Economic Research Service
U.S. DEPARTMENT OF AGRICULTURE

# Environmental Sectors: Soils

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Thursday, October 3, 2024

# Disclaimer

- The findings and conclusions in this presentation are those of the author(s) and should not be construed to represent any official USDA or U.S. Government determination or policy.

- This presentation was supported in part by the U.S. Department of Agriculture, Economic Research Service.

# Soils Account

- U.S. National Strategy (Executive Summary)
  - “People depend on nature to supply important services and economic opportunities… *soils*, water, and bees work with America’s farmers to grow food; and trees, grasses, and other plants are the original carbon capture and storage system and also filter other pollutants...”

- USDA’s Mission
  - We provide leadership on food, agriculture, natural resources, rural development, nutrition, and related issues based on public policy
  - Managing for soil health allows producers to work with the land – not against – to reduce erosion, maximize water infiltration, improve nutrient cycling, save money on inputs, and ultimately improve the resiliency of their working land. – farmers.gov

# Why account for soils?

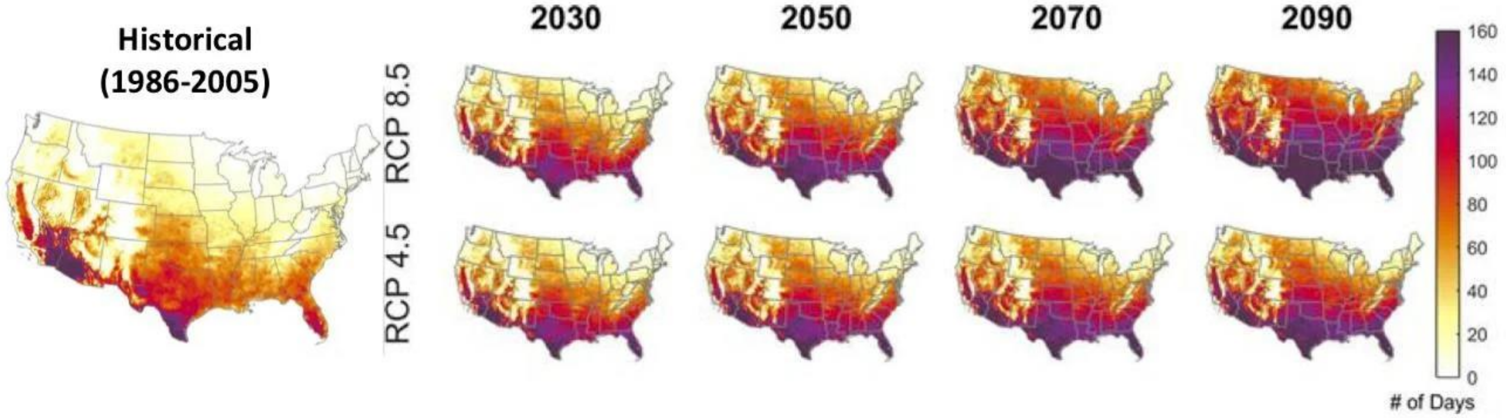
- Dust Bowl (1930s)
  - Fed gov't encouraged settlement of the Plains with the Homestead Act (1862)
  - Farmers deeply plowed the topsoil over several decades
  - Great Plains suffered severe droughts in the 1930s
  - "Black Sunday" (1935)
    - Dust storms occurred across the entire sweep of the Great Plains from Canada to Texas
  - Human displacement

- Fed gov't responded during the FDR admin
  - Quickly initiated programs to conserve soil
    - Soil Conservation Service
      - Natural Resources Conservation Service
    - US Forest Service
    - Farm Security Administration


Source: William L. Farr (2022)

Source: George Everett Marsh (1935)

# Why account for soils?




Changing temperature patterns across the U.S.
Source: Union of Concerned Scientists (2019)

- Climate change is expected to negatively impact soils over the next several decades
  - Soil erosion (Borrelli et al., 2020)
  - Soil salinization (Corwin, 2020)
  - Microbiomes and the carbon cycle (Naylor et al., 2020)
  - Loss of soil biodiversity (Tibbett, Fraser, and Duddigan, 2020)

