  

CURRENT SCIENCE OF CARBON SEQUESTRATION

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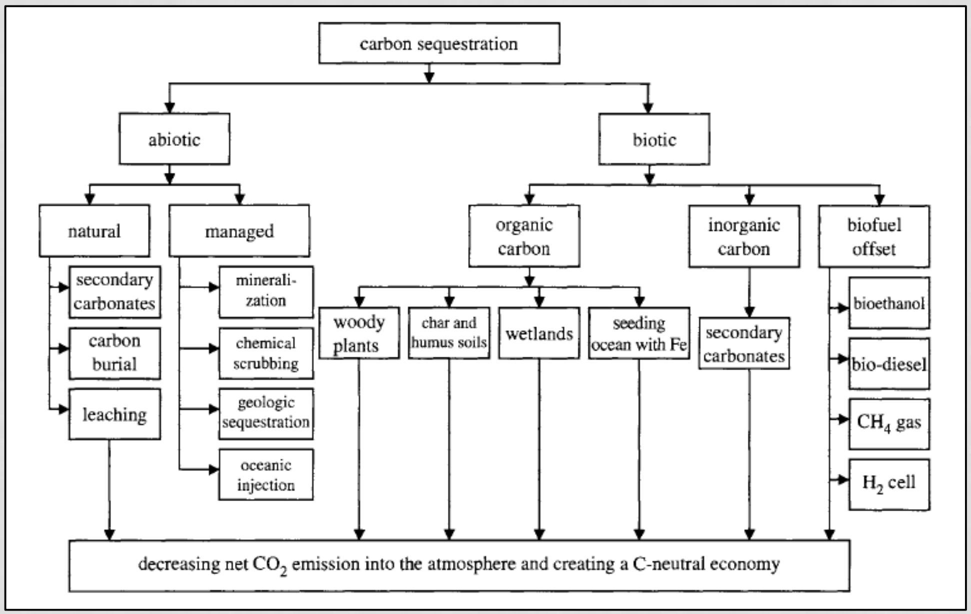
CARBON SEQUESTRATION FOR CLIMATE CHANGE MITIGATION

Carbon sequestration = capture and storage of CO_2 that would otherwise be emitted to or remain in the atmosphere.



Lal (2008)

Greenhouse gas benefits = emissions reduction or carbon sequestration

The biosphere acts naturally pull CO_2 out of the atmosphere.

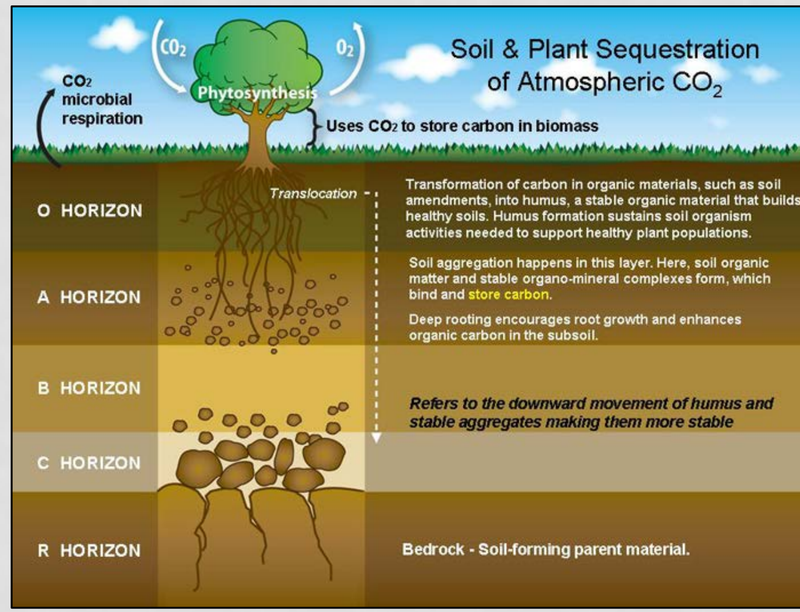
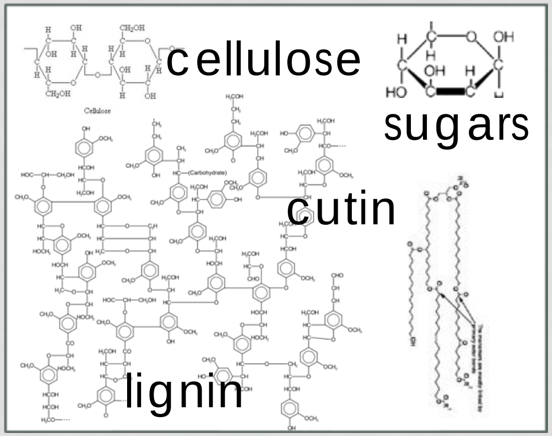


Image Courtesy of EPA, www.clu-in.org

Management decisions influence the longevity in terrestrial pools, and therefore whether it counts as sequestration – and as carbon credit.

