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Regional Representative Soil Project for Cameroon: Incorporation of Cultural Identity into Earth Science Education

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ABSTRACT

Representative regional soils have agricultural, cultural, economic, environmental, and historical importance to Cameroon. We have identified 27 regional representative soils

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in Cameroon, and developed a set of laboratory exercises, assignments and exam questions utilizing the Regional Representative Soil Project (RRSP) that gives students an opportunity to practice interpretation of soil series descriptions, taxonomic classes, soil forming factors, and soil physical and chemical properties. The RRSP can be incorporated into Earth Science curricula in secondary and high schools as well as bachelor's degree programs at the university-level Incorporation of the RRSP in earth science education in Cameroon is expected to change the perception of soil science education and to improve enrollment of students in the discipline. With time, the knowledge gained from this project will help land managers and farmers make proper use of their land. As the project expands, it is expected that a GIS soils database and related attributes from the different regions will be used to build a soils information system database for Cameroon.

Keywords: Africa Soil Information Service, agriculture, culture, earth science, education, erosion, and Soil Information Systems.

Introduction

The educational system in Cameroon is unique for Africa, consisting of both an Anglophone and Francophone sub-systems inherited from former colonial influence by Britain and France (Ayonghe 1999; Njong 2006). The Anglophone educational system

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consists of primary education (6 years), secondary education (5 years), high school education (2 years) and bachelors' degree education (3 years). Since 2006, efforts have been made to harmonize both systems, especially at the basic level in charge of primary education where the duration is now 6 years for both systems. A strong focus has been given to primary education especially of the girls, as a gateway out of poverty (INS, 2001; Njong 2010). Since independence of Cameroon, the educational sector in Cameroon has allotted a significant part of the national annual budget to cover operating cost in public schools and 80% in non-public schools (private, faith and community based). Colclough (2005) states that in developing countries the social returns of primary education are much higher when compared to tertiary education.

Despite progress made in the development of the educational system in Cameroon, some weaknesses to the system still remain: the English-mediated curriculum falls short of promoting the needed emphasis on the identity and history of minority cultures (Trudell, 2015). The predominant method of instruction in most schools is teacher centered, an approach known to inhibit development of critical thinking (Trudell, 2015). Since majority of subjects are taught in English, significant effort is allocated into teaching English vocabulary instead of subject matter (Trudell, 2015).

"Teacher-centered" instruction in which learning is based on mastery of content with little development of the skills necessary for scientific inquiry is a common type of instruction from elementary to higher educational institutions in Cameroon (Trudell,

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2005; Taraban et al., 2007). This is contrary to "active learning" and "project-based pedagogy" practiced in the United States and many other western countries (Taraban et al., 2007; Barak and Raz, 2000; Krajcik et al., 2007). The limited emphasis on hands activities in the educational curriculum tends to undermine the opportunity for students to reinforce theory with practical application of knowledge towards a more meaningful application to research and development. The approach of Earth sciences education in Cameroon is a good example of how a "teacher-centered" approach may limit students understanding, relevance and application to society and development.

In Cameroon earth science is taught mainly as geology with very little emphasis placed on other branches (e.g. soil science). Many environmental issues that continue to plague Cameroon and other countries south of the Sahara stem from unsustainable environmental practices such as slash and burn practices in agriculture, deforestation and cattle rearing in fragile ecosystems. The consequences of such unsustainable land use are the prevalence of water and wind erosion problems, fatalities and loss of property from hazards such as land and mudslides.

In the United States, environmental issues related to poor land management and use have reduced significantly since the time of the disastrous dust bowl that swept through the country following the settlement of people in the mid-west (Rich, 2013). The State Soil Project inspired by the Smithsonian Soil Exhibit entitled "Dig it! The Secret of

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Soil" (Mikhailova et al., 2009), soil judging (Karthanasis et al. 2011) and other hands on related soil education studies have been designed to enhance sustainable land use practices.

Cameroon presents a unique opportunity to diversify and enrich earth science education through the adaptation of Regional Representative State Soil project and soil judging in the earth science curriculum in, primary schools, secondary schools and universities. This potentially can positively impact many aspects of land management, development and society as a whole. For instance, soil interpretations for suitability for septic tank absorption fields, basement and road construction are some practical ways a hand-on approach to learning can be directly relevant to Cameroon.

In the past four decades, soil science education in Cameroon as a subject under earth sciences has never been taught as a standalone subject in the curriculum of secondary and high schools (Ayonghe, 1999). Earth science as a discipline was taught only in the lone state university of Yaoundé since its creation in 1962. Today, earth science is taught in at least three of the eight public universities in Cameroon. As a result of its colonial past, Cameroon's educational system uses French and British curricula and languages, which leads to a non-harmonized approached to teaching soil sciences among colleges and universities (Ayonghe, 1999). Although advances have been made in earth science

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programs in Cameroon, shortage of qualified faculty and well equipped soil science laboratories pose as major limitations (Ayonghe, 1999).

