NRM 5403 Special Topics
Soil Morphology, Genesis, and Classification
Summer 2025

Instructor: Dr. Lynn Loomis

Ocotillo and pinyon, two plants with quite different environmental requirements, grow side-by-side in the Glass Mountains (left), the Broke-off Mountains (right), and other limestone mountain habitats west of the Pecos River. What do these plants, occurring together, tell us about that habitat?

I am a retired soil scientist with ~30 years of experience making ecological site/soil surveys for USDA Natural Resources Conservation Service in Far West Texas. From 1996 to 2000, I served full-time on the Sul Ross Natural Resource Management faculty. Currently I work as a land resource consultant, developing and implementing rangeland restoration plans for ranches in Far West Texas. During the past 30 years I have taught this course about 10 times.

Telephone: 432-888-5126; call me at my home near 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. You will observe rocks, sediments, landscapes, landforms, 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 soil-water-vegetation systems.

In lectures, 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 will allow you to concisely communicate the essential attributes of a soil class to other scientists (soil classification).

Classroom instruction simply provides a foundation for hands-on instruction on range ecology, soil morphology, soil genesis, and soil classification "out in the field", where the real learning takes place. You will also be taught to make block diagrams and maps of ecological site/soil bodies with [Arc-Q]GIS.

Prerequisites: Required is only senior status in the Sul Ross College of Agriculture, Life and Physical Sciences or admission to a Sul Ross State University graduate program. This course will build upon your personal and academic background in natural science.

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

Learning 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. Explain the relationships among genetic factors, genetic processes, range ecology, soil morphology, and ecological site and soil classification.
3. Given the name of a taxon within Soil Taxonomy, identify its categorical level, and its 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 ecological site/soil map of the part of the Mimms Ranch at Marfa.
6. Apply the scientific method to landscape water-vegetation-soil studies.

Class meetings: Tuesday, Wednesday, and Thursday 10:00 am to 12:00 noon
Schedule leaves weekends free to do your research project.
I will conduct classes and deliver lectures online from my home near Weimar, Texas.
Class meetings will begin on Wednesday, May 28. The final meeting will be on Wednesday, August 12, 2025.

Grade (200 points total)

Participation in class exercises and discussions (50 points, 10%)
One-page summaries of scientific papers (200 points, 40%)
Individual project (75 points, 15%)
State factor assignment (50 points, 10%)
Group vector soil map project (75 points, 15%)
"Figure this out and tell me what I need to know" project (50 points, 10%)

Notice: No exams, only practical demonstrations of your acquired knowledge, skills, and abilities.

Field Week: I will provide five full days in the field (Monday to Friday, July 21 through 26) of essential, dedicated face-to-face instruction on 1) orienting oneself to the geologic-geomorphic-vegetation-soil environment; 2) describing soil morphology;3) recognizing restrictions, diagnostic features, and horizons; 4) classifying each pedon to the family level in Soil Taxonomy; 5) evaluating genetic factors; and 6) creating an ecological site/soil map of part of the Mimms Ranch at Marfa. You will need to clear your schedule to take advantage of this opportunity.

Group Project Soil description/classification/mapping exercise: Create a vector (polygon) ecological site/soil map of ~500 acres of the Mimms Ranch at Marfa using GIS. Each student will deliver part of the soil map and a map unit description in an informal PowerPoint summary during the final class meeting.

Field attire: Long pants, long sleeves, sturdy shoes or boots, wide brim hat
Supplies: Sun block, water, snack, smartphone/digital camera
Summer weather in Far West Texas is rather predictable; most days will be suitable for outside work. Be prepared to walk distances up to 2 miles. Remember that shade is sparse on the Mimms Ranch.

State factor assignment: Knowledge of the vegetation/soil forming factors is essential for mapping ecological site/soil. As a service to the mapping team, each student will thoroughly research one of the five factors for the mapped area and present his findings to the class.

Individual project: Each student will 1) select a geographic area of particular interest (a family ranch, thesis study area, favorite vacation spot, etc.); 2) 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 the vegetation, soil and natural resources of that area, and 3) portray using [Arc][Q]GIS the important soil-water-vegetation-landscape-wildlife relationships of it. Each student will deliver an informal PowerPoint project summary during the final class meeting.

"Figure this out and show me what I need to know" project: Each student will 1) develop skills to [learn] [pioneer] and demonstrate new software and data types that help to discover, decipher, understand, and communicate relationships among bedrock, landform, landscape, soil, vegetation, and wildlife, 2) create a document archiving the rationale, data, methods (software workflow), and results, and 3) instruct the professor and classmates on the use of the software and data.

I have an extensive list of potential "Figure this out and show me what I need to know" projects.

Time commitment: 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 projects, etc. Because this is a 4-hr credit course, you should devote about 4 to 8 hours per week outside time to these activities.

Field/Lab Exercises: Exercises are listed on the class schedule.

Computer Software to learn and use: Access, Excel, ArcGIS Pro, QGIS, TauDEM, SAGA, WhiteBox

Texts and references: Pdf's of all the following documents 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. 2022. Keys to Soil Taxonomy (Thirteenth edition). USDA Natural Resources Conservation Service. 401 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.

Soil Survey Staff. 2024. Field book for describing and sampling soils, Version 4.0. Natural Resources Conservation Service, National Soil Survey Center, Lincoln, NE. 312 pp. You can request a hardcopy of this useful reference by calling the NRCS Distribution Center at 888-526-3227.

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

Written summary of Reading assignments

You can gain basic knowledge of the literature of range ecology and soil science by completing the reading assignments. Each week three scientific papers will be assigned to be read. A one-page summary (MicroSoft Word document, 12pitch font, double-spaced, 1-inch margins) of each paper will be due at the beginning of class the following Wednesday. 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. pp 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.