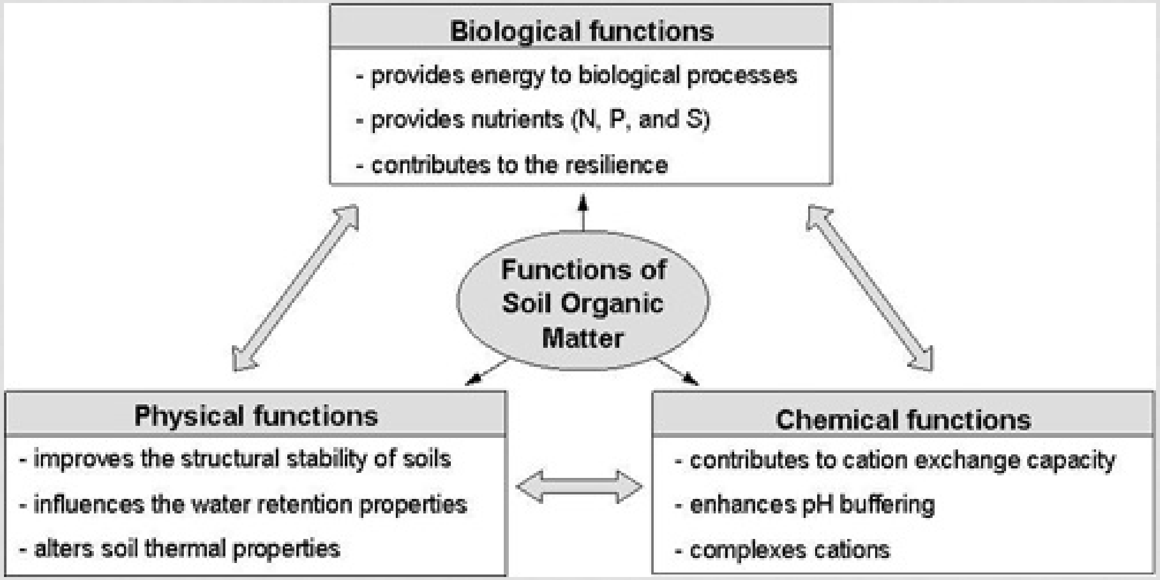
SOIL CARBON CONUNDRUM



Soil organic matter

=

47% Carbon



Soil organic matter must simultaneously decompose and accumulate

HEALTHY SOILS - ISLAND RESILIENCY

Photo source: (2016). Globa
European Commission, Publi

VALUE IN HEALTHY ECOSYSTEMS

- Market and non-market value exists for soil ecosystem services

Market and market-based

- Improved water holding capacity = reduced irrigation costs
- Decomposition of organic amendments = decreased chemical fertilizer

Societal costs of climate change

- Uncertainty in food, water, and energy sectors
- Natural disasters
- Carbon market

