



Environmental Sectors: Soils

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- 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.
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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



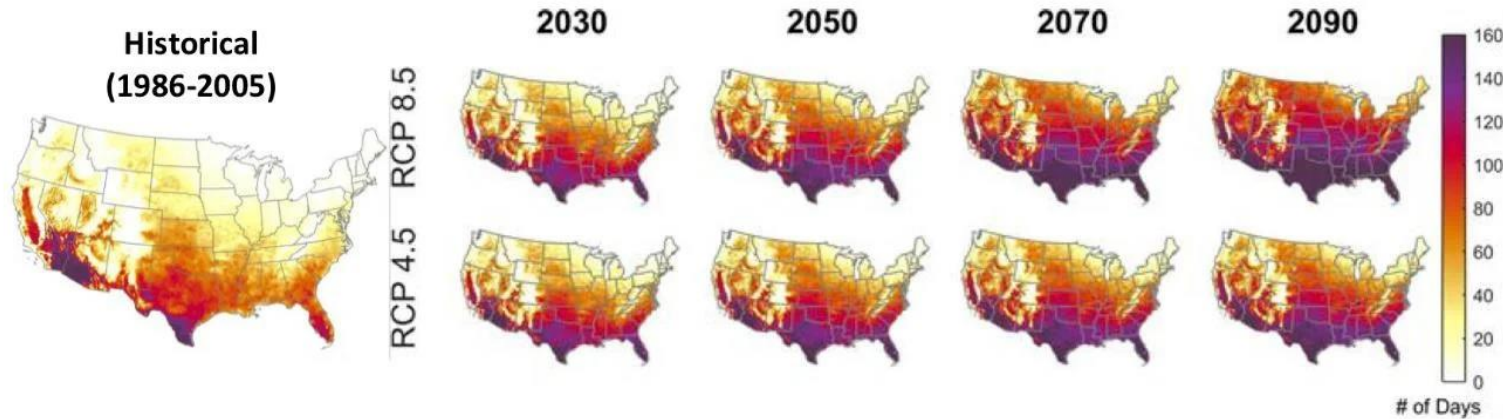
Source: William L. Farr (2022)



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 I 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														
	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

USFS



Smokey Bear



Bac!