Development of the Regional Representative Soil Project (RRSP) was inspired by the State Soil Project (SSP) (Mikhailova et al., 2009) and the Smithsonian Soils Exhibit entitled “Dig It! The Secrets of Soil”, which opened in July 2008 (Kamps, 2005). During this exhibition, each state in the United States represented their state soil embedded in a soil monolith (Kamps, 2005). *“A state soil is a soil that has special significance to a particular state. Each state in the United States has selected a state soil, twenty of which have been legislatively established. These "Official State Soils" share the same level of distinction as official state flowers and birds. Also, representative soils have been selected for Puerto Rico and the Virgin Islands (USDA/NRCS, 2008).”*
State symbols are often adopted after a concerted effort by citizens, organizations or school children to have a significant item recognized for its importance to the state by making a request for a bill through the Legislative process (Shearer and Shearer, 2001). According to Mikhailova et al. (2009), feedback from students who participated in a state representative soils project was positive and students’ comments indicated that they acquired practical skills on how to use and interpret soil information (e.g., Web Soil Survey, Soil Series Description Database, Soil Data Mart, etc.).

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Soils in Cameroon are used predominantly for subsistence farming, plantation agriculture, and cattle rearing (Yerima and Ranst, 2005). Major food crops include corn, beans, cassava, Irish potatoes, sweet potatoes, yams, plantains, bananas and sorghum. Major cash crops include cocoa, coffee, rubber, tea, and palm oil which are grown in the volcanic soils of the of the southwest region and the western regions (Obale-Ebanga et al., 2003; Yerima and Ranst, 2005). However, soil degradation, primarily due to erosion as a result of poor farming methods, is common in Cameroon (Obalum et al., 2012). Thus, there is a dire need for land owners, farmers and the population at large to understand basic soil science.

Poor farming methods, including slash and burn, intensive shifting cultivation and heavy use of agrochemicals, have not helped improve soil fertility (Ickowitz, 2011; Mokiendje, et al. 2006; Obale-Ebanga et al., 2003; Yemefack et al., 2006; Yerima and Ranst, 2005). Soil water erosion appears to be one of the biggest factors limiting soil productivity in the tropical regions of Africa and throughout the world (Board on Agriculture, 1993; Dregne, 1990). Soil erosion in Africa, like in many regions of the world, remains one of the biggest threats to soil productivity (Nguetnkam and Dultz, 2011; Sullivan, 2004). Although rich topsoil can be lost through the activities of heavy farm machinery, water and wind erosion remain important agents causing soil erosion (Ngwu et al. 2005; Obalum et al. 2012). Soil erosion, especially in the tropics, is also considered an important source of non-point source pollution (Kjaergaard et al. 2004;

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Nguetnkam and Dultz, 2011). Soil erosion is particularly common in humid regions of sub-Saharan Africa such as Cameroon, where soil is under increasing pressure from human population growth, deforestation and heavy rain fall (Mbuh, et al. 2012; Obalum et al. 2012). In Sub-Saharan Africa, soil loss attributed heavily to torrential rainfall has been put at over 50 tons/ha (FAO, 1995).

There are 10 regions in Cameroon with 8 out of 12 soil orders (Soil Survey Staff, 1998): Alfisols, Andisols, Aridisols, Entisols , Inseptisols, Oxisols, Ultisols, and Vertisols (Yerima and Van Ranst, 2005). A variety of soils in Cameroon provide a unique opportunity to create various practical exercises to be incorporated in soil science education to stimulate enthusiasm in the subject matter (Sulzman, 2004). Each student in the soil science course will be assigned to a representative regional soil to be researched through a series of in-class laboratory exercises, and take-home assignments given throughout the semester and the results of these "inquiry-based" projects will be summarized in a regular or electronic folder called "The Regional Representative Soil Project." Student's accomplishments in mastering soil science knowledge will be tested with exams that use non- representative/regional soil descriptions carefully selected by the instructor from available databases such as FAO, UNSECO, USDA/NRCS.

"Teacher-centered" instruction in which learning is based on mastery of content with little development of the skills necessary for scientific inquiry is a common type of

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instruction in Cameroon (Taraban et al., 2007). However, studies have shown that "student-centered" or "inquiry-based" approaches are more effective methods to promote student learning in the Science, Technology, Engineering and Mathematics (STEM) disciplines, including earth science and its sub-disciplines such as soil science (http://www.nga.org/cms/stem). The RRSP can enhance soil science education in Cameroon by incorporating "active learning" and "project-based pedagogy" (Taraban et al., 2007; Barak and Raz, 2000; Krajcik et al., 2007).

The objectives of the RRSP are to provide students with an opportunity to practice soil science knowledge in a meaningful context, and to establish a framework for a GIS data base of regional representative soil in Cameroon.

Materials and Methods

These exercises require a computer lab equipped with personal computers (Pentium 2.8 GHz processors and a dedicated 128 MB video card) and ready access to the internet. Both internet and computer laboratories are available in most universities in Cameroon.

Description of map creation

This map was created using ArcMap10.1 software. To define the projection of the data frame, first a shapefile layer of the hydrology of Cameroon with the desired

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projection Clarke_1880_UTM_Zone_32N was added. Next another shapefile of the administrative region of Cameroon was added to the data frame and then exported and its projection projected to Clarke_1880_UTM_Zone_32N. The FAO soils map data of Africa was added, and clipped to the administrative boundaries of Cameroon. Using the editing tool, a reclassification of the FAO soils groupings was done to conform to USDA soil taxonomy. The decoding from FAO to USDA classification used the following resource: "Major soil classification systems used in the tropics: soils of Cameroon and world class data set of soil derived properties by FAO-UNESCO soil unit for global modeling (Batjes, 1997; Van Randst, 2005). The editing tool was used to add the abbreviated names of the regions of Cameroon on the map. Finally, the soil pits locations were added directly on the final map using the XY coordinate tab on the ArcGIS formatting tool bar.