# National Strategy

| | | Co-Lead Departments/ Agencies | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 | 2036 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Phase II Environmental Sectors | Minerals & Energy | DOI, BEA, NOAA | | | | | | | | | | | | | | |
| | Forests | USDA, USFS | | | | | | | | | | | | | | |
| | Urban green space | DOI, USDA, NOAA, USFS | | | | | | | | | | | | | | |
| | Pollinators | USDA | | | | | | | | | | | | | | |
| | Marine natural capital (II) | NOAA, BEA | | | | | | | | | | | | | | |
| Phase III Environmental Sectors | Wildlife, including birds, mammals, and fish | DOI | | | | | | | | | | | | | | |
| | Wetlands and peatlands | DOI, NOAA | | | | | | | | | | | | | | |
| | Soils | USDA | | | | | | | | | | | | | | |
| | Grasslands, deserts, tundra, etc. | USDA, DOI | | | | | | | | | | | | | | |
| | Marine natural capital (III) | NOAA, BEA | | | | | | | | | | | | | | |
| | Non-traditional geologic assets | DOI, BEA | | | | | | | | | | | | | | |
| Supporting Activities | Classification systems | CSOTUS, BEA, EPA, BLS, Census, DOI | | | | | | | | | | | | | | |
| | Data sharing protocols | CSOTUS, NASA, DOI, NOAA, Census | | | | | | | | | | | | | | |
| | Valuation standards for national accounting | OMB, BLS, BEA, EPA, NOAA, DOI, USDA | | | | | | | | | | | | | | |
| | Guidance for using the system in Federal benefit-cost analysis | OMB | | | | | | | | | | | | | | |
| | International engagement | CSOTUS, Treasury, State | | | | | | | Ongoing | | | | | | | |
| | Website and data serving system | BEA or other | | | | | | | | | | | | | | |

*Pending expected new guidance from the international statistical community in 2025.
**May articulate to the G20 data gaps initiatives.

**Note: Light gray indicates pilot account; dark gray is prototype account.**

# Different ways to measure soil health

- Soil health cannot be determined alone by
  - Crop yield
  - Water quality
  - Any singular outcome
- Typical measurements
  - Physical tests
    - Bulk density, infiltration, water holding capacity
  - Biological tests
    - Count of earthworms, microbial biomass, particulate organic matter
  - Soil organic matter
    - Nutrient retention, soil fertility, soil structure
  - Chemical
    - Electrical conductivity, reactive carbon, soil nitrate, soil pH
- Comprehensive indicators should be
  - Easy to measure
  - Assess changes in soil function
  - Encompass chemical, biological, and physical properties
  - Accessible to different users
  - Sensitive to variations in climate and management
- Constraints to soil health
  - Failure to return organic residues to the soil
  - Intensive tillage
  - Overgrazing
  - Limited crop rotation
  - Excessive application of fertilizers

# Public and Private Data

- Measuring soil health is going to require data
  - Valuation (*P*)
  - Physical assets (*Q*)

- Physical assets
  - Soil Survey Geographic database (SSURGO)
    - Accessible through the USDA's Web Soil Survey
    - Maintained by the NRCS
    - Contains multiple estimated properties of soil landscapes
  - State Soil Geographic database (STATSGO)
    - Broad inventory of soils and non-soil areas
    - Smaller set of estimated properties
  - Natural Resources Inventory (NRI)
    - Longitudinal survey of the nation's land-use characteristics
  - Forest Inventory and Analysis
    - Maintained by the U.S. Forest Service
    - Produces annual survey of U.S. forests and forest soils
  - Remote sensing databases
    - NASA Earth Data

Source: Agriculturepost.com (2018)