Food Safety and Inspection Service

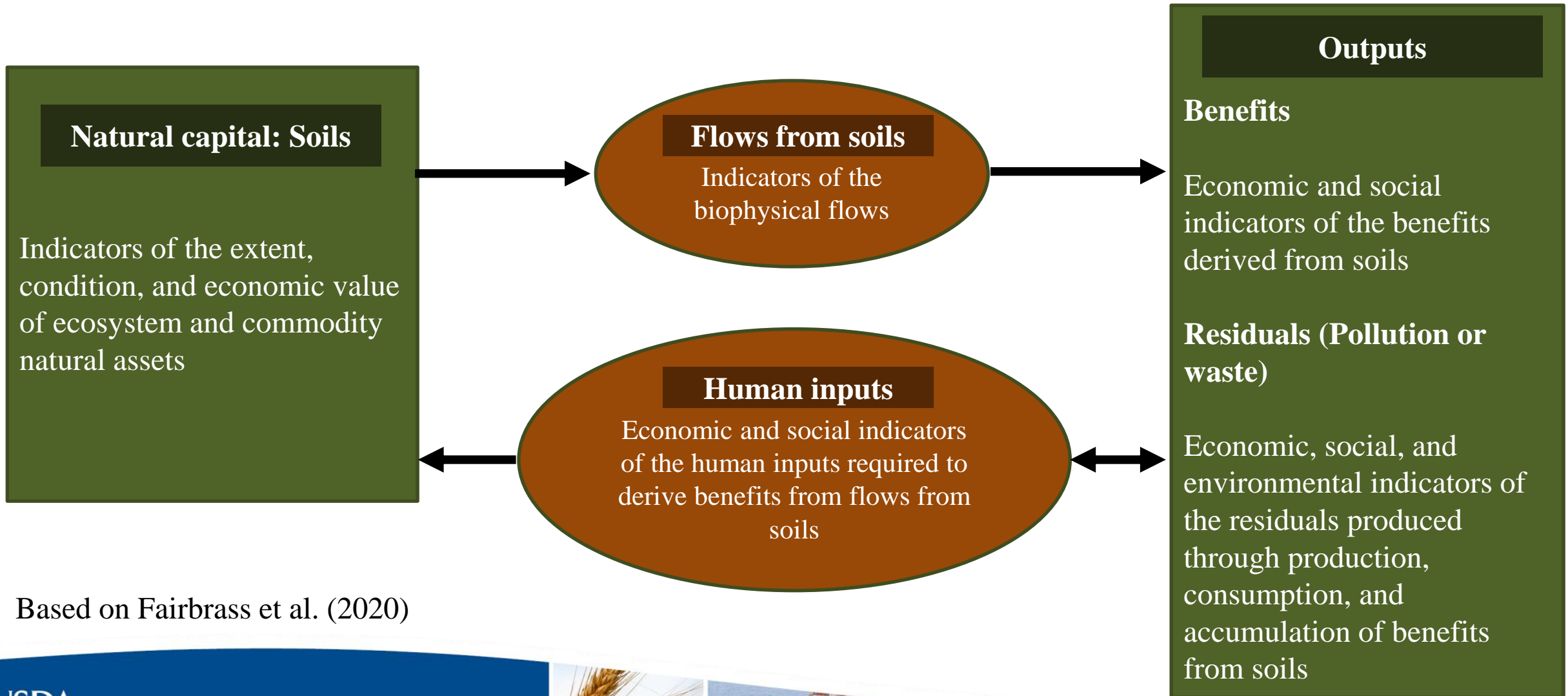


Sammy Soil

Natural Resources Conservation Service



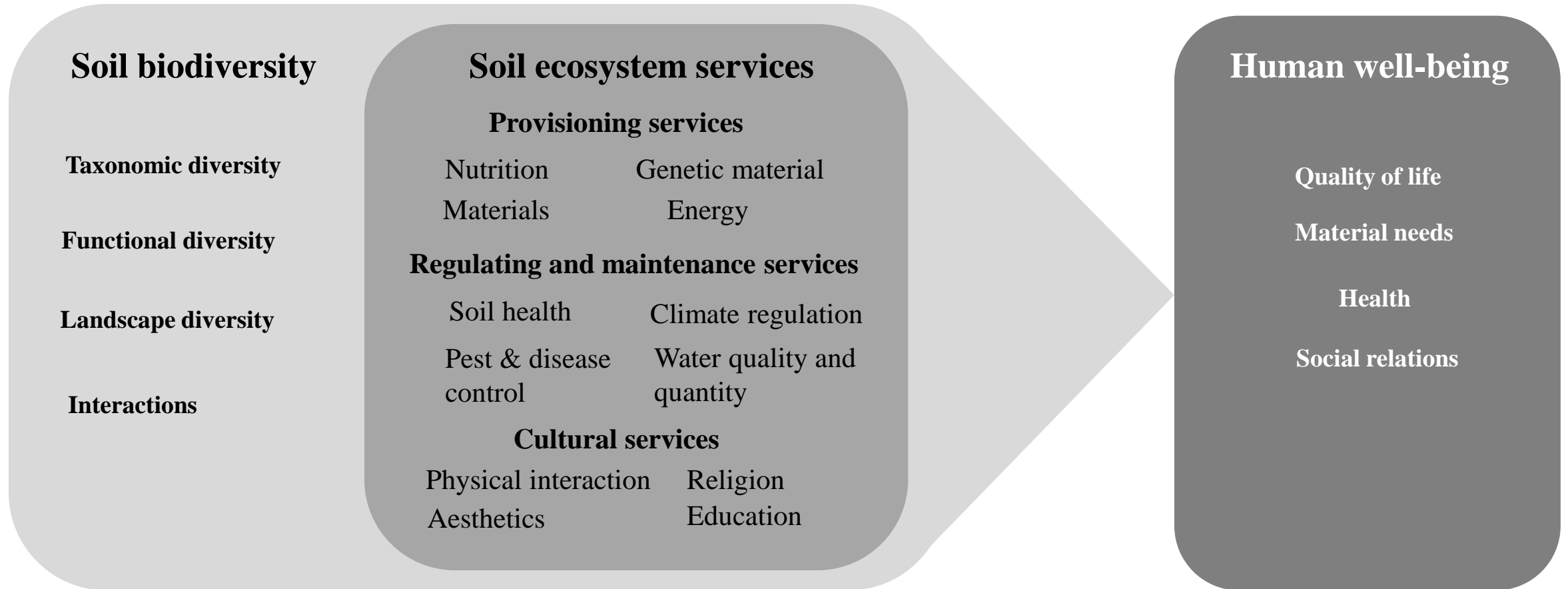
Broad scope of soil account



Based on Fairbrass et al. (2020)