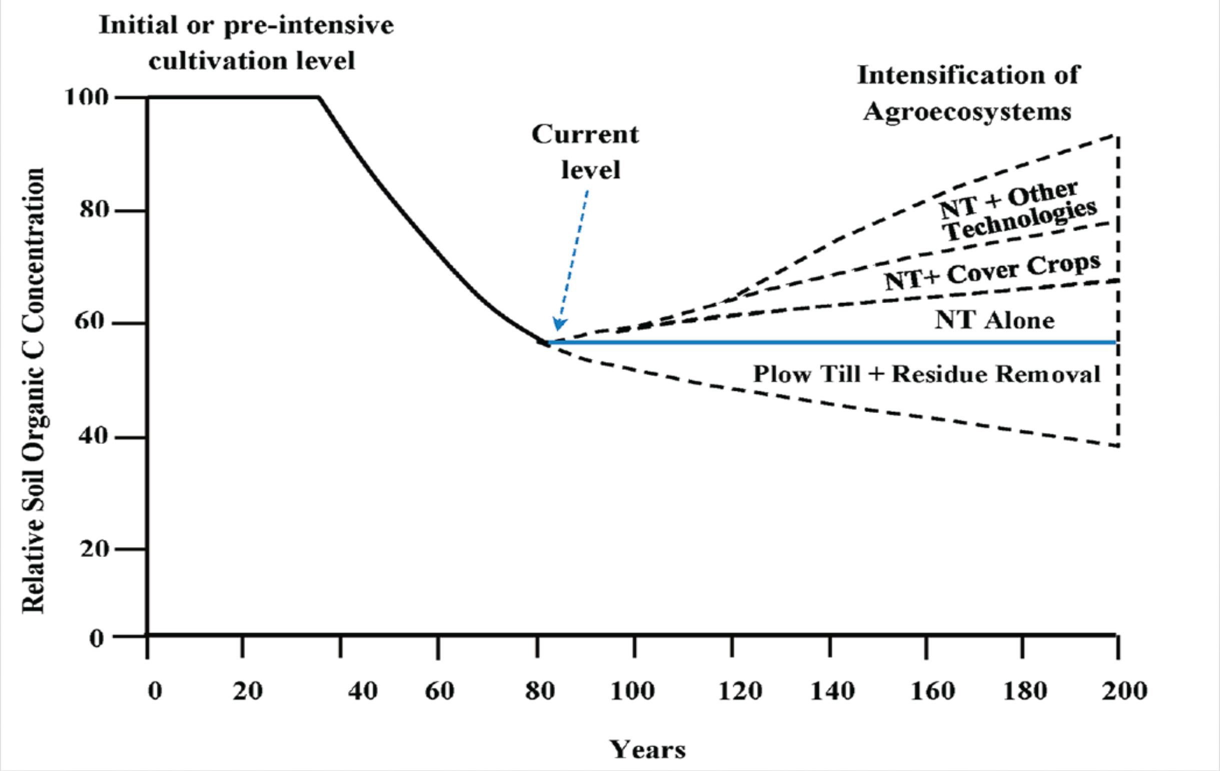
Non-market based

- Practical benefits = reduction in transport, more time spent with family
- Cultural value = respect for the aina and cultural practice
- Ethical value = a living landscape, beauty in nature

AGRICULTURE

Photo credits: https://mauimagazine.net/wp-content/uploads/hawaiian-forests.jpg (Forested)

All others by Susan Crow and Lab group



Blanco-Canqui H., et al., 2015. Agron. J. 107:2449-2474.

Considerations:

- CC biomass input
- Years in CCs
- Antecedent soil C Soil type
- CC species
- Tillage management
- Climate
- Amendments (biochar!)
- **If expanded from 177 million acres to day to 1 billion by 2015, estimated to reduce CO_2 by 17.35 gigatons globally.**

AGROFORESTRY

Tree intercropping

Parkland systems

http://flickr.com/photos/76187282@N00/5669419104

Traditional agroforestry

Photos from Jonathan Deenik

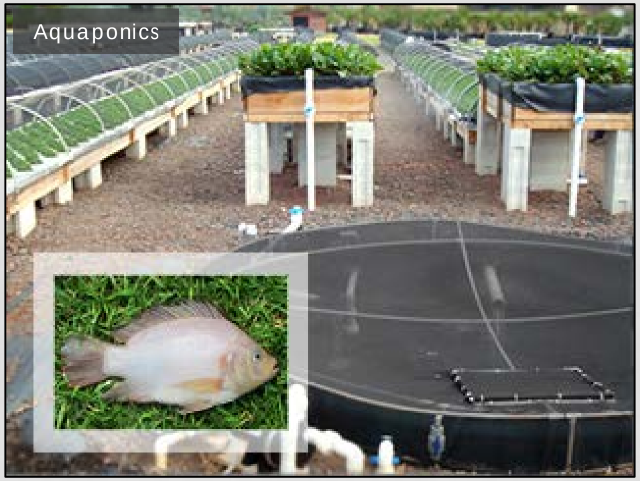
- Principle: Diversity promotes soil health and productivity
- Carbon sequestration in tree biomass (but, only a fraction counts) and in soils (but, only if there is a degraded starting point)
- Reduced fertilizer and avoided emissions from food transport
- **Although depending highly on site conditions and on the selected system, agroforestry has been recognized as having the greatest potential for C sequestration of all the land uses analyzed in the Land-Use, Land-Use Change and Forestry report of the IPCC (2000) potentially resulting in additional benefits such as reduction of soil erosion and improved water quality**.

