Soil & Human Impacts

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Healthy Soil: Cornerstone of Life

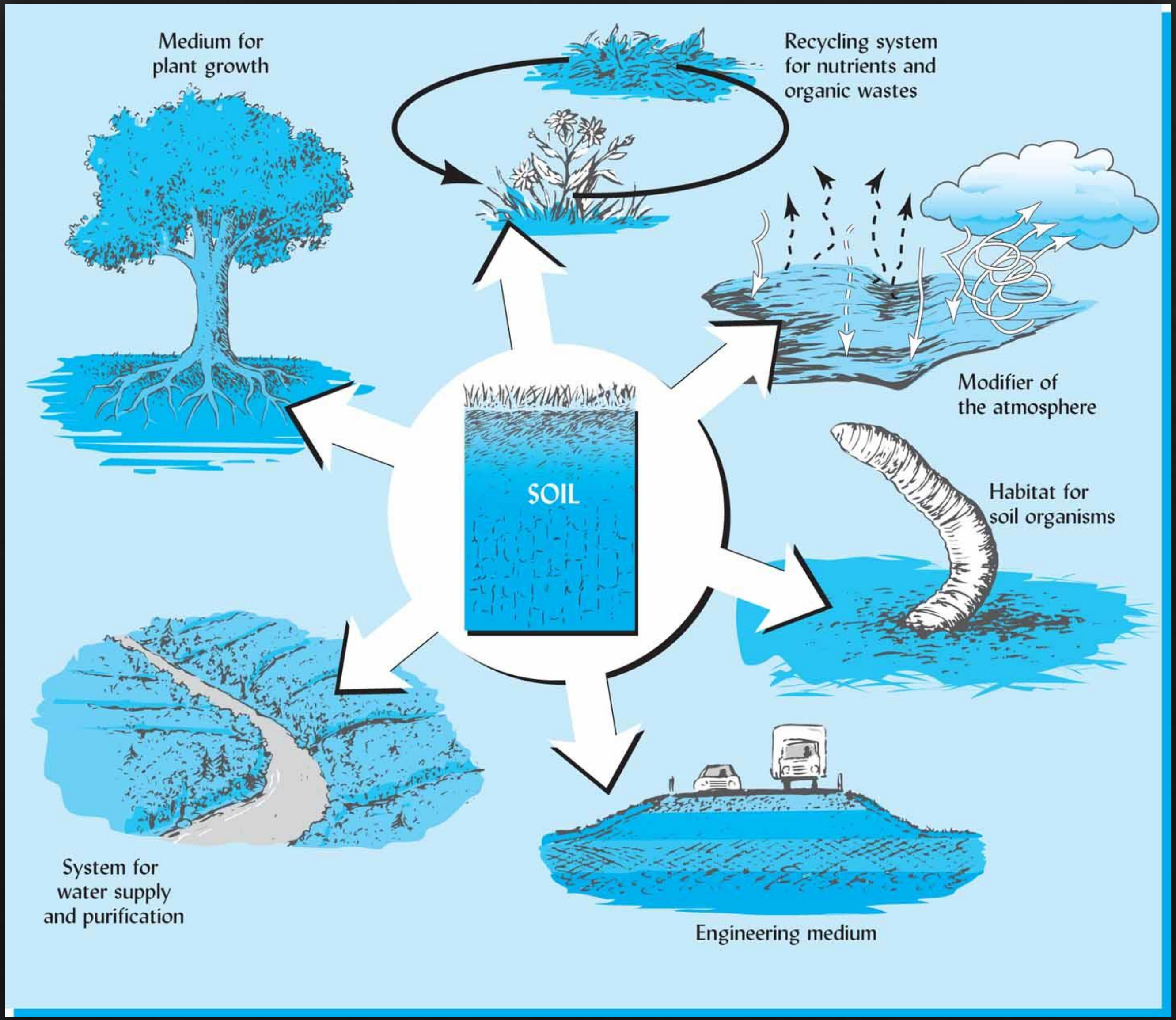
- Biological Diversity
- Food Production
- Water Benefits
- Carbon Storage

https://global.nature.org/content/rethinking-soil

Why is Healthy Soil Important?