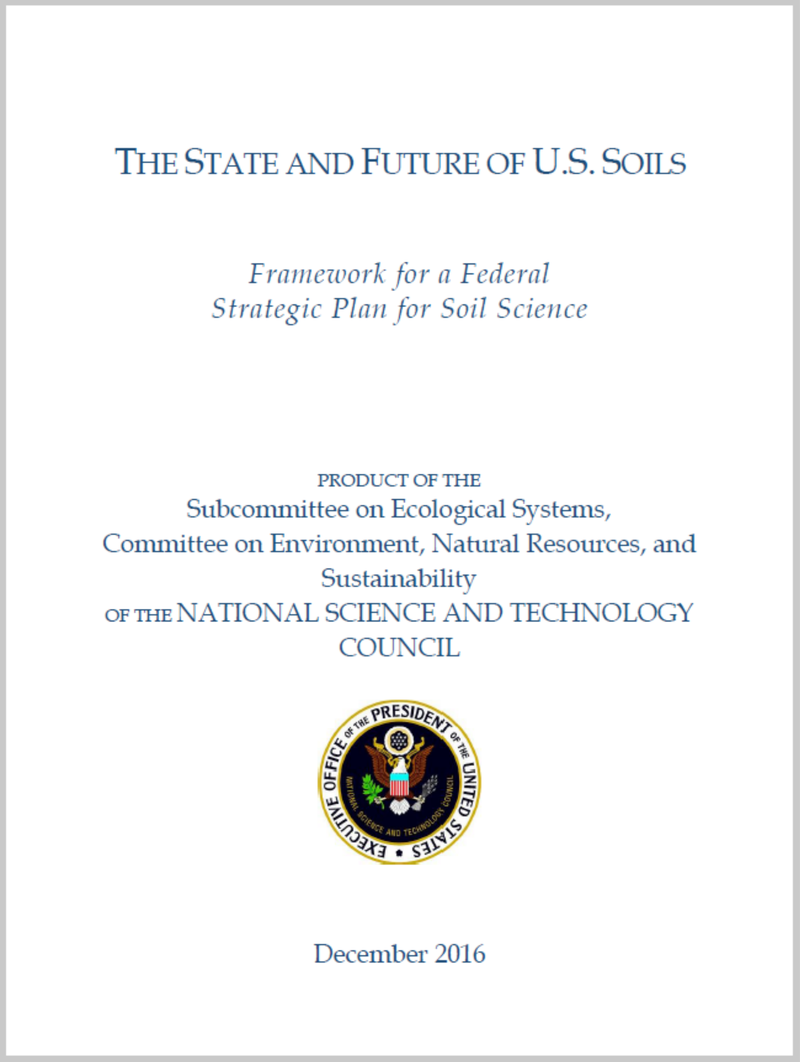
Source: University of Nebraska (2024)

# The State and Future of U.S. Soils

- Public perception of soil
  - “just dirt”

- Found that natural soil formation rates cannot (on its own) offset the current rates of soil losses due to erosion

- Five recommendations
  - Support applied social-science research in soils
  - Advance the national research infrastructure for soil data
  - Support a coordinate research effort
  - Expand and increase investment in long-term research
  - Prioritize programs and technical assistance to promote sustainable land-management practices


THE STATE AND FUTURE OF U.S. SOILS

*Framework for a Federal Strategic Plan for Soil Science*

PRODUCT OF THE
Subcommittee on Ecological Systems,
Committee on Environment, Natural Resources, and Sustainability
OF THE NATIONAL SCIENCE AND TECHNOLOGY COUNCIL

December 2016

# Soils need a prominent mascot




Woodsy Owl

Smokey Bear

USFS

Bac!