AQUACULTURE

The farming or ranching of any plant or animal species in a controlled salt, brackish, or freshwater environment; provided that such is on or directly adjacent to land.

https://www.kauaishrimp.com/images/farm_aerial.jpg


http://www.hawaiiforvisitors.com/images/oahu/attractions/kahuku-shrimp-farm-0395-398x235.jpg



https://www.ctahr.hawaii.edu/site/images/Ext/AQU.jpg

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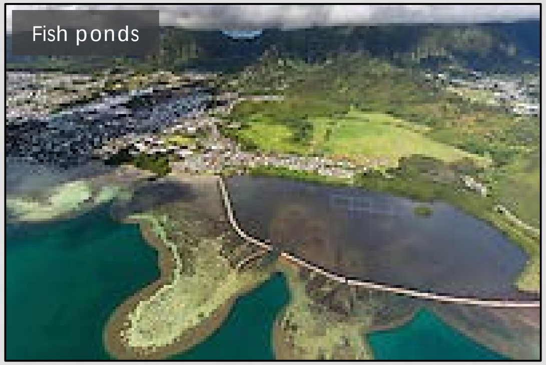
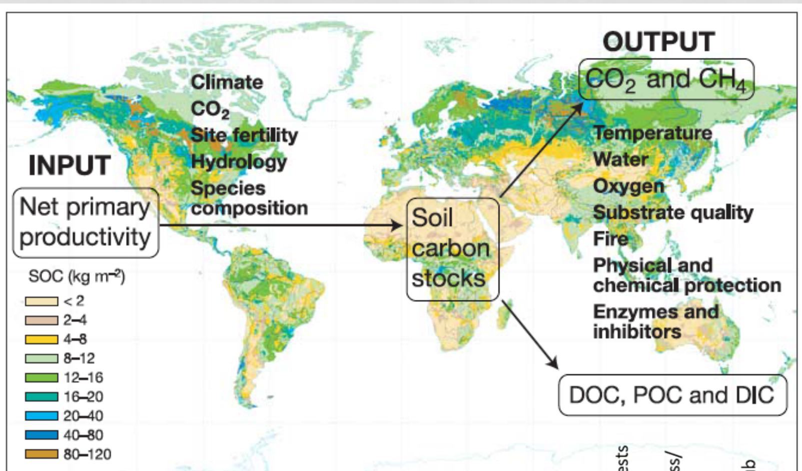



http://www.midweek.com/wp-content/uploads/2012/06/cover_2.jpg

Primary greenhouse gas benefit comes in avoided or reduced emissions.