Soil services:

- Good soil usage helps regulate climate and prevent droughts
  - Soil conservation = water conservation
- Soil is nature's kidney (especially wetland soils)
- Modifies and purifies the atmosphere



Why is Healthy Soil Important?

- Soil is alive!
  - It is home to microbes and bugs that nourish the soil and plants – there are more microorganisms in the soil than there are stars in the universe and the number in one teaspoon equals the human population of Africa – *Nature Reviews Microbiology, 2011*
- It can save your life!
  - Scientists found a new antibiotic living in soil that is able to kill some Superbugs such as MRSA and tuberculosis that are currently antibiotic-resistant – *Kim Lewis, Northeastern University, Boston, MA, 2015*
- Soil is a finite resource
  - Misusing soil has helped topple civilizations

How soils control civilization and economics

- Plato (427-347 BC) first recognized the effects of human actions on soil erosion and the consequent negative impacts on economic livelihood in classical Greece.

- Centuries of intensive soil erosion impoverished much of the Mediterranean region, where ancient ports are now kilometers inland.

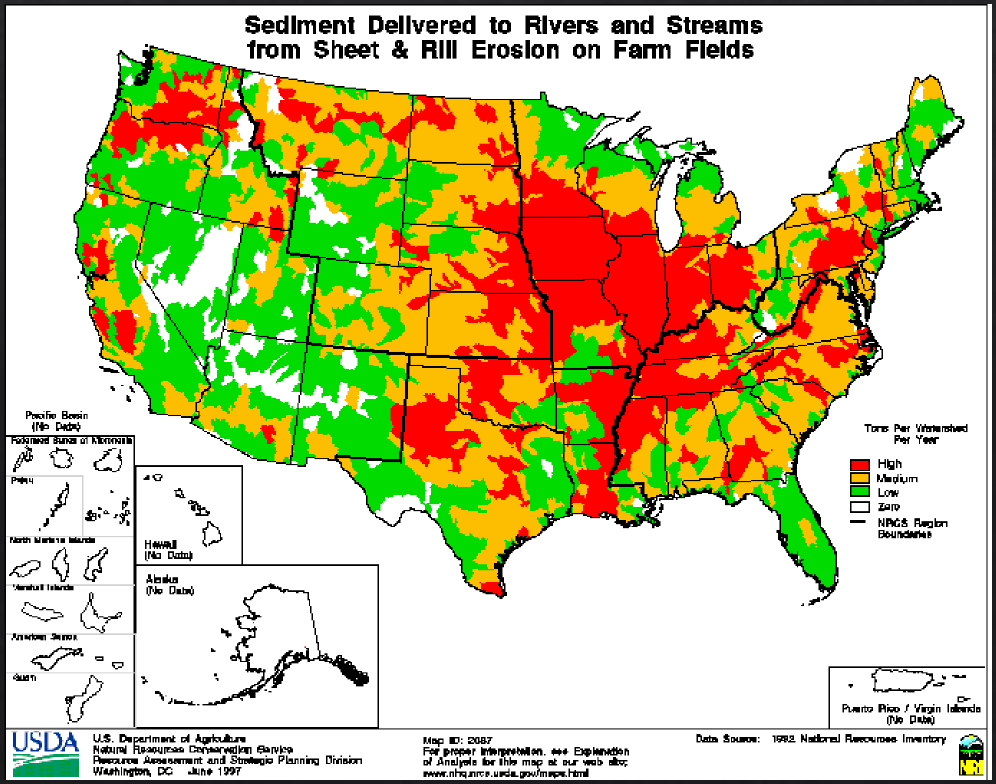
The Rome port of Trajan, as seen in 1582 on the Tyrrhenian Sea with a unique hexagonal shape

