonomy (ST) and the FAO-UNESCO World Reference Base for Soil Resources (WRB).

Some students ('Soil resources and soil functioning' specialisation) can choose more detailed studies on the theory of soil systematics, the history of development of soil classifications and the structure of modern classifications. This course used to be optional, but has now become obligatory. In compliance with modern standards of post-graduate education, this course includes tutorial materials in English – lectures, scientific presentations and a handbook (Krasilnikov et al. 2009), as well as practical work using international classification systems. Through attending this course the MSc students become familiar with the international terminology. At the end of this course the students take a theory test and present a paper on correlation of several soil classification systems by use of an example of a specific soil profile. General descriptions and analytical characteristics of soil profiles are taken from field guides of WRB workshops and similar sources. Each soil description is complemented by a high-resolution photograph (Fig. 1). The students are required to make a Russian–English or an English–Russian translation of a soil description and to name the soil in terms of Russian (CRS and CSS) and international (ST and WRB) classification systems. In addition, as an interesting example of

Location: Gödöllő, University woods - Profile No1.

Topography: Undulating
Landform: Slope 5%
Elevation: 205 m
Land use: Forest

Temperature regime: Mesic
Soil moisture regime: Ustic
Parent material: Aeolian stratified material

Profile Description

A1 Dark grayish brown (10YR 4/2), dark gray (10YR4/1) moist. Weak medium subangular blocky structure. Loose common roots and partially decayed organic residues. Gradual smooth boundary.

A2 Dark brown (10 YR 4/3), dark grayish brown (10YR 4/2) moist. Slightly hard, compacted, weak, medium subangular blocky structure. Common roots and crotovinas. Gradual smooth boundary.

AB (Bw) Dark yellowish brown (10YR 4/6), dark yellowish brown (10YR 3/6) moist. Weak, medium subangular blocky structure. Friable. Gradual smooth boundary.

2Bt 2Bwb) Strong brown (7.5YR 5/6), strong brown (7.5YR 4/6) moist. Hard when dry, slightly cemented, weak medium prismatic primary structure, medium blocky secondary structure. Few clay skins on pad faces. Common crotovinas. Clear, smooth gradual boundary.

3C Yellowish brown (10YR 5/6), yellowish brown (10YR 5/8) moist. Weak, coarse blocky structure. Hard, brittle, slightly cemented. Few crotovinas. Abrupt (in color) boundary.

4Ck Light yellowish brown (10YR 6/4,) light brownish gray (10YR 6/2) moist, with 5YR 8/1, 8/2 (dry, moist) soft lime accumulations in forms of thin layers and concretions. Soft, structureless.. Clear boundary.

5Ck Light olive gray (5Y 6/2), olive gray (5Y5/2) moist, Abundant, small (1-2 mm) lime concretions. Loose, single grained, sand.

Diagnostic horizons: Ochric horizon, Argic horizon (Cambic horizon)

Analytical data

Genetic layer	Depth (cm)	pH H_2O	OC (%)	$CaCO_3$ (%)	y1	CEC Cmol/kg	B %	% Sand 2-0.02 mm	% Clay <0.002 mm	Bulk Density (g cm^{-3})	Texture (USDA)
A1	**0-5**	4.7	2.7	0	24.8	20.5	-	68.4	9.7	1.20	SL
A2	**5-25**	4.5	0.5	0	11.1	10.4	46	68.5	14.9	1.13	SL
AB	**25-50**	5.0	0.2	0	10.1	10.0	51	65.3	16.9	1.11	SL
Bt	**50-85**	5.2	0	0	12.2	14.2	51	59.7	23.6	1.48	SCL
C	**85-125**	5.3	0	0	2.0	8.8	54	68.3	10.2	1.56	SL
2Ck	**125-150**	8.1	0	18.2	0.0	8.3	98	82.7	3.8	1.47	SL
3Ck	**150-**	8.2	0	17.1	0.0	6.7	98	90.2	2.7	1.54	S

Abbreviations: *WRB - World Reference Base, ST-Soil Taxonomy, HSC - Hungarian Soil Classification, OC - Organic Carbon, CEC - Cation Exchange Capacity, B% - Base Saturation, BD - Bulk Density, y1-hydrolytic acidity .*

Fig. 1. The description of Bathycalcic Chromic Luvisol/ Dystric Haplustept - the example of a task for paper on correlation on the course Systematics and classification of soils (by Michely E. (ed.) Field Guide of the International Symposium "Soil Classification 2001", 13-15 October, 2001, Hungary), photo of the author.

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world soil classification, they are taught to identify soils according to the French reference book of 'Référentiel pédologique' translated into Russian (Pochvennyi spravochnik 2000).

The 'Systematics and classifications of soils' course has recently also been recommended for students specialising in 'Ecology and environmental management' following their aforementioned success in grasping the principles of soil classifications. This can be taken as an optional course the in case that their research project has a connection with soils. Knowledge of soil systematics has now become a solid foundation for studies in different branches of soil science.

Conclusions

To summarise, the BSc students learn how to use professional terminology to describe different soils and the MSc students further learn the key principles of soil formation, as well as historical and current trends in the development of soil science and the main concepts of international terminology in soil science. The schedule of courses is presented in Table 1. For ecolog students, soil classifications are the primary source of information about soils.

Studying different aspects of the theory and practice of soil classification at different stages of education at the Faculty of Soil Science of the LMSU gives our students a solid base for systematising their knowledge and acquiring skills in scientific research.