Example of soil biodiversity



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

THE STATE AND FUTURE OF U.S. SOILS

Framework for a Federal Strategic Plan for Soil Science

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

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The natural capital indicator framework (NCIF) for improved national natural capital reporting

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RESEARCH ARTICLE

Foundations for a national assessment of soil biodiversity

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Abstract
Soils, just like all other ecosystem compartments, change over time and, consequently, conditions for soil-inhabiting organisms are also changing, affecting their composition and diversity. Soil biodiversity is a critical component of ecosystems that supports many essential ecosystem functions and services, such as nutrient cycling, carbon sequestration, water regulation and biomass production for food, fodder, fibre and energy. However, and despite the importance of soil biodiversity for ecosystem health and human well-being, neither current state, drivers, potential consequences for ecosystem services nor options for sustainable governance of soil biodiversity are well understood. Here, we provide a framework for and argue that conducting a national assessment of soil biodiversity, albeit being a complex endeavour, is fundamental to building a baseline to understand the current state and trends of soil biodiversity, but also to identify the main drivers of change, the impacts of soil biodiversity loss and the potential pathways for conservation and sustainable governance of soil biodiversity.

KEYWORDS
belowground biodiversity, biodiversity change, conservation, ecosystem services, governance options, science policy

ARTICLE INFO

Keywords: Commons, Ecosystems, Environment, Natural capital, Sustainable Systems of (SEEA)

SCIENTIFIC REPORTS

OPEN

Soil natural capital in Europe; a framework for state and change assessment

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Soils underpin our existence through food production and represent the largest terrestrial carbon store. Understanding soil state and change in response to climate and land use change is a major challenge. Our aim is to bridge the science-policy interface by developing a natural capital accounting framework for soil. For example, attempting a mass balance between soil erosion and production, which indicates that barren land, and arable crop areas are most vulnerable to potential loss. We first test our approach using earth observation, modelling and ground-based sample data from the European Union's Land Use Cover Area Frame dataset of Survey (LUCAS) soil monitoring program. Using land cover change data for 2000–2012 we are able to identify land covers susceptible to change, and the soil resources most at risk. These covered soils are associated with the highest carbon stocks, and are the forests, while areas of arable crops are declining, but artificial surfaces are increasing. The framework developed offers a substantial step forward, demonstrating the development of biophysical soil accounts that can be used in wider socio-economic and policy assessment, including the development of an integrated soil monitoring approach called for by the United Nations Intergovernmental Technical Panel on Soils.

Soils underpin our very existence through food, fibre and timber production, as well as through earth system functions that support the delivery of other ecosystem services¹. It is critical that we generate our soil resources' best practice knowledge and facilitate that support the delivery of ecosystem services in order to meet the United Nations Sustainable Development Goals (SDGs)^{2,3} and our own purpose economic gain. The Sustainable Development Goals constitute a shift in thinking regarding global policy from the earth focus on economic sustainability to the three pillars of sustainable development: economic, social and environmental⁴. Recent work shows conceptually how soil resources underpin soil functions, the delivery of ecosystem services and the SDGs⁵. The current gap is a monitoring and assessment framework that can inform policy regarding progress on achieving economic, social and environmental goals.

The United Nations System of Environmental and Economic Accounting (SEEA) is well positioned to provide an international system that can support this effort. SEEA offers a broad-scale monitoring tool that is joining global momentum in the European Union for the development of soil natural capital accounts in environmental terms, although they are to date focusing on environmental flows and not resources. Environmental accounts cover water regulation (EU 2017), which provides the legal framework for a harmonised collection of comparable data from all EU Member States and the European Free Trade Association (EFTA) countries⁶. The EU accounts are consistent with SEEA. With regard to soils, they recently commented that 'Integrating information on soil resources with other measures of natural capital and economic activity remains one of the least developed areas of the United Nations SEEA'. However, there is a need to develop an appropriate framework for soil reporting and data integration starting with the SEEA Central Framework (SEEA CF), based on state and flows, that SEEA experimental accounts account⁷ (SEEA EXA) which are being developed that will require more emphasis on condition.

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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

