BOOK REVIEW

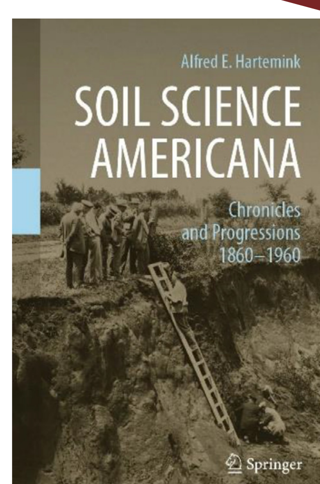
Soil Science Americana: Chronicles and Progressions 1860–1960, Alfred E. Hartemink, ISBN 978-3-030-71135-1. Cham, Springer Nature Switzerland, 2021. eBook, 623 pages Price: $34.99, Hardcover, 623 pages Price $44.99.

Central to the American soil science story is how we responded when soils became "tired," "sick," "out-of-condition," or "worn-out." In the early 19th century, this was called soil exhaustion, a broad term including any soil depleted of fertility. Settlers who farmed unsustainably exhausted the soil. Following years of declining crop yields, many Americans responded by moving west to the seemingly unlimited fertile lands in the frontier. Those who stayed responded to soil exhaustion by experimenting with additions of lime and manure to improve fertility. Over time, the frontier pushed further into more marginal lands, and America eventually ran out of new land to farm. Within a few decades, the U.S. suffered the Great Depression, prolonged drought, and an ecological disaster. Ignorance and carelessness had caused the most severe soil exhaustion in American history. This time, America responded by accelerating soil surveys, land classification, and land-use planning.

Soil Science Americana covers the roughly 300 people who responded to soil exhaustion, where they lived and worked, and how they interacted. The author, Alfred Hartemink, expertly draws on unpublished diaries, interviews, photographs, personal letters, and every bibliography and publication he could find on the subject. The main protagonists are Emil Truog, a long-time professor at the University of Wisconsin (1909–1953), and Charles Kellogg, the long-serving leader of the US Soil Survey (1934–1971), both of whom were scientists responding to soil exhaustion. Truog worked to grow plants with better quality and yields, while Kellogg observed and mapped how soils varied. Long time friends, they both believed "*that understanding soils was crucial to helping people on the land make a better living*." As typical of the time, American soil scientists often stayed in long-term leadership positions creating an old-boys network that entrenched tradition and lacked diversity. On this later point *Soil Science Americana* suggests we would have had more frequent paradigm shifts if the discipline was more diverse. Their long years of service in those positions created routines and together they trained a lot of people.

The book's 15 chapters include a Prologue on the roots of Soil Science, early differences between Russian and American soil research, biographies of Emil Truog, Charles Kellogg, and Roy Simonson (a student of Truog and Kellogg), contributions from Western US soil scientists, Building an American Survey, Of Soils and Men, Russian immigrants to the US, four chapters on the progression of International Soil Science, a summary of American chronicles and progressions, and an epilogue on the legacy of Truog and Kellogg. The 1860s are a logical starting point as (amidst a Civil War) the US established the US Department of Agriculture (USDA) to provide agricultural leadership through policy, science, and management, and land grant universities to teach "practical agriculture." Within the century, the US had become a global scientific leader in agriculture and soil science.

Rangelands play a supporting role in this American story. Interestingly, there were only a few countries in the world that possessed the vast land with predictable climatic gradients necessary to develop universal theories of soil formation and distribution. The US and Russia both possessed such expanses (prairies or steppes), and both regions contained the visually striking "black earth" soils (Mollisols or Chernozems) for which soil horizon properties change predictably across temperature and moisture gradients. Russians had the first significant breakthrough in the 1880s by the geologist and mineralogist Vasily Dokuchaev (1846–1903). Through observation and inference of Chernozems on the Russian steppes, Dokuchaev untangled the role of climate, geology, vegetation, and topography on soil properties and found they occurred across the land according to ordered geographic principles. He stated, "*…soil is a natural independent body which like any other natural body or organism has a specific origin, history of development, and external appearance.*" Around this time in the US, the geologist John Wesley Powell (1834–1902) observed that at the country's midway point (the 100th meridian) begins a region "*so arid that agriculture is not successful without irrigation*."[1] Instead of using empirical observations to understand the nature of soils across this expanse, the US responded by building dams to irrigate even more marginal lands. Language barriers and insular politics limited the US's exposure to pedologic advances out of Russia, and America's focus on agrarian practices and agricultural development delayed the US from making the same breakthroughs.



America's first soil science pioneer was German born and long-time UC-Berkeley agricultural chemistry professor (1875–1904), Eugene Hilgard (1833–1916). Hilgard believed in a geologic origin of soil and that soil fertility was primarily controlled by its chemical composition. He created first-of-its-kind soil sampling guidelines, and many of our soil science definitions, concepts, physical parameters, standard units, and techniques originated with him. In chapter 6, "The Mother of the West," we learn Hilgard did not get along well with Milton Whitney (1860–1927), the Baltimore-born first chief of US Soil Survey (1894–1913) whose work on eastern tobacco farms showed that soil physical properties and soil moisture primarily influenced soil fertility. Hilgard was also offered the soil survey chief position but declined. Had Hilgard taken the position, early soil surveys would have had a unique soil chemistry focus and perhaps very different beginnings.

