NRM 5403
Soil Morphology, Genesis, and Classification

Instructor: Dr. Lynn Loomis

I am a retired soil scientist with ~30 years of experience making soil surveys in Far West Texas for USDA Natural Resources Conservation Service. Currently I serve as Land Resource Scientist for Alamito Foundation, developing rangeland restoration plans for a ranch in the Desert Grassland vegetative zone of Presidio County.

Telephone: 432-888-5126; call me at my home in Weimar in the evening between 6:30 and 8:30 pm, and Sunday afternoon between 2:00 and 6:00 pm.

Email: lynn.loomis@sulross.edu Email is probably the best method to communicate with me.

Introductory statement: This class will introduce you to a world that has existed for eons. Your eyes will open to landscapes, landforms, rocks, sediments, soil, water, plants, vegetation, and animals. You will learn to recognize and appreciate some of the incredibly complex interactions among these components at varying spatial and temporal scales. These components perform many functions essential for life, human and otherwise. In the words of Hudson (1992) you will undergo a "gestalt shift." Once you learn to view your surroundings in the manner taught in this class, you will never be able to "unsee" the world that way again. In this course you will learn three languages of soil science so you can communicate with others about the natural world. Furthermore, you will learn various approaches to solving environmental problems related to the soil-vegetation-water systems.

In the lecture portion of this course, you will learn the specialized terms and vocabulary used to describe soil bodies ranging in size from particle-size separates to hillslopes and watersheds (soil morphology). From that starting place, you will learn to analyze soil bodies and develop rational and testable explanations for how and why they formed (soil genesis). Then you will learn yet another language, the language of Soil Taxonomy, that allows you to communicate the essential attributes of a soil class to other scientists (soil classification).

Classroom instruction provides a foundation for hands-on instruction on soil morphology, soil genesis, and soil classification 'out in the field', where the real learning takes place. You will also learn to make maps of soil bodies and soil classes with ArcGIS.

Objectives:
1. Describe soil morphology of a pedon, identify its diagnostic features and horizons; and classify the pedon to the great group level in Soil Taxonomy.
2. Understand the relationships among soil morphology, soil classification, genetic factors, and genetic processes.
3. Given the name of a taxon within Soil Taxonomy, identify its categorical level, and it soil order.
4. Possess an overview of the Soils of the United States, Soils of Texas, and Soils of the Trans-Pecos.
5. Create a vector soil map of the Sul Ross Rangelands.
6. Understand the scientific method as it applies to soil-landscape studies.

Class meetings: Tuesday and Thursday 2:00 pm to 4:00 pm

For most meetings, I will conduct class and deliver lectures online from my home near Weimar. During selected field meetings, I will provide face-to-face instruction on soil morphology description and soil mapping in the field.

Lecture notes: PowerPoint files will be posted on Blackboard. They are available for downloading and printing before class. Print the notes as handouts 6 slides per page; or if you need space to take notes, 3 slides per page.

Time committment: To gain maximum benefit from this class, you will spend time with the class materials. For each hour of class meeting, you should plan to spend 1 to 2 hours of reading, studying, writing, working on class project, etc. Because this a 3-hr semester credit hour course, outside time devoted to these activities will amount to about 3 to 6 hours per week.

Texts and references: Pdf's of all these have been posted on BlackBoard.

Jenny, H. 1941. The factors of soil formation: a system of quantitative pedology. McGraw Hill Book Co. 191 pp.

Soil Survey Staff. 2017. Soil survey manual, Third edition. USDA Natural Resources Conservation Service. 603 pp.

Soil Survey Staff. 1999. Soil Taxonomy: A Basic System of Soil Classification for Making and Interpreting Soil Surveys. Second edition. USDA Agriculture Handbook 436. 870 pp.

Soil Survey Staff. 2014. Illustrated Guide to Soil Taxonomy. USDA Natural Resources Conservation Service. 552 pp.