The Rome port of Trajan is currently “Trajan’s Lake” in the modern coastal city of Fiumincino, hexagonal and well preserved. *http://www.thehistoryblog.com/archives/3405*

How soils control civilization and economics

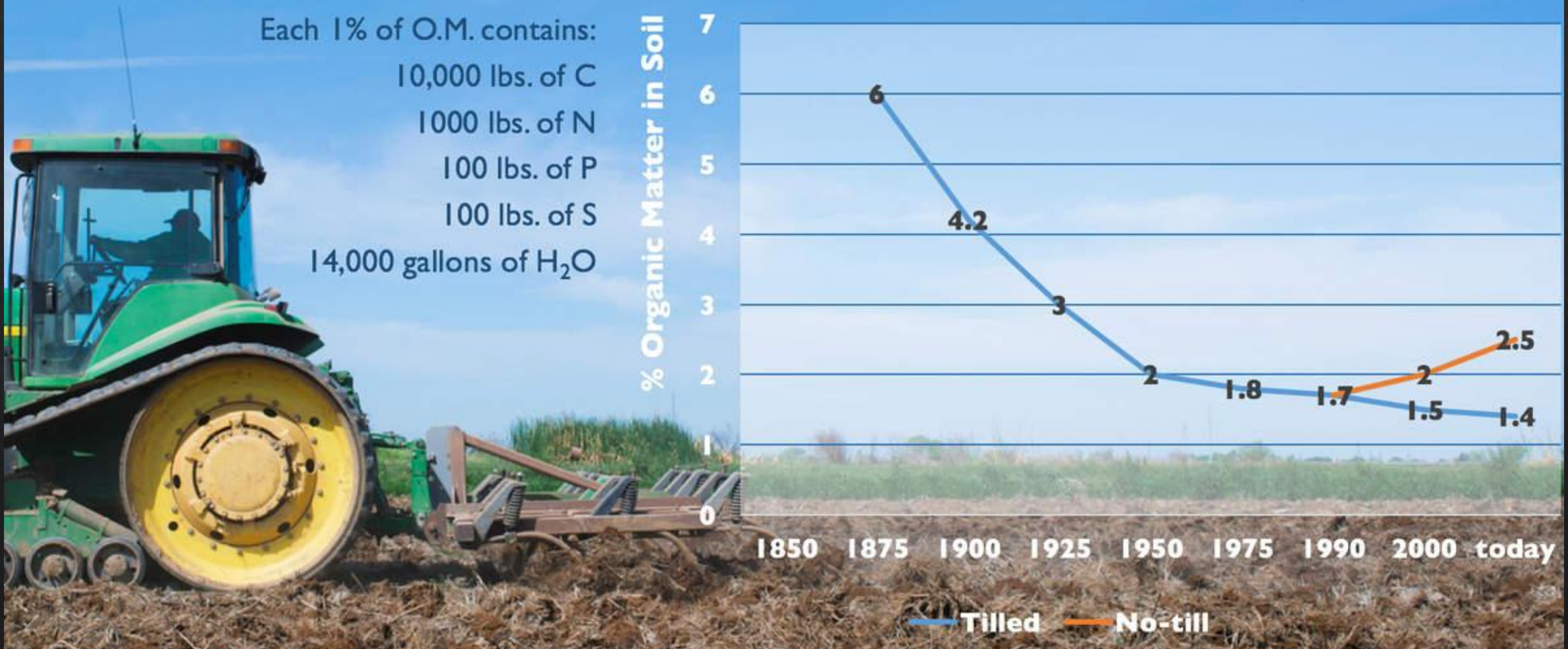
Contemporary perspective:

- The ‘quiet crisis’ of soil erosion is still an enormous problem in the modern world, as millions of tons of topsoil are still lost every year in the U.S. alone. *-- Oliver Milman,* The Guardian, *2015*
- ~10% of the *best agricultural land* is damaged due to soil erosion and overuse in the last 50 years
- Also leads to sediment pollution, and loss of carbon storage and water cleaning capabilities