The chapter "The Mother of the West" also follows the Missouri-born geologist Curtis Marbut (1863–1935) and Swiss-born soil chemist Hans Jenny (1899–1992). Marbut became interested in soils while mapping geology in Missouri's Ozark Mountains, an interest that led him to become the 2nd director of US Soil Survey (1913–1935). By this time, Russian breakthroughs by Dokuchaev were translated into German by Konstantin Glinka (1867-1927), and Marbut taught himself German to translate these ideas to English. By the 1930s, Marbut was classifying soil by dividing them at the highest level based on properties observed across the Great Plains moisture gradient. He called the dryer soils Pedocals (accumulated carbonates), and wetter soils Pedalfers (accumulated aluminum and iron sesquioxides). Hans Jenny was a soil chemist and long-time professor at UC-Berkely (1936–1992). Partly influenced by train rides across the Great Plains, Jenny published the popular state factor model in 1941 with the "Factors of Soil Formation – A System of Quantitative Pedology"[2]. The state factor model was mostly dismissed by US Soil Survey at the time, although its quantitative focus on soil properties over genetic principles has persisted and serves as a theoretical foundation for digital soil mapping.[3]

Michigan-born Charles Kellogg became the third chief of the US Soil Survey in 1934 (his actual title was Principal Soil Scientist and Chief of the Division of Soil Survey, USDA-Bureau of Plant Industry) and held a leadership position in the soil survey until 1971. During his time as chief, Kellogg published the first Soil Survey Manual in 1937. Hartemink states of this work, "*It is impossible to overstate the contribution of the Soil Survey Manual for the subsequent evolution and application of soil surveys worldwide. The manual has been used, adopted, or translated by soil survey centers across the world.*" Not only did the manual contain well-tested methods, but it was also distributed freely. Beginning in 1935, the USDA essentially had two soil mapping programs: one in the Division of Soil Survey headed by Kellogg, and one in the Soil Conservation Service (SCS) headed by the North Carolina-born Hugh Hammond Bennett (1881–1960). The SCS mapped land instead of soil and emphasized slope and erosion classes. The Soil Survey maintained a pedological focus with their mapping, although they started to develop land-use interpretations, including the land capability classification beginning in 1939. The two surveys eventually merged in 1952, with Kellogg remaining in charge of the Soil Survey.

With the 1950's came a critical mass of systematically described soil series data (up to 5,000 series by 1960). This provided enough data to develop a universal taxonomic classification based on measured soil properties instead of theories of soil genesis. Guy Smith (1907–1981), an Iowa-born past student of Jenny was hired by Kellogg to lead this effort. Smith surprised the world at the 1960 World Soil Congress with a long sought-after global soil taxonomy system, the Seventh Approximation, also freely distributed to all attendees. While not without its detractors, the Seventh Approximation brought in a new age of data-driven science and classification. Of note, two things have consistently preceded the creation of any soil map: a standardized methodology of describing soil horizons and a systematic taxonomy to classify soil concepts. These are both significant American contributions to global soil science, and Hartemink shows that these ideas and concepts trace back to only a few personalities.

How America responded to rangeland soil exhaustion is not well explored in Soil Science Americana, yet it follows a similar story. Beginning in the 1890s, increased soil erosion and loss of native plants on arid rangelands led to acute cattle mortality. Indiana-born Elmer Otis Wooton (1865–1945), a "broadly trained jack of all trades" botany professor at New Mexico State University (1890–1911) attributed deteriorating rangeland conditions to drought and overgrazing.[4] Wooton was also frustrated by the lack of large lands necessary to apply research to the typically large Southwest ranches. Responding to this need, the US Forest Service established large experimental ranges at the beginning of the 20th century, most notably the Santa Rita (established in 1903), Great Basin (1912), and Jornada (1912) Experimental Ranges. With the SCS in the 1930s, came rangeland monitoring, methods aligned more with Bennett's land survey over Kellogg's pedologic methods. Kellogg's survey continued with a distinctly agrarian focus, as he considered one of the most important boundaries on a soil map as the limit between the sown and unsown land, the cultivated land versus land that can only grazed.[5] In 1949, E.J. Dyksterhuis (1910–1991), a rangeland scientist with the SCS (1944–1964), published "Condition and Management of Rangeland Based on Quantitative Ecology,"[6] showing that range condition could be quantified and evaluated against a reference state defined by climate, soil, and vegetation variables. This quantitative approach to land management gave us a framework to understand the optimal land potential at a desired structure and is still used today.[7] Acknowledging that less attention is given to Western US Soil Survey, Hartemink points us to the autobiography of Macy Lapham,[8] who surveyed the west during US Soil Survey's first 45 years. It is also a wonderful read about the people and places of (Western) American Soil Science.

On reading about the outsized influence of only a small few people on the discipline, I couldn't help and reflect on my own soil-family tree. A quick survey of my mentors traces an unsurprising genealogy to Francis Hole and Hans Jenny. I suspect this is confirmation bias of my interest in quantitative soil geography. Francis Hole (1913–2002) was another long-time professor at Madison, WI (1946–1983) and was a quaternary geologist turned soil geographer—he also makes a few cameos in the book. In my favorite, Hole, a Quaker opposed to racial segregation, refused to cross the Mason-Dixon line during the 1960s World Soil Congress Field Tour.

Responding to soil exhaustion, Americans tried to understand how soil makes plants grow and how the soils differed across the landscape. Hartemink presents a fascinating narrative of how they allied, argued, and innovated. This book is an excellent first chapter in American Soil Science's evolving arena of ideas, people, and places.

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