Soil Survey Staff. 2014. Keys to Soil Taxonomy (Twelfth edition). USDA Natural Resources Conservation Service. 360 pp.

Soil Survey Staff. 2022. Land Resource Regions and Major Land Resource Areas of the United States, the Caribbean, and the Pacific Basin. USDA Agricultural Handbook 296. 669 pp.

Schoeneberger, P.J., D.A. Wysocki, E.C. Benham, and Soil Survey Staff. 2012. Field book for describing and sampling soils, Version 3.0. Natural Resources Conservation Service, National Soil Survey Center, Lincoln, NE. 228 pp. You can request a hardcopy of this useful reference by calling the NRCS Distribution Center at 515-270-4864.

Peterson, F.F. 1981. Landforms of the Basin & Range Province defined for soil survey. Nevada Agricultural Experiment Station Technical Bulletin 28. 52 pp.

Grade (200 points total)

Participation in class exercises and discussions (50 points, 25%)
One page summaries of scientific papers and Class discussion (50 points, 25%)
Individual project (50 points, 25%)
Group project vector soil map (50 points, 25%)

Written summary of Reading assignments

You can gain basic knowledge of soil science literature by completing the reading assignments. Each week three scientific papers will be assigned to be read. A one-page summary (MicroSoft Word document) of two papers, one Scientific Method paper and one Soil Genesis paper (your choice), will be due at the beginning of class the following week. Pdf's of all papers have been posted on BlackBoard.

Scientific method papers

Chamberlin, T.C. 1890. The method of multiple working hypotheses. Science 15:92-96.

Williams, B. 1997. Logic and science in wildlife biology. Journal of Wildlife Management 61:1007-1015.

Platts, J.R. 1964. Strong inference. Science 146:347-353.

Hudson, B. 1992. Soil survey as a paradigm-based science. Soil Science Society of America Journal 56:836-841.

Dijkerman, J.C. 1974. Pedology as a science: the role of data, models and theories in the study of natural soil systems. Geoderma 11:73-93.

Kinrade, T.B., and R.F. Denison. 2003. Strong inference-the way of science. American Biology Teacher 65:419-424.

Guthery, F.S., J.J. Lusk, and M.J. Peterson. 2004. Hypotheses in wildlife science. Wildlife Society Bulletin 32:1325-1332.

Cleland, C.E. 2001. Historical science, experimental science and the scientific method. Geology 29:987–90.

Major, J. 1951. A functional, factorial approach to plant ecology. Ecology 32:392-412.

Baker, V.R. 2014. Uniformitarianism, earth system science, and geology. Anthropocene 5:76–79.

Stoskopf, M.K. 2005. Observation and cogitation: how serendipity provides the building blocks of scientific discovery. ILAR Journal 46:332-337.

Soil genesis papers

Simonson, R.W. 1959. Outline of a generalized theory of soil genesis. Soil Science Society of America Proceedings 23:152-156.

Swanson, F.J., T.K. Kratz, N. Caine, and R.G. Woodmansee. 1988. Landform effects on ecosystem patterns and processes. BioScience 38:92-98.

Jacob, J.S., and B.L. Allen. 1990. Persistence of a zeolite in tuffaceous soils of the Texas Trans-Pecos. Soil Society of America Journal 54:549-554.

Allen, B.D. 2005. Ice age lakes in New Mexico. pp 107-114 IN: Lucas, S.G., G.S. Morgan, and K.E.Zeigler, (eds). New Mexico's Ice Ages. New Mexico Museum of Natural History and Science Bulletin No. 28.

Gile, L.H. 1975a. Causes of soil boundaries in an arid region: I. Age and parent material. Science Society of America Proceedings 39:316-323.

Gile, L.H. 1975b. Causes of soil boundaries in an arid region: II. Dissection, moisture, and faunal activity. Soil Science Society of America Proceedings 39:324-330.

Wondzell, S.M, G.L. Cunningham and D. Bachelet. 1996. Relationships between landforms, geomorphic processes, and plant communities on a watershed in the northern Chihuahuan Desert. Landscape Ecology 11:351-362.

