Principles Feed Practice

Building the Soil Carbon Sponge in Our Backyards and Communities
To Meet Climate Change, Manage Extremes and Stay Well.

Connecting communities to affect positive change from the ground up.

soil Carbon coalition

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Humans have been the most influential species in modifying global land surfaces.

We can continue to greatly impact land.

We get to decide what kinds of impact we have.

The world has 60 years of topsoil left?

If present rates of degradation continue, all of the world's topsoil could be lost by 2075.

~ Senior UN official. Dec 12, 2014

<u>Average soil loss, USA midwest</u>

1 bushel corn harvested
= 1 bushel soil lost
1 bushel soy harvested
= 1.2 bushels soil lost

~ Corn and soybean digest 2017

<u>Average soil loss</u>

According to the United Nations, 30 Million Acres (46,000 square miles) of productive land is lost globally each year.*

*source:
www.un.org/press/en/2019/sgsm19680.doc.htm

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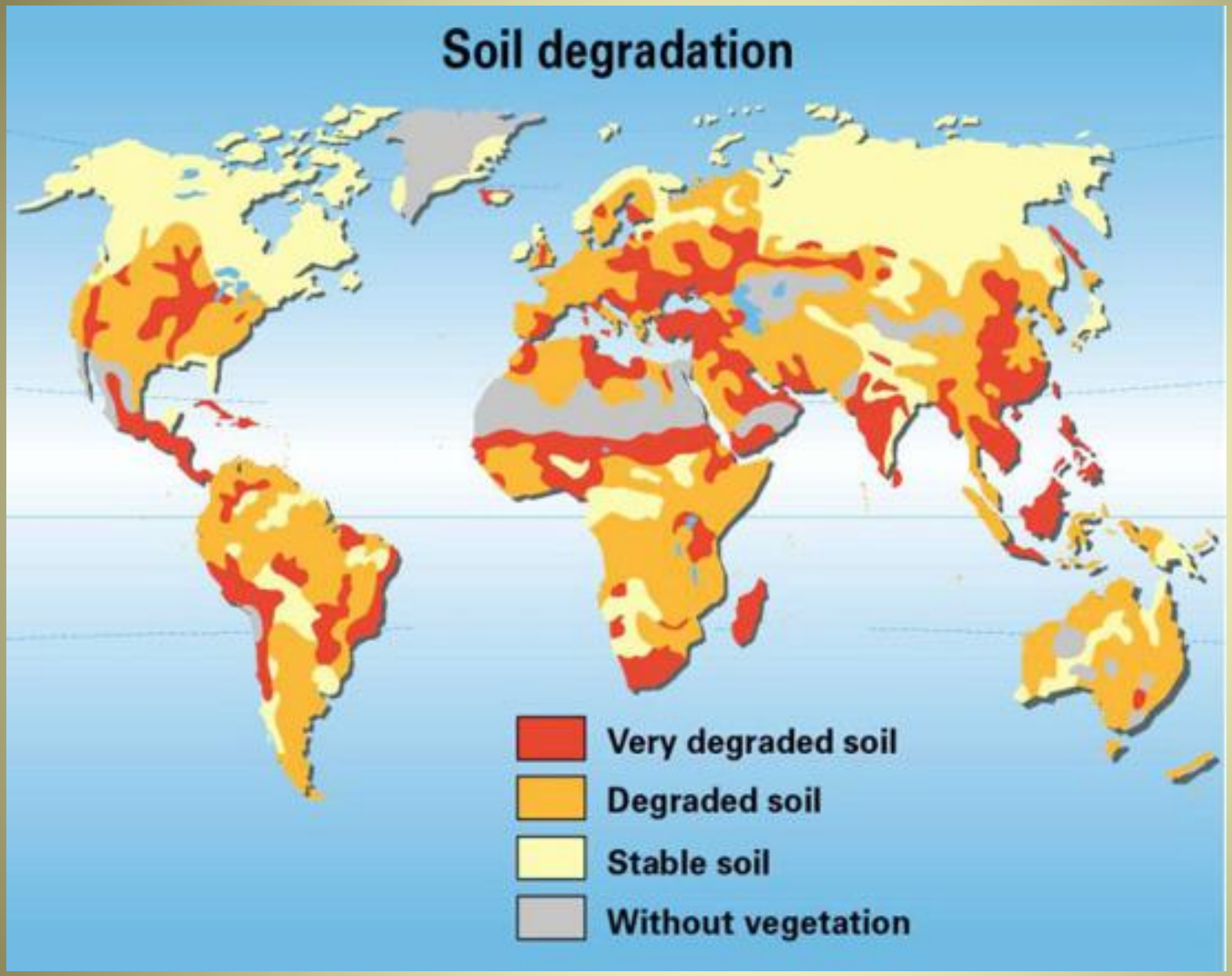
photo: Iowa corn field in July, 2018. Peter Donovan