Table 1. Courses on soil classification systems at the Faculty of Soil Science of the LMSU

Profession	Stage of education	Academic year	Type of discipline	The name of discipline	Educational purpose of soil systematics
Soil science	Bachelors	1	General obligatory	Soil science	Representation of soil diversity and the principles of soil formation
		1	General obligatory filed-work course	Introduction to the profession	Representation of soil diversity
		2	General obligatory	Soil geography	Representation of soil diversity
		2	General obligatory filed-work course	Soils and flora of the natural zones	Representation of soil diversity, professional terminology
		2	General obligatory with filed-work course	Soil mapping	Representation of soil diversity
		4	Specialised obligatory	Soils of the world	Representation of soil diversity
	Masters	1	General obligatory	History and methodology of soil science	Representation of current trends in the development of soil science, professional terminology
		1	Obligatory for educational profile	Systematics and classifications of soils	Representation of historical and modern trends in the development of soil science, principles of soil formation, soil diversity, professional terminology
Ecology and environmental management	Bachelors	1	General obligatory	Pedology	Representation of soil diversity and the principles of soil formation
		2	General obligatory with filed-work course	Biogeography	Representation of soil diversity, professional terminology and soil information
	Masters	1-2	Optional, chosen individually	Systematics and classifications of soils	Representation of the principles of soil formation, soil diversity, professional terminology and soil information

The balanced structure of our educational plan and our progressive consolidation of the approaches used to reflect soil diversity to match the goals of different disciplines allow the effectiveness of soil science teaching to be maximised. Ideally, the theoretical and practical base of soil systematics should be considered part of the foundation of soil science education.

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References

EGOROV V.V., FRIDLAND V.M., IVANOVA E.N., ROZOV N.N., NOSIN V.A., FRIEV T.A., 1977, Classification and diagnostics of soils of the USSR. Moscow, Kolos (in Russian).

CSORBA Á., MICHÉLI E., SZEGI T., LÁNG V., LEVINE M.J., GALBRAITH J., 2015, Official Handbook of the International Year of Soils (IYS), Field Course and Soil Judging Contest September 1–5, 2015. Gödöllő, Hungary. Retrieved February 8, 2017 from http://soil-judging-iys2015.com.

GERASIMOVA M.I., LEBEDEVA I.I., KHITROV N.B., 2013, Soil horizon designation: state-of-the art, problems and proposals. Eurasian Soil Science, 5: 599–609, doi: 10.1134/S1064229313050037.

GUIDELINES FOR SOIL DESCRIPTION (5th Edition), 2006, Food and Agriculture Organization of the United Nations. Rome. Russian version: Rukovodstvo po opisaniyu pochv. Rim: Prodovolstvennaya i selskohoziaystvennaya organizatsyia obedinennyh natsyi (FAO), 2012.

IUSS WORKING GROUP WRB, 2015, World Reference Base for Soil Resources 2014, update 2015. International soil classification system for naming soils and creating legends for soil maps, World Soil Resources Reports No. 106. FAO, Rome. Russian version: Mirovaya referativnaya baza pochvennyh resursov 2014. Megdunarodnaya systema pochvennoy klassifikacii dliadiagnostiki pochv I sozdaniya legend pochvennyh kart. Ispravlennaya I dopolnennaya versiya 2015. Perevod: I.A. Spiridonova. M.: Prodovolstvennaya I selskohoziaystvennaya organizatsyia obedinennyh natsyi, MSU im. M.V. Lomonosova, 2017.

KRASILNIKOV P., IBAÑEZ MARTI J.-J., ARNOLD R., SHOBA S. (eds), 2009, Handbook of soil terminology, correlation and classification. London, EARTHSCAN.

MIKHAILOVA E.A., POST C.J., 2014, Laboratory exercises for Soil Judging. 2ed edition. Printed in the United States of America. Paperback. Amazon.

Official Handbook Inaugural International Soil Judging Contest June 5–7, Jeju, Korea, IUSS. 2014. Retrieved February 8, 2017 from http://www.20wcss.org/sub03_5.php

PROKOF'EVA T.V., BUIVOLOVA A.Y., 2017, "Soil Judging contest" – form of training in field diagnostics of soils and international form of work with students, Proceedings of the III all-Russian conference with international participation "problems of sociology, methodology and history of soil science" (Pushchino, November 15–17, 2017), Pushchino, 123–126 (in Russian).

PROKOF'EVA T.V., GERASIMOVA M.I., BEZUGLOVA O.S., BAKHMATOVA K.A., GOL'EVA A.A., GORBOV S.N., ZHARIKOVA E.A., MATINYAN N.N., NAKVASINA E.N., SIVTSEVA N.E., 2014, Inclusion of soils and soil-like bodies of urban territories into the Russian soil classification system. Eurasian Soil Science, 47(10): 959–967, doi: 10.1134/S1064229314100093.

RÉFÉRENTIEL PÉDOLOGIQUE, 1995, INRA, Paris. Russian version: Pochvenniy spravochnik. Smolensk, Oikumena, 2000.

SHISHOV L.L., TONKONOGOV V.D., LEBEDEVA I.I., GERASIMOVA M.I. (eds), 2004, Classification and Diagnostics of Soils of Russia. Oikumena, Smolensk (in Russian).

SOIL SURVEY STAFF, 1999, Soil Taxonomy. A basic system of soil classification for making and interpreting soil surveys. 2nd Edition. Agric. Handbook, 436, Washington, DC, Natural Resources Conservation Service, United States Department of Agriculture.

TARGULIAN V.A., GERASIMOVA M.I. (eds), 2007, World Reference Base for Soil Resources: the basis for international classification and correlation of soils, Moscow, Partnership of scientific publications KMK (in Russian).

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