Courses Background

The RRSP can be incorporated in various soil science courses currently taught in Cameroon (Ayonghe, 1999):

University of Yaoundé: Structure of Sub-soil (ST 202), Weathering and Pedology (ST 309), Classification and Evolution of Soils (ST 313), Structural Analyses and Pedogeneses in Tropical Areas (ST 436), and Structural Analyses and Pedogeneses in Tropical Zones (ST 528).

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University of Douala: Weathering and Pedology (ST 313), Classification and Mapping of Soils (ST 314), and Morphology of Soils and Classification (ST 415).

University of Buea: The Geology of Cameroon and Pedology (Elective).

Learning Management System

Modular Object-Oriented Dynamic Learning Environment (Moodle) is a free source e-learning software platform, which can be used for storing course materials, and assessing student's learning via electronic quizzes and tests (https://moodle.org/).

Results and Discussion

In the context of Cameroon, regional soil names could be adapted based on the extent of soil types, the most common use of soil in a region, and historical and cultural heritage values of a region. Currently there are 10 administrative regions in Cameroon, formally called provinces, which encompass 27 soil groups. These soil groups belong to 8 out of 12 soil orders: Alfisols, Andisols, Aridisol, Inceptisols, Oxisols, Ultisols, and Vertisols (Soil Survey Staff, 1998; Table 1). Climate and parent materials stand out as the most important soil forming factors. Rainfall and temperature are the two most significant components of climate, while humidity and evapotranspiration play a rather indirect influence on vegetation (Yerima and Ranst, 2005).

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Cameroon has a growing predominantly youthful population of over 19.4 million people (Table 1) based on 2010 national demographic statistics. Out of the ten administrative regions in Cameroon (Figure 2) 2 are English speaking and the remaining 8 French speaking. French and English have remained the official languages of instruction in schools across the country since colonial times (Ayonghe, 1999; Che, 2008). Education of children remains a priority for the government, as continued investments are being made in new infrastructure and equipping of schools and laboratories (Amin, 1994). Each of the 10 regions has been in turn divided into administrative Divisions and Subdivision. All administrative Divisions across the Cameroon have at least one government secondary and high school, usually with a host of other private and faith based school institutions. These secondary and high schools which typical have yearly enrollments ranging from a few hundreds to a few thousands, offer a ready platform for potential implementation of the RRSP model. The North West Region has been earmarked as potential host of the pilot regional representative soil project for a number of reasons: First, this region has one of the best secondary and high schools in Cameroon where earth sciences (geology) have been taught for several decades. Second, there are at least 5 recognized institutions of high learning (Table 1) based in the North West Region. Third, soil profile data already exist in Fundong Boyo division (Yerima and Ranst, 2005). Additionally one of the 3 government owned nutrient analysis laboratories in Cameroon is only 45 minutes away from the North West Region

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(Table 1). Lastly, the North West Region is predominantly covered by one main soil order, (Oxisols; Table 1, Figure 1), when compared to other regions such as the Adamawa region with 4 main soil orders: Alfisols, Entisols, Oxisols and Ultisols. It is hoped that dealing with fewer soil orders would make the pilot representative soil project a less tedious first experience for students, coaches and soil judges. The soils map of the ten regions of Cameroon would be a useful tool in decision making regarding local soil orders and groupings especially in the RRSP. The FAO soils layer of Cameroon includes soil subgroup details for the whole country which may serve as a guide to determine dominant soils types in a particular locality in a region (Figure 1). For instance working in the South Region of Cameroon which is predominantly oxisols, classifying any soil as vertisols (only found in North Cameroon) would be suspicious and may need further investigation. Figure 1 may also be important in determining which representative regional soil order to choose for a region based on spatial extent. The attribute table of the FAO soils map layer has quantifiable data on the different soil groupings that can be verified for spatial extent.

Five assignments and exam questions have been created to give to students. Assignments can be done at variable times. Some can be take home assignments and others could be done during the 2-hour lab period. Descriptions of the assignments and exam questions are shown in Tables 3 to Table 5. Result of using RRSP can be compiled in a three-ring or electronic folder entitled Regional Representative Soil Project and used

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this information to practice for the exams, and to create power point presentation/ poster summarizing the knowledge they have acquired as a result of the project. Exams are related to the RRSP, except that the Soil Description used for the exam questions will be different from representative soil descriptions (Table 4).

Amin et al. (1994) posed a strong argument that Cameroon must be alerted to the urgent need for continual educational reforms if realistic progress is hoped to be attained past its present stage in development. Such a change in the educational sector will require boldness, resolve and initiative, because it involves changes in a system that basically has not shifted from what was inherited during pre-colonial times. Amin et al. (1994) emphasized that such a system must place a strong emphasis on sciences and technology, and secondary school students, especially girls who must be encouraged to devote more time for the sciences. Within this context and framework, the RRSP could be a great way of fostering science and development in Cameroon for the future. However, the anticipated impact in the long run will ultimately depend on several other factors including the cooperation and backing of the ministry of higher education in Cameroon.