McAuliffe, J.R. 1994. Landscape evolution, soil formation, and ecological patterns and processes in Sonoran Desert bajadas. Ecological Monographs 64:111-148.

Peterson, F.F., J.W. Bell, R.I. Dorn, A.R. Ramelli, and T. Ku. 1995. Late Quaternary geomorphology and soils in Crater Flat, Yucca Mountain area, southern Nevada. Geological Society of America Bulletin 107: 379–395. Read pages 379-385 and Discussion, and Conclusions and Implications for Future Studies on pages 391-394.

Hallmark, C.T., and B.L. Allen. 1975. The distribution of creosotebush in west Texas and eastern New Mexico as affected by selected soil properties. Soil Science Society of America Proceedings 39:120-124.

Woodruff, C.M. and L.P. Wilding. 2007. Bedrock, soils, and hillslope hydrology in the Central Texas Hill Country, USA: implications on environmental management in a carbonate-rock terrain. Environmental Geology 55:605-618.

Wilcox, B.P., L.P. Wilding, and C.M. Woodruff. 2007. Soil and topographic controls on runoff generation from stepped landforms in the Edwards Plateau of Central Texas. Geophysical Research Letters 34:1-6.

Hall, S.A., and J.A. Peterson. 2013. Floodplain construction of the Rio Grande at El Paso, Texas, USA: response to Holocene climate change. Quaternary Science Reviews 65:102-119.

Culver, J.R. and F. Gray. 1968a. Morphology and genesis of some grayish claypan soils in Oklahoma: I. Morphology, Chemical and Physical Measurements. Soil Science Society of America Proceedings 32:845-851.

Culver, J.R. and F. Gray. 1968b. Morphology and genesis of some grayish claypan soils of Oklahoma: II. mineralogy and genesis. Soil Science Society of America Proceedings 32:851-857.

Wilding, L. P. 1994. Factors of soil formation: Contributions to pedology. p p 15-30 IN: R. Amundson, J. Harden, and M. Singer, eds. Factors of Soil Formation: A Fiftieth Anniversary Retrospective. Soil Science Society of America Special Publication 33.

Arnold, R.W. 1965. Multiple working hypothesis in soil genesis. Soil Science Society of America Proceedings 29:717-724.

Individual project: Each student will select a geographic area of particular personal interest (a family ranch, thesis area, favorite vacation spot, etc.), obtain the imagery (NAIP, LandSat, SPOT, ASTER, etc) and geospatial attribute data (DEM, DRG, SSURGO, Geology, measured stratigraphic sections, Official Series Descriptions, soil characterization data, etc.) relating to soils and natural resources of that area, and portray using ArcGIS and ArcScene the important soil-vegetation-landscape-wildlife relationships of it. Each student will deliver an informal PowerPoint project summary the during the final class meeting.

Lab Exercises: exercises are listed on the class schedule.

Soil description / classification / mapping exercise: An important aspect of this course (about 1/4 of class meeting time) will be spent in the field describing soil morphology, recognizing diagnostic features and horizons, identifying taxonomic class, evaluating genetic factors, and creating soil maps of the RAS Rangelands and Sul Ross Hill.

Describe the morphology of pedons in the field, identify restrictions and diagnostic features / horizons, then classify pedon to the family level of Soil Taxonomy.

Fall weather in Far West Texas is rather predictable; most days will be suitable for outside work.

Field attire: Long pants, long sleeves, sturdy shoes or boots, wide brim hat
Supplies: Sun block, water, snack, digital camera

Group Project: Create a vector (polygon) soil map of Sul Ross Hill / RAS Rangelands using ArcGis. Each student will deliver part of the soil map and a map unit description in an informal PowerPoint summary the during the final class meeting.

Computer Software to learn and use: MS Access 2010, MS Excel 2010, ArcGIS 10.8, ArcCatalog, ArcScene, QGIS, TauDEM, SAGA