Top Soil Stockpile

Healthy Soil: *Increasingly Rare*



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Leads to the 'invisible crisis' ⇨ dying soil

Every 1% Saves…

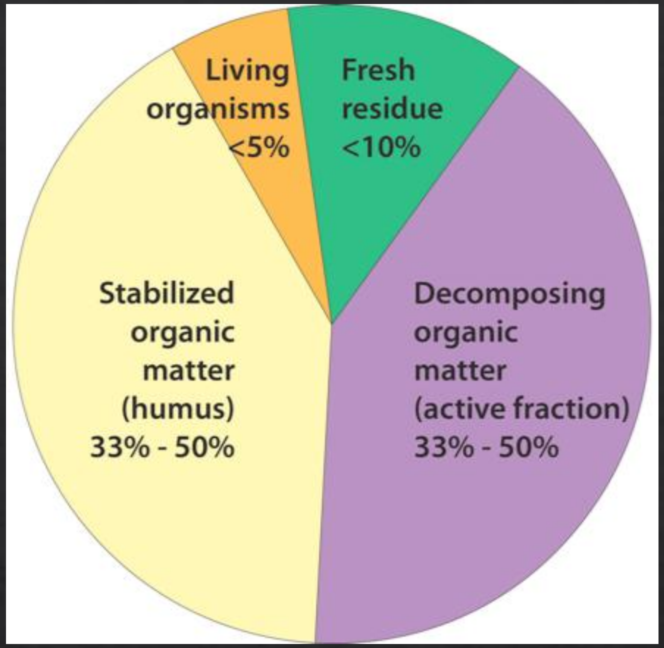
- 10.5 million pounds of **nutrient runoff**
- 825,000 metric tons of **CO_2 emissions**
- 3.3 million metric tons of **erosion**
- 120,000 acre-feet of **water**
- **$226 million** in societal benefits

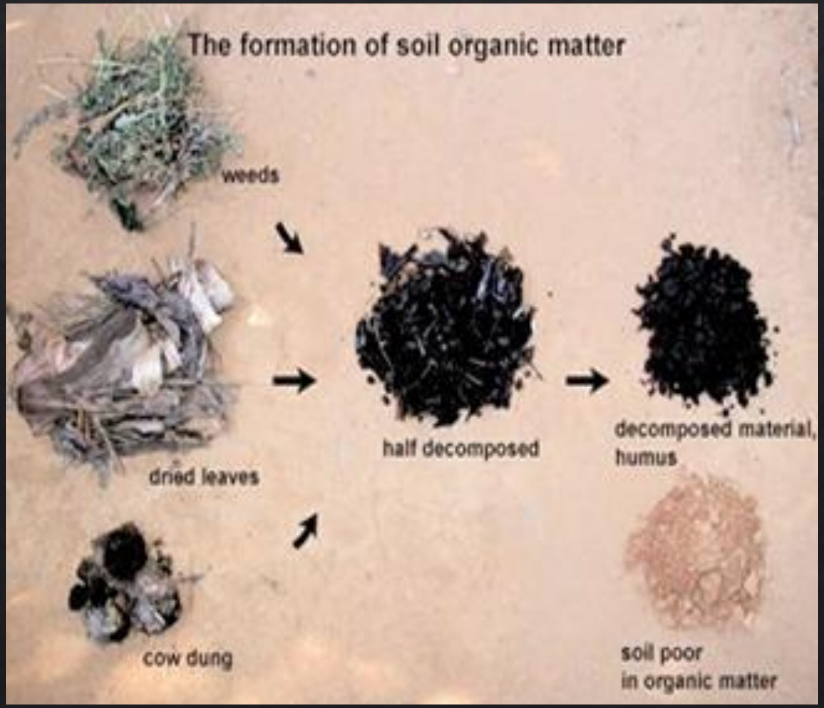
…and boosts **farm profits** by **$37 million**

https://global.nature.org/content/rethinking-soil

What Makes a Healthy Soil?