Perhaps one of the most critical aspects of lasting reform in education is the role of teachers (Amin, 1994). Faculty in the Geology/Earth Science departments in the University of Buea, Yaoundé II, Dschang and a host of other higher institutions in

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Cameroon form an important base for the potential introduction and adaptation of the regional representative soil project to Cameroon. These three universities remain of strategic importance as they host departments which train hundreds of teachers for primary, secondary, and high schools every year. Precedence for the RRSP could be taken from the design of the geology degree program in the University of Buea; contrary to similar programs in Cameroon, it was carefully designed to suit the geology of Cameroon and Sub-Saharan regions of Africa (Ayonghe, 1999). Cameroon currently possesses the basic infrastructure and technology needed to start this project even at a small scale. Adaptation and interpretation of RRSP should take into account cultural transferability and cross-cultural educational development pointed out by other researchers (Zajda, 2004).

Conclusions

In order for the establishment of the RRSP to be a success in Cameroon, the long term goal of the project must be brought into perspective; which is to provide students with an opportunity to practice soil science knowledge in a meaningful context, and to establish a framework for a GIS data base of regional representative soil in Cameroon. Undergraduate enrollment for earth sciences programs in Cameroonian universities combined may range up to several hundreds. A RRSP course potentially offers great opportunities for rapid and easy digitized data collection of soil types, soil nutrient data

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and detail classification of the specific soil orders and groupings. The GPS coordinates of each soil sample taken, will enable these data to be given a spatial reference, and thus contributing in ongoing efforts for a GIS soils information system for Africa. In this way, RRSP will be not only offer helpful information to some immediate beneficiaries such as farmers and other land owners, but also providing digitized soils information on the World Wide Web for research, education and development.

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1 Table 1. General information about regions of Cameroon (Source: Institut National de la Statistique Cameroun, 2010.

Region	Capital	Population (2010)	Area (km^2)	Population density (people/km^2)	Higher education institutions (with soil/geology sciences)	Government or private soil analysis laboratories	Common land-use practices in the region
1. Adamawa	Ngaoundéré	1,015,600	63,701	16	1	N/A	Grazing, building construction
2. Centre	Yaoundé	3,525,700	68,953	51	7	1	Logging, timber, industry, subsistence farming, commerce
3. East	Bertoua	802,000	109,002	7	N/A	N/A	Logging, timber, mining, timber, building, fishing
4. Far North	Maroua	3,480,400	34,263	102	N/A	N/A	Tourism, building, subsistence farming
5. Littoral	Douala	2,865,800	20,248	142	3	N/A	Major industrial zone, commerce, building, fishing , subsistence farming
6. North	Garoua	2,050,200	66,090	31	1	N/A	Tourism, building, subsistence farming.
7. Northwest	Bamenda	1,804,700	17,300	104	5	N/A	Subsistence farming, small businesses and crafts, building, quarry
8. South	Ebolowa	692,100	47,191	15	N/A	N/A	Logging, timber, subsistence farming
9. Southwest	Buea	1,384,300	25,410	55	4	1	Plantation and subsistence farming, building
10. West	Bafoussam	1,785,300	13,892	126	2	1	Plantation and subsistence

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	farming, industry, trade and commerce.

2 Note: N/A = not available.

Citation: Che, C.A., Mikhail ova, E.A., Post, C.J., Schlautman, M.A., and T.O. Owino. 2014. Regional Representative Soil Project for Cameroon: Incorporation of Cultural Identity into Earth Science Education. On-line publication.

3 Table 2. Soil regions of Cameroon

Region	**Ecological regions**	**Soil Map Symbol**	**Soil Group Name**	**Soil Order (Soil Survey Staff, 1998**
1. Adamawa	Ngaoundéré	Ao2	Haplic Acrisols in association with Haplic Ferralsols	Ultisols
		Fo1	Haplic Ferralsols	Oxisols
		Fo3	Haplic Ferralsols in association with Haplic Acrisols	Oxisols
		Fr1	Rhodic Ferralsols in association with Haplic Ferralsols and Rhodic Nitisols	Oxisols
		I	Leptisols	Entisols
		Lg1	Gleyic Luvisols in association with Planosols	Alfisols
		Nd2	Rhodic Nitisols in association with Ferralsols	Alfisols/Ultisols
		Rd1		
2. Centre	Yaoundé	Ao2	Haplic Acrisols in association with Haplic Ferralsols	Ultisols Oxisols
		Fo1	Haplic Ferralsols	Oxisols
		Fo4	Haplic Ferralsols in association with Haplic/Rhodic Nitisols	
		Fo5	Haplic Ferralsols in association with Humic Gleysols/Histosols	Oxisols and Histosols

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3. East	Bertoua	Ao1	Haplic Acrisols	Ultisols
		Ao2	Haplic Acrisols in association with Haplic Ferralsols	
		Fo1	Haplic Ferralsols	Oxisols
		Fo3	Haplic Ferralsols in association with Haplic Acrisols	Oxisols
		Fo5	Haplic Ferralsols in association with Humic Gleysols/Histosols	Oxisols and Histosols
4. Far North	Maroua	Gh1	Re1	Alfisols
		Re1	Regosols in association with Leptisols and Luvisols	Entisols
		Je1	Eutric Fluvisols in association with planosols/Gleyic Solonetz	Entisols
		Vp1	Eutric Vertisols in association with Gleysols, Fluvisols and Arenosols	Vertisols
		Vp3	Eutric Vertisols	Vertisols
		Ws1	Planosols in association with Gleyic Luvisols	Alfisols/Ultisols
		Ws2	Planosols in association with Gleyic Luvisols	Vertisols Alfisols
5. Littoral	Douala	Fr1	Rhodic Ferralsols in association with Haplic Ferralsols and Rhodic Nitisols	Oxisols
		Fo1	Haplic Ferralsols	Oxisols
		Fo4	Haplic Ferralsols in association with Haplic/Rhodic Nitisols	Oxisols
		Gd1	Dystric Gleysols in association with Dystric Fluvisols	Inceptisols
6. North	Garoua	I	Leptosols	Entisols
		Lg1	Gleyic Luvisols in association with Planosols	Alfisols