Food Safety and Inspection Service

Sammy Soil

Natural Resources Conservation Service

# Broad scope of soil account

**Natural capital: Soils**

Indicators of the extent, condition, and economic value of ecosystem and commodity natural assets

**Flows from soils**

Indicators of the biophysical flows

**Human inputs**

Economic and social indicators of the human inputs required to derive benefits from flows from soils

**Outputs**

**Benefits**

Economic and social indicators of the benefits derived from soils

**Residuals (Pollution or waste)**

Economic, social, and environmental indicators of the residuals produced through production, consumption, and accumulation of benefits from soils

Based on Fairbrass et al. (2020)

# Example of soil biodiversity

## Soil biodiversity

**Taxonomic diversity**

**Functional diversity**

**Landscape diversity**

**Interactions**

## Soil ecosystem services

**Provisioning services**

Nutrition
Genetic material
Materials
Energy

**Regulating and maintenance services**

Soil health
Climate regulation
Pest & disease control
Water quality and quantity

**Cultural services**

Physical interaction
Religion
Aesthetics
Education

## Human well-being

**Quality of life**

**Material needs**

**Health**

**Social relations**

Source: Guerra et al. (2024)

# Soil health content in SNA and SEEA

| System of National Account | SEEA–Central Framework | SEEA–Ecosystem Accounting |
|---|---|---|
| Crop gains/losses | Imperfect valuation in land accounting | |
| Environmental protection expenditures | Environmental protection for hazard mitigation | Reduced ecosystem extent |
| | | Hazard mitigation ecosystem services |
| | | |
| | | |

# Soil natural capital accounting

- Recent research provides a road map
- Studies describe how to construct accounts for
  - Soil biodiversity
  - Measure state and change of soils
  - Defining indicators
- However, more research is needed to convert the data into production-grade accounts

# Overlap with other accounts

- It is expected that the soils account will be jointly recorded with other U.S. NCA accounts

- We will flag relevant content to reduce double counting

- Other accounts
  - Land
  - Water
  - Forests
  - Grassland, deserts, and tundra

# A path forward

- How will we produce a pilot account?

1. Interagency agreement on how to define soil health (biophysical accounting)
    a. What are the best metrics?
        i. Easy to measure
    b. Determine how to assess the change in soil function over time
    c. Ensure the measure is sensitive to variations in climate and mgmt

2. Leverage a similar type of interagency agreement (valuation accounting)
    a. Determine how to place a value on soil health
    b. Simple models are unlikely to meet the end goals (production-grade account)
        i. For example, perpetual inventory method
    c. Compare and contrast results of simple model to more complex models

# Interagency Agreement

- The US federal govt is made up of numerous independent departments and agencies
  - Each department operates independently
    - Although there is cooperation and coordination between departments
  - Data can either
    - Not be shared with other depts or agencies b/c of privacy reasons
    - Formal bilateral agreement between two units
    - Federal statistical research data centers
    - Made publicly available

- The US Department of Agriculture has 29 separate agencies and offices
  - Each agency operates somewhat independently
  - Units have same data rules as the federal govt as a whole
  - Interdepartmental agencies tend to work closely and share data where possible

# USDA Interagency Agreement for Soils

- There at least seven USDA agencies involved in this effort
  - NASS, NRCS, OCE, ERS, USFS, ARS, and Climate Hubs

- NRCS
  - Maintains soils database
    - SSURGO and STATSGO
  - Administers conservation programs

- NASS
  - Administers large dept datasets
    - Census of Agriculture
  - Federal statistical agency
  - Statistical research

- ARS
  - Chief scientific in-house research agency
  - Soil science, agronomy, and other physical sciences

- Climate Hubs
  - Collaboration between department agencies
    - Led by ARS and USFS
  - Focus on healthy ag production under climate variability and climate change

- ERS
  - Administers dept datasets
  - Federal statistical agency
  - Social science research – economic focus
  - Coordinating agency for natural capital account



# Questions for the London Group

- Do countries have experience they can share
  - Satellite remote sensing to measure changes in soils?
  - Models to quantify and value soils?
  - How to quantify changes to soil function over time?
  - How to value soil health?

- Should the initial pilot account be created
  - Using satellite remote sensing?
  - Simple models to estimate soil health and biodiversity?

- What thoughts do you have about measuring soil health?
  - Should the method for soils be similar to how land accounts are measured?



# Thank you

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# Natural Resource Conservation Service

- Mission

  – Deliver conservation solutions to protect natural resources

  – Promote
    - Abundant water
    - Healthy soils
    - Resilient landscapes
    - Thriving agricultural communities