- What does surface erosion impact?
- Soil organic matter (SOM)
  - Necessary for an A horizon (aka, topsoil) that will be nutrient rich, have a high water storage capacity, and have *organisms* that actively cycle new inputs of nutrients and remediate toxins
- SOM includes fresh residue, living organisms, decomposing organic matter (active fraction), and stabilized (well-decomposed) organic matter (humus)





Soil Remediation

- How do we revitalize a degraded soil?
  - Create soil structure for good infiltration of precipitation, good aeration, and good root penetration → add organics and *biota*
  - Add organics for good water and nutrient holding capacity
  - Add living organisms for nutrient cycling

= Add Compost

- + Liquid biologic amendments if needed

Poor Health Good Health

http://www.nrsl.umd.edu/research/NRSLResearchAreaInfo.cfm?ID=14

Compost Benefits

- Adds three of the four SOM components: fresh residue, active fraction, and living biota
  - It just takes time to change the active fraction to humus
- Helps form soil structure by aggregation and producing pore spaces
- Buffers a soil from sudden changes in pH
  - organic materials are charged particles and will adsorb (latch on to) molecules and compounds, keeping them from raising or lowering the pH in the soil solution
- Adsorbs nutrients and some toxins (any charged particles)
- Promotes an increase in biota quantity and diversity – some are bioturbators that will mix organics/nutrients lower into the soil profile, some promote soil structure, and some break down toxins

Biota Communities

- Different organic material carry different bacteria/fungi communities and, therefore, create different soil biota communities
  - Soil biota communities also contain protozoa (such as amoeba) and other microbiota and larger soil fauna (earthworms, nematodes, insects, etc.)
- Gram-positive and gram-negative bacteria:
  - Gram-positive bacteria are widely dispersed in soil and tend to decompose complex organic material that has been partially decomposed by fungi or gram-negative bacteria and help reduce pathogens
  - Gram-negative bacteria predominate in the rooting zone when in soil and are nitrogen fixers and transformers – but also include pathogens

Research at KU Edwards Campus

- Research Questions:
  - What compost components and creation process provide the optimal biota diversity and quantity?
    - Is Compost Tea a good LBA alternative when poor quality compost is the only option?
    - Do we need nearly equal bacteria types or should one be more prominent for best vegetation growth?
    - Does too much gram-negative bacteria actually promote invasive and non-native plants? How much is too much?
    - It has been found that native grasslands have different biota communities than suburban lawns – can we produce a compost/LBA that will imitate those conditions and promote the best growth for each?
  - Do compost amendments increase carbon sequestration processes without side effects? What is the temporal scale of impact?

Research at KU Edwards Campus

- Research is driven by collaboration with local professionals
  - Carbon Sequestration study:
    - Craig Wood – Solid Waste Management Coordinator – Johnson County
    - Ted Hartsig – Senior Soil Scientist – Olsson Associates
  - Prairie Restoration/Soil Biota Communities study:
    - Ted Hartsig – Senior Soil Scientist – Olsson Associates
    - Hilary Noonan – Owner – Syntax Land Design; Mad Hatter Compost Tea
    - Alaine Hudlin – Wildlife Education Coordinator – Kansas Department of Wildlife, Parks and Tourism