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		Lf1	Ferric Luvisols in association with Acrisols and Regosols	Alfisols
		Rd1		
		Re1	Regosols in association with Leptisols and Luvisols	Entisols
		Vp1	Eutric Vertisols in association with Gleyic Luvisols	Vertisols
		Vp2	Eutric Vertisols in association with Planosols and Luvisols	Vertisols
7. Northwest	Bamenda	Fo2	Haplic Ferralsols in association with Rhodic Ferralsols	Oxisols
		Fh1	Humic Ferralsols	Oxisols
8. South	Ebolowa	Fo5	Haplic Ferralsols in association with Humic Gleysols/Histosols	Oxisols
9. Southwest	Buea	Nd3	Rhodic Nitisols in association with Acrisols	Alfisols/Ultisols
		Ne1	Haplic Nitisols in association with Ferralsols	Alfisols/Ultisols
		Ne2	Haplic Nitisols in association with Rhodic Nitisols	Alfisols/Ultisols
		No	Andosols in association with Leptosols	Andisols
		I	Leptosols	Entisols
10. West	Bafoussam	Fo1	Haplic Ferralsols	Oxisols
		Nd2	Rhodic Nitisols in association with Ferralsols	Alfisols/Ultisols

Citation: Che, C.A., Mikhail ova, E.A., Post, C.J., Schlautman, M.A., and T.O. Owino. 2014. Regional Representative Soil Project for Cameroon: Incorporation of Cultural Identity into Earth Science Education. On-line publication.

4 Table 3. Summary of objectives and tasks for laboratory exercises.

OBJECTIVES AND TASKS FOR LABORATORY EXERCISES

Assignment 1

Objective: To find assigned regional representative soil and identify the soil order it belongs to;

Task: Find assigned Regional Representative Soil in Yerima and Van Ranst (2005).

Assignment 2

Objective: To identify six soil forming factors (parent material, climate biota, topography, time, land use) from the soil description;

Task: Find Regional Representative Soil profile description in Yerima and Van Ranst (2005). Write a report with a paragraph on each soil forming factor.

Assignment 3

Objective: To identify soil physical properties (texture, structure, consistence, and drainage and permeability) from the soil group description and quantitative data from Yerima and Van Ranst (2005);

Task: Write an interpretive report with a paragraph on each soil physical property.

Assignment 4

Objective: To identify soil chemical properties from the soil group description and quantitative data from from Yerima and Van Ranst (2005);

Task: Write a report with a paragraph on each soil chemical property.

Assignment 5

Citation: Che, C.A., Mikhail ova, E.A., Post, C.J., Schlautman, M.A., and T.O. Owino. 2014. Regional Representative Soil Project for Cameroon: Incorporation of Cultural Identity into Earth Science Education. On-line publication.

Objective: To decode the taxonomic class and explain the meaning of their derivatives, connotation of formative elements and major characteristics;

Task: Write one-page report.

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Table 4. Example of questions related to the Regional Representative Soil used in the Exams.

EXAMPLE OF QUESTIONS FOR EXAMS RELATED TO SOIL GROUPS

LOCATION Fundong Subdivision North West Region
(Lat. 6° 33’ 15”, Long. 10° 27’ 50”)

Source: FAO/UNDP, 1987

Fo2 (Soil Map Symbol)

The Fo2 group consists of very deep, well drained soils that formed in residuum weathered mostly from migmatite of the undulating lands. Slopes commonly are 2 to 8 percent.

CLASSIFICATION:

IUSS/FAO/ISRIC WRB (1998): Hapli-Rhodic Ferrasols

TAXONOMIC CLASS: Sols Ferrallitique, fortement desatures, typicques mondaux, sur migmatite

TAXONOMIC CLASS: Haplustox, clayey

TYPICAL PEDON: Clayey Haplustox - cropped. (Colors are for dry soil.)

Ap--0 to 28 cm; yellowish red (5YR 4/6 dry) fine sandy clay loam; moderately strong fine and subangular blocky structure, breaking into very fine granular; soft, slightly sticky, slightly plastic; few strongly weathered fine grained basement rock; many fine, few medium pores, many fine, common medium, few coarse roots; clear smooth boundary.

BA--28 to 50 cm; Dark red (2.5YR3/6) clay loam to clay; somewhat weak medium sub angular blocky structure; slightly hard, sticky, slightly plastic; many fine, few medium pores common fine, few medium and coarse slightly, hard, sticky, slightly plastic; many

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fine, few medium and coarse roots; clear smooth boundary.

Bo1--50 to 95 cm; red (2.5RS5/8, moist) clay; moderate coarse subangular blocky structure; friable, sticky, slightly plastic; many fine, few medium pores; common fine roots, few medium roots; gradual smooth boundary.

Bo2-95-150 cm; Red (2.5YR-10YR 4/8, moist) clay; moderate coarse subangular blocky structure; friable, sticky, slightly plastic; many fine few medium pores; few fine roots; gradual smooth boundary.

Bo3-150 to 200 cm: Red (10R4/8, moist) clay; somewhat weak coarse and very coarse subangular blocky structure; friable, sticky, slightly plastic many fine pores; few fine and medium roots.