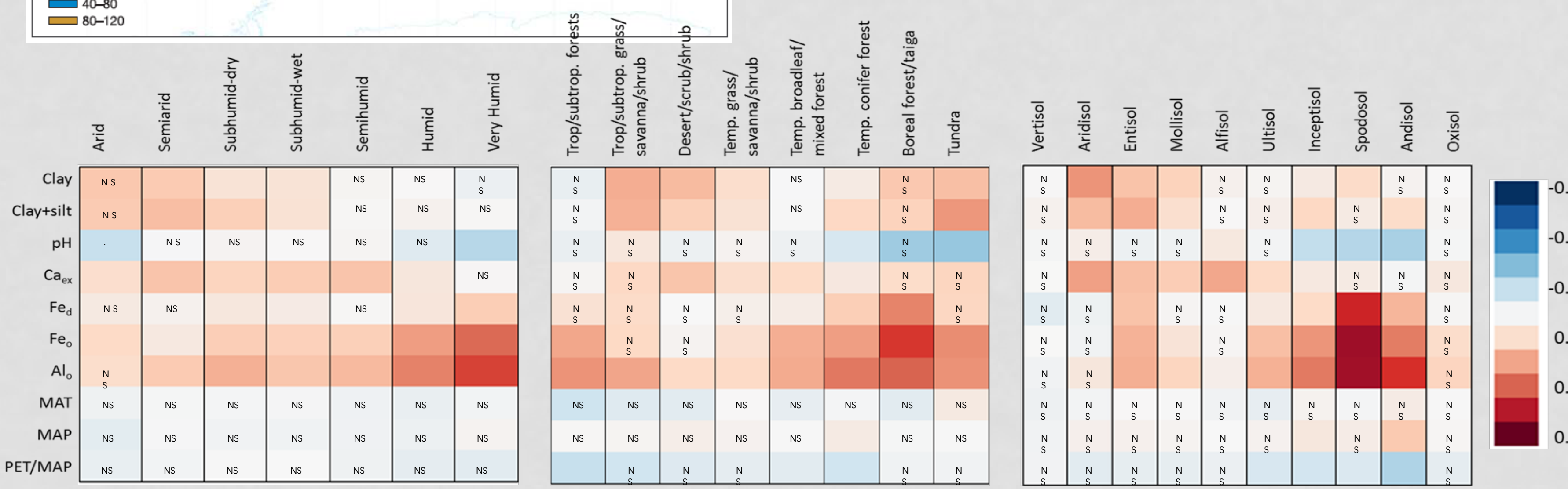
CHALLENGES AND OPPORTUNITIES

From: Davidson and Janssens (2006)



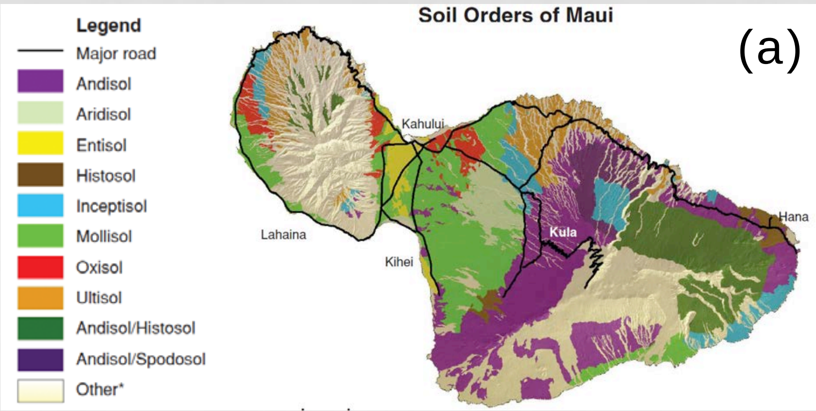
Why is it so hard to predict carbon stocks?

- Ecosystems are complex
- Climate, soil, biome all differ in their relationship to soil properties to influence soil carbon stocks.



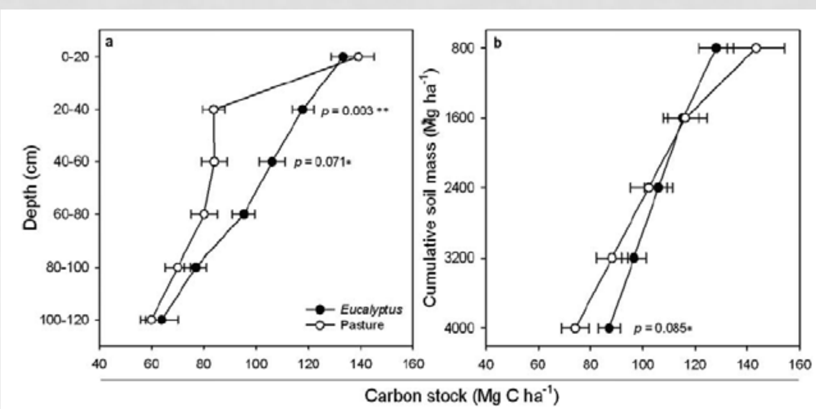
From: Rasmussen and the Powell Center Working Group

CHALLENGES AND OPPORTUNITIES



From: Deenik and McClellan 2007

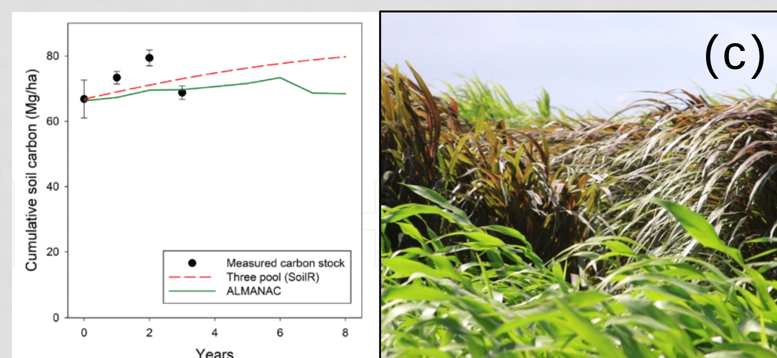
(b)



From: Crow et al. 2016 – Big Island pasture conversion to eucalyptus plantation

Why is it so hard to predict how carbon stocks will change with land use in Hawaii?