KU Edwards Campus Research Plots

Land Use History

- Agricultural/farmstead – created erosion, degradation, and compaction

1954

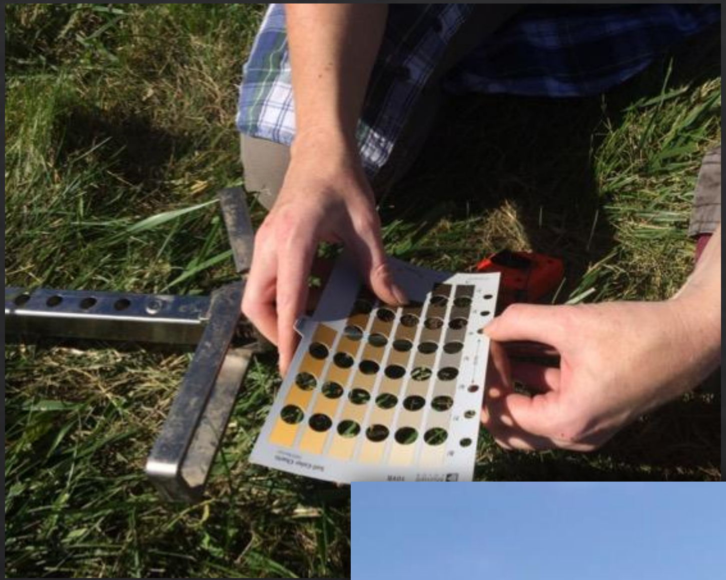
1991

Land Use History

- 2003 and 2011 Construction zones – created compaction and an anthropogenic soil layer

Research at KU Edwards Campus

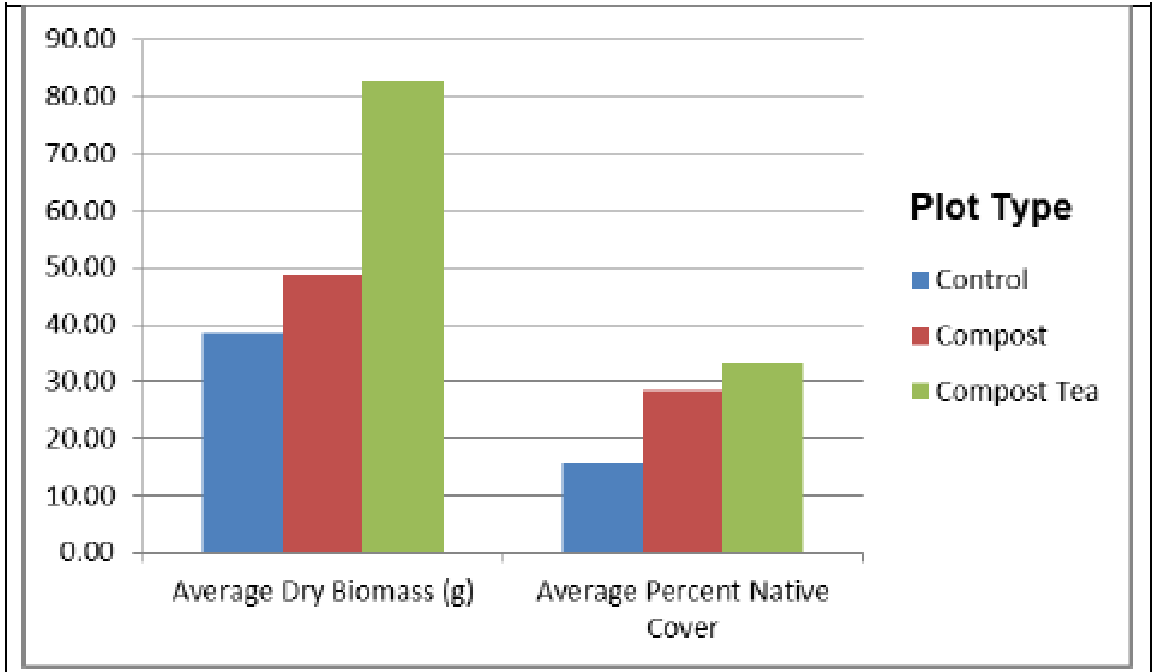
- Study plot preparation and analysis
  - Soil descriptions
  - Biomass measurements
  - Compost additions – woody and non-woody; compost tea created from native prairie soil
  - Biota analysis of compost and soil



Research at KU Edwards Campus

Preliminary Results

- Prairie establishment plot – After 1 year:
  - Soils: compost plots' A horizon has thickened by an average of ½ inch; O horizon is fully incorporated
  - Biomass measurements: compost tea