GEOGRAPHIC SETTING: Ferralsols have good physical properties and poor chemical properties. They are comparatively less susceptible to erosion than many other soils because of their great depth, high permeability and stable microstructure (Yerima and Van Randst, 2005). Hapli-Rhodic Ferralsols in Fundong Subdivision North West Region is located along the road from Tricorners Ketambo to Fonfukka (Lat. 6o 33’15”, Long. 100 27’ 50”). The topography is undulating land with a slope of 2% to 8%. The landform has low planation surface and relief. Parent material is made of magmatite. Yearly rainfall is about 3031 mm (Kimbi).

DRAINAGE AND PERMEABILITY: Well drained.

USE AND VEGETATION: Mountane forest. Cleared areas are used for maize, sweet potato, groundnuts, oil palm, coffee, and some eucalyptus.

DISTRIBUTION AND EXTENT: The Northwest region. The soil group is of large extent.

SOURCE OF DATA: Yerima and Van Ranst, 2005

GROUP ESTABLISHED: FAO/UNDP, 1987.

QUESTIONS

1. What is the soil map symbol for the above soil? Fo2
2. What is the soil order for the above soil? Oxisols

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3. What is the soil moisture regime for the above soil? Ustic
4. What is the soil texture in the BA horizon? Clay loam to clay
5. What is the soil structure in the Bo1 horizon? moderate coarse subangular blocky structure
6. What is the soil consistence in the Bo2 horizon? friable, sticky, slightly plastic
7. What is the soil boundary in the BA horizon? clear smooth boundary
8. In which region(s) do you find this soil? Fundong Subdivision North West Region
9. What are the six soil forming factors for the above soil?
    a. Parent material: migmatite; b. Topography: Undulating lands. Slopes commonly are 2 to 8 percent; c. Climate: Ustic, Temp: ?; d. Biota: Montane Forest; e. Time: Highly weathered; f. Land-use: cropland with maize, sweet potatoes, oil palm etc.
10. In which soil horizons do you expect maximum illuviation? Bo1, Bo2, Bo3 (o=oxides)
11. Which horizons indicate parent material? Not indicated in the soil profile.
12. Which horizons indicate true soil? Ap, BA, Bo1, Bo2, Bo3
13. Which horizons indicate regolith? Ap, BA, Bo1, Bo2, Bo3
14. Parent material belongs to what kind of rock (e.g. igneous, metamorphic, sedimentary, igneous/metamorphic)? Igneous/metamorphic
15. Is parent material formed in place or transported? Residuum (formed in place).
16. What is (are) the name(s) of colloids(s) found in this soil? Iron oxides
17. What is the type of colloids (e.g. 1:1, crystalline, 2:1, amorphous, sesquioxide clays)? sesquioxide clays

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18. What kind of predominant "charge" does this colloid have (e.g. permanent, pH-dependent) and why? pH-dependent charge

19. What is the shrink-swell potential of this soil and why? None. Highly weathered soils.

Table 5. Summary of Objectives and Tasks for "Final Representative Regional Soil Project Presentation."

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1. **Objective:** To reinforce representative regional soil project laboratory exercises taught throughout semester.

   Task: Retrieve and organize data collected from previous exercises to be included in the presentation.

2. **Objective:** To learn to effectively present data in an electronic presentation format.

   Task: Create ten slides in Microsoft Power Point as follows:

   1. Title Page
   2. What is a Representative Regional Soil?
   3. (Your Region Soil) Profile
   4. Geographic Extent of (Your Region Soil)
   5. (Your Region Soil) is a Function of…
   6. Soil Taxonomy
   7. Soil Physical Properties Table
   8. Graph 1
   9. Graph 2
   10. Land Use

3. **Objective:** To learn to effectively present data in a tabular format.

Task: Choose three interesting soil physical or chemical properties and create a table in Microsoft Power Point displaying the chosen properties for each soil depth.

4. **Objective:** To learn to effectively present data in a chart.

   Task: Choose one property from soil physical or chemical properties that would be interesting to display graphically and create a chart in Microsoft Power Point.

5. **Objective:** To learn to effectively present data in a pie chart.

   Task: Choose a soil depth and create a pie chart to display the soil texture (% sand, % silt, % clay) for that depth.