- Hawaii has 10 of the 12 soil orders (a) and 70% of global climatic life zones
- Compaction makes measurement difficult in many of our soils (b)
- Predictive models do not match our measured values (c)



From: Wells et al. 2017 – Maui perennial grasses sequestered carbon belowground quickly, not capture by the ALMANAC simulation model.

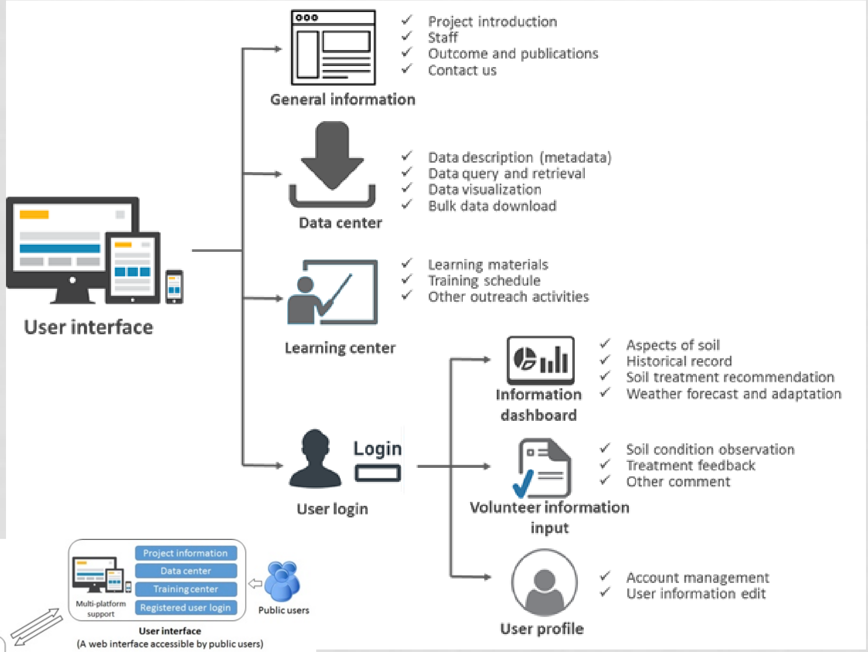
DIVERSE LANDSCAPES AND CLIMATE GRADIENTS; NO ONE SOLUTION

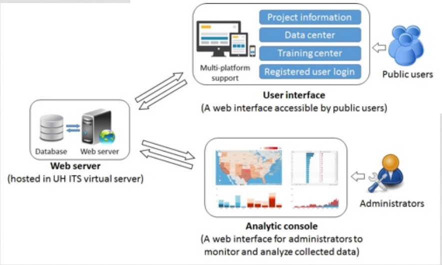
Progress on selecting soil health parameters for Hawaii

Parameters for a *potential* Soil Health Index for Hawaii, described in detail below.

Indicator	Function	Methodology
Physical		
Available H_2O	Plant water relations	Pressure plate
Water stable aggregates	Infiltration, porosity, resistance to erosion	Wet sieving (>4 mm size class)
Chemical		
pH	Nutrient availability and potential for toxicity	pH electrode
CEC	Nutrient retention, buffering capacity	Effective CEC
Extractable nutrients	Nutrient supply	Mehlich 3
Total organic C and N	Biological resource	Elemental analysis
Biological		
Carbon Pools		
- Carbon in water stable aggregates	Protection of carbon within aggregate structure	Wet sieving and elemental analysis (0.25-1.0 mm size class)
- Stable carbon	Potential carbon sequestration	28-day incubation and 3-pool modeling
CO_2 respiration - burst	Microbial activity	24 hr incubation
Beta glucosidase	Cellulose degradation	Enzyme assay
Potentially mineralizable N	Plant available N reserves	28-day Incubation

Proposed tool for outreach, recommendations, measurement, and monitoring





OUR TASK

"Identify practices to improve soil health and promote carbon sequestration"

Funding

Collaborators

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- Mae Nakahata, HC&S plantation crews

Lab

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- Maxim Irion, Mariko Panzella, Heather Kikkawa, Nate Hunter, Mark Miller, Anne Quidez, Daniel Richardson, Eryn Opie, Kylie Wong (undergraduate research assistants)
- Mataia Reeves, Yudai Sumiyoshi, Meghan Pawlowski, Hironao Yamazaki, Lauren Deem, Whitney Ray, Jon Wells (graduate students);