Plot	Average Dry Biomass (g)	Average Percent Native Cover (%)
Control	38	16
Compost	49	28
Compost Tea	83	33

Research at KU Edwards Campus

Preliminary Results

- Prairie establishment plot – After 1 year:
  - Biota analysis of amended soil
    - Gram positive bacteria increased in all prairie plots, gram negative decreased in all – may be due to the bacteria found in prairie plants themselves (future research)
    - Eukaryotes (amoebas) increase only in soils with compost and compost tea amendments – they eat the bacteria to release usable nitrogen into the soils – may account for the biomass results (future research)
    - PLFAD analysis under-represents fungi

Plot-Season	AM Fungi	Gram Negative	Gram Positive	Eukaryote	Fungi	Anaerobe	Actinomycetes
Control-Spring 2017	5.02	43.04	27.43	3.69	4.26	2.02	14.54
Control-Fall 2017	4.74	38.49	30.93	2.56	1.98	1.42	19.88
Control-Spring 2018	4.80	38.57	30.64	2.27	2.12	1.75	19.85
Compost-Spring 2017	4.70	44.62	24.79	1.42	3.16	6.76	14.55
Compost-Fall 2017	5.43	39.43	30.43	2.71	2.34	1.36	18.31
Compost-Spring 2018	5.49	40.82	28.46	3.07	1.83	1.76	18.56
Compost Tea-Spring 2017	4.08	44.46	25.59	1.34	4.92	6.54	13.07
Compost Tea-Fall 2017	4.97	39.12	30.87	2.22	1.86	1.37	19.60
Compost Tea-Spring 2018	5.75	41.69	28.57	2.68	1.98	1.49	17.84


reThink Soil
A Roadmap to U.S. Soil Health
SCIENCE
Overcome the science and research gap to support expansion of soil health management
1. Create cost-effective soil health measurement standards and tools
2. Develop operational management strategies for adaptively integrating soil health practices and systems
3. Advance the science of soil health benefits
4. Align incentives between landowners and farmers
5. Leverage technological innovation to overcome operational hurdles
ECONOMY
Overcome economic obstacles by providing the market systems to secure soil health
6. Provide broader access to products and services supporting soil health
7. Create market signals in sustainability programs for soil health
POLICY
Improve the policy environment to advance soil health
8. Reward farmers who optimize long-term soil health with lower crop insurance premiums
9. Support policies that enable greater investment in soil health
10. Build a more diverse constituency for soil health policy
Increased coordination and investment in the Soil Health Roadmap will lead to tangible economic and environmental benefits for U.S. farmers, businesses and communities.
Working together, committed partners can help ensure a sustainable future for generations to come.
Visit nature.org/soil or email soil@tnc.org.
The Nature Conservancy
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KU Edwards Campus Environmental Assessment & Environmental Geology Programs

Professional Science Masters (PSM) and Graduate Certificates

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PSM Programs & Certificates

- **PSM in Environmental Assessment**
  - 33 credit hours
- **Graduate Certificate in Environmental Assessment**
  - 4 courses, 12 credit hours
- **PSM in Environmental Geology**
  - Full launch in Spring 2019; 36 credit hours
- **Graduate Certificate in Environmental Geology**
  - 4 courses, 1 workshop, 13 credit hours
- **Graduate Certificate in Environmental Justice**
  - 4 courses, 12 credit hours
- **Graduate Certificate in Science & Technology Management**
  - 3 courses, 9 credit hours
- **Indigenous Studies Program Partnership (“Bundle”)**
  - PSM-Environmental Assessment
  - Graduate Certificate in Indigenous Studies

Top 3 Reasons to get a PSM

1. Graduate-level science courses that include legal and regulatory aspects of environmental work.
2. Project management and people skills that you'll need as you assume greater responsibility in your career.
3. The Capstone gives you applied project experience in a 'real-world" setting.