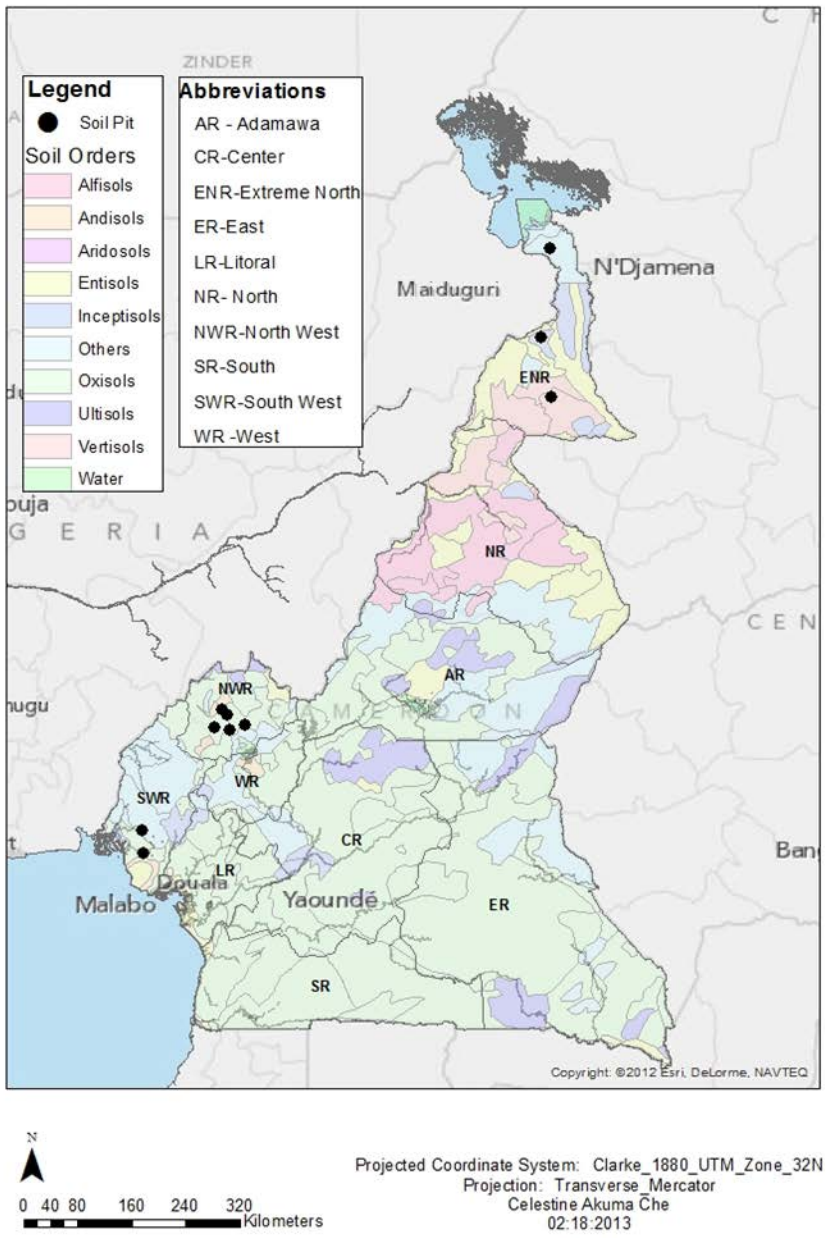


Figure 1. Generalized regional (EN=Extreme North, N=North, A=Adamawa, E=East, S=South, C=Center, L=Litoral, W=West, SW=South West, NW=North West) and soil (with ten soil pit locations) map of Cameroon.

North West Region Representative Pilot Soil Project

Prepared by,

Celestine A. Che
Ph.D Candidate

Clemson University

What is a North West Regional Soil?

- Has special significance to that region with respect to:

- Used to build houses (sun-dried building blocks), and create pottery;
- Arabica coffee grows on this soil;
- Occupies most of the North West region.

North West Region Representative Soil Profile

TYPICAL PEDON: Clayey Highlation - cropped. (Colors are for dry soil.)

Ap--0 to 28 cm, yellowish red (5YR 4/6 dry) fine sandy clay loam, moderately strong fine and subangular blocky structure, breaking into very fine granular; soft, slightly sticky, slightly plastic; few strongly weathered fine grained basement rock; many fine, few medium pores, many fine, common medium, few coarse roots; clear smooth boundary.

BA--28 to 50 cm, Dark red (2.5YR3/6) clay loam to clay; somewhat weak medium sub angular blocky structure, slightly hard, sticky, slightly plastic; many fine, few medium pores common fine, few medium and coarse slightly, hard, sticky, slightly plastic; many fine, few medium and coarse roots; clear smooth boundary.

Bs1--50 to 95 cm, red (2.5R5/8, moist) clay; moderate coarse subangular blocky structure; friable, sticky, slightly plastic; many fine, few medium pores; common fine roots, few medium roots; gradual smooth boundary.

Bs2-95-150 cm, Red (2.5YR-10YR 4/8, moist) clay; moderate coarse subangular blocky structure; friable, sticky, slightly plastic; many fine few medium pores; few fine roots; gradual smooth boundary.

Bs3-150 to 200 cm. Red (10R4/8, moist) clay; somewhat weak coarse and very coarse subangular blocky structure, friable, sticky, slightly plastic many fine pores; few fine and medium roots.

Sources: Yerima and Ranst, (2005).

Geographic extent of soils of North West Region

Source: Google.com

NWR Soil profile forming factors

- Parent material: Parent material is made of magmatite.
- Climate: High rainfalls(3013mm), short dry season (2-3 months), mean temperature of 20.1 •C, relative humidity of 67 %. Ustic moisture regime.
- Biota: Savannah grassland, interspersed with shrubs and stunted trees.; *Bridelia speciosa, Eucalyptus globulus, Calliandra calothyrsus, Leucoena leucocephala* and *Casuarina equisefolia*. Valleys are filled with palm bushes.
- Topography: The topography is undulating land with a slope of 2% to 8%. The landform has low planation surface and relief.
- Time: Highly weathered soil.
- Land Use: Montane forest. Cleared areas are used to farm maize, sweet potato, groundnuts, oil palm, coffee, and some eucalyptus

Sources: Focho et al. 2009; Yerima and Ranst, 2005

Classification

- CLASSIFICATION:
- IUSS/FAO/ISRIC WRB (1998): Hapli-Rhodic Ferrasols
- TAXONOMIC CLASS(French CPCS, 1967): Sols Ferrallitique, fortement desatures, typiques mondaux, sur migmatite
- TAXONOMIC CLASS: Haplustox, clayey