The PSM exemplifies the evolving links between universities and the workforce by providing advanced training and professional skills valued by employers and built on External Advisory Board input.

PSM™ PROFESSIONAL SCIENCE MASTER'S

PSM-EA Curriculum

Masters Courses | *12 credit hours*

Required courses:
- EVRN 616: Environmental Impact Assessment
- EVRN 721: Environmental Regulation and Policy

Select two from:
- EVRN 611: Water Quality, Land Use and Watershed Ecosystems
- EVRN 740: Soil Science for Environmental Assessment
- EVRN 750: Environmental Air Quality Assessment

Elective Courses | *6 credit hours*

For a full list of electives, visit edwardscampus.ku.edu/psm-curriculum.

Capstone Course | *3 credit hours*
- EVRN 815: Professional Science Master's Capstone

Professional Skills Courses | *12 credit hours*
- PMGT 833: Management of Internal Projects
- COMS 730: Writing and Speaking for Decision Makers
  or COMS 811: Applied Organizational Communication

Private Sector Track
- ENTR 701: Entrepreneurship - Starting Your Own Business
  or PMGT 802: Innovation and Change Management Process
- PMGT 810: Financial Management

Public Sector Track
- PUAD 845: Public Mgmt. and Org. Analysis
  or PUAD 854: Innovation and Org. Change
- PUAD 835: State and Local Public Finance
  or PUAD 837: Budgeting and Resource Allocation

Total credit hours: 33

Elective Options:

EVRN 720: Wetland Delineation (3) – Summer, even years
EVRN 730: Environmental Toxicology (3) – Spring
EVRN 736: Environmental Remote Sensing (3) – Spring B 8-week online
EVRN 737: Water Resource Sustainability (3) – Fall, odd years
EVRN 743: Natural Hazards and Environmental Risks (3) – Fall, even years
EVRN 745: Environmental Data Analysis and Statistics (3)
EVRN 747: Fluvial Geomorphology (3) – Summer, odd years
EVRN 755: Energy and Environment (3) – Fall, even years

PSM-EG Curriculum – Online*

Professional Skills Courses

- PMGT 833: Project Management Fundamentals
- PMGT 802: Innovation and Change Management Process, ***or***
  PUAD 854: Innovation and Organizational Change
- PMGT 810: Financial Management
- COMS 730: Writing & Speaking for Decisionmakers, ***or***
  COMS 811: Applied Org. Communications

Science Concentration

- EVRN 721: Environmental Regulation and Policy
- GEOL 751: Physical Hydrogeology *(pre-requisite: GEOL 552: Introduction to Hydrology)*
- GEOL 753: Chemical and Microbial Hydrogeology
- GEOL 755: Site Assessment and Remediation
- GEOL 815: Professional Science Master's Capstone

Field Workshops | *1 credit hour each. 3 required.*

- GEOL 851: Field and Laboratory Methods: Physical Hydrogeology
- GEOL 852: Field and Laboratory Methods: Contaminant Transport
- GEOL 853: Field and Laboratory Methods: Chemical Hydrogeology
- GEOL 854: Field and Laboratory Methods: Geobiology
- GEOL 855: Field and Laboratory Methods: Environmental Geophysics
- GEOL 856: Field and Laboratory Methods: Special Topics

Sampling of Additional Electives | *Select 6 credit hours with advisor.*

- GEOL 536: Geological Log Analysis *(1 credit hour)*
- GEOL 577: Environmental Geophysics
- GEOL 715: Geochemistry
- GEOL 791: Applied Environmental Chemistry

*Additional course options available in person; workshops are one-day events at KU Edwards Campus, Overland Park, KS

Professional Science Master's Programs

- **Non-thesis programs**
  - Capstone project for the practicum provides similar experience
- **Flexible**
  - classes one night a week, hybrid, or online (PSM-EG is almost fully online)
- **All Inclusive Rates**
  - Resident and non-resident have a single rate

Thank You!

- Questions?