- <u>USDA Classification:</u>
- Order: Oxisols
- Suborder: Ustox
- Great Group: Haplustox
- Family: Clayey Haplustox

Sources: Yerima and Ranst, 2005

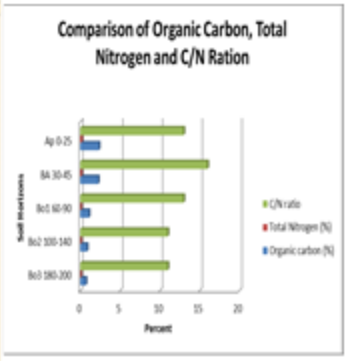
Soil Physical Properties

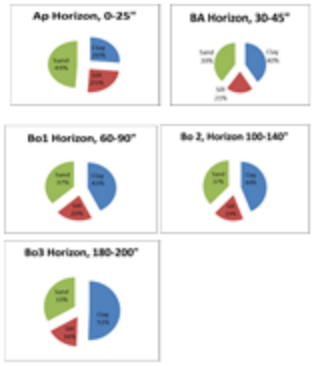
	Ap 0-25	BA 30-45	Bo1 60-90	Bo2 100-140	Bo3 180-200
Organic carbon (%)	0.25	0.06	1.09	0.05	0.7
Total Nitrogen (%)	0.12	0.14	0.02	0.06	0.06
C/N ratio	12	16	12	11	11
Texture (%)	Sandy clay loam	Sandy clay loam	Sandy clay loam	Clay	Clay
Clay	24.6	40.4	42.2	42.2	50.6
Silt	22.9	20.6	20.6	12.9	16.4
Sand	45.5	29.6	26.6	27.2	22.1
pH H2O	5.1	5.2	5.2	5.4	5.5
CEC (Cmol/100g soil)	9.2	2.6	2.6	2.7	4.9
BS-CEC (%)	14	9	9	16	56

Based on Yerima and Ranst, 2005

Soil Physical Properties

- Texture by soil depth





Based on Yerima and Ranst, 2005

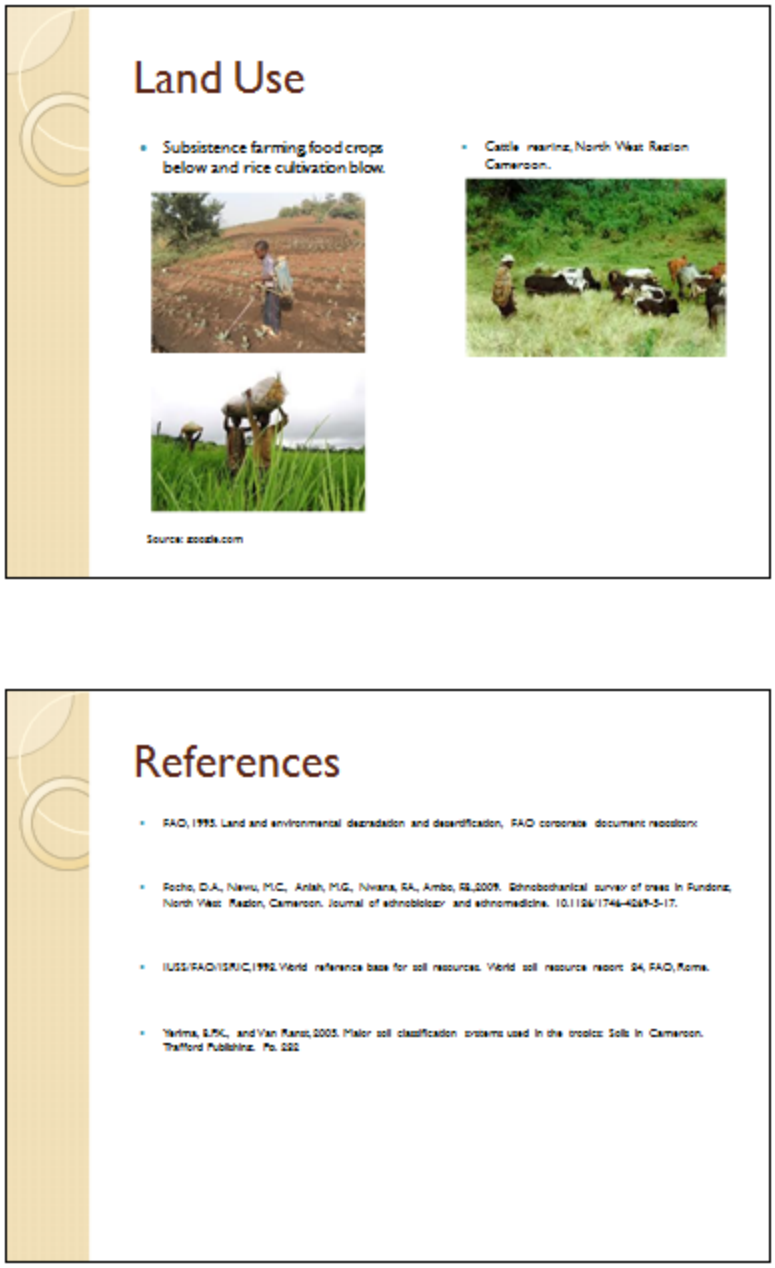


Figure 2. Example of Regional Representative Soil Project for North West Region of Cameroon.