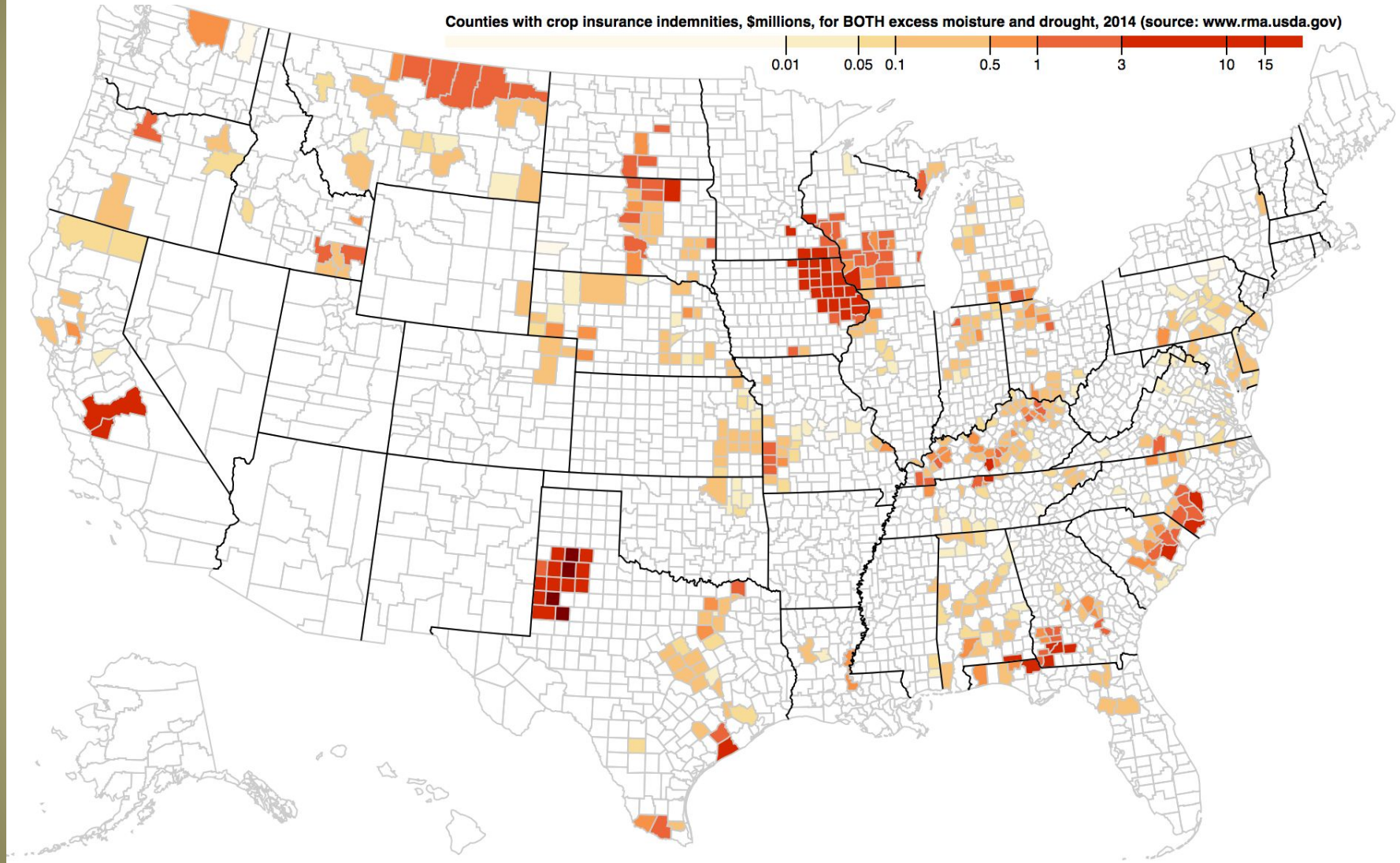
WE BROKE THIS

BUT

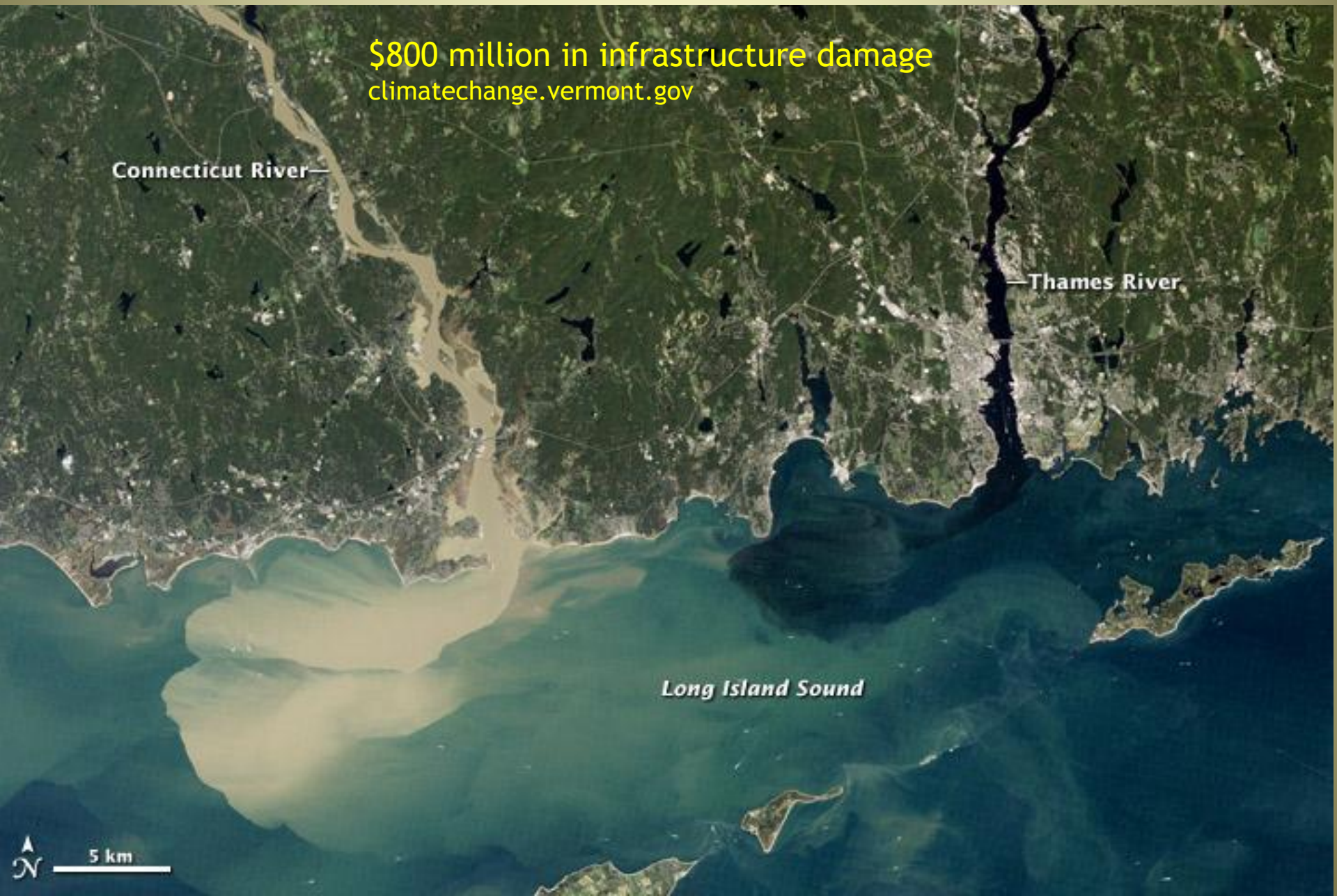
WE CAN FIX THIS!

Cartographer: Philippe Rekacewicz, UNEP/GRID-Arendal https://www.grida.no/resources/5507

Counties with crop insurance indemnities for BOTH excess moisture and drought. ($millions) 2014



Soil Loss (runoff) from Tropical Storm Irene, 2011



LEFT
Crops and fields destroyed by TS Irene in Waitsfield, VT.

BOTTOM LEFT
Standing floodwater after TS Irene in Pittsford, VT

BOTTOM RIGHT
Schoolyard flooding on July 1 2017 Thetford VT

EXTENSION

AGRICULTURE

Climate Change and Agriculture in Vermont

Quick Guide: Observations, Projections, and Impacts

INTRODUCTION

Climate change is impacting Northeastern agriculture on a regional basis in differing ways and at varying magnitudes. Effects are largely dependent upon the dominant production methods and systems within a given area, as well as the localized shifts in climatic factors. Similarly, future effects will be governed by the degree of climate change that occurs, as well as the extent of adaptations and resilience measures adopted by producers. Past observations and future projections of climatic trends can help inform producers and service providers and aid in planning and developing effective management strategies. This fact sheet offers 1) a brief summary of observed climate trends in Vermont, 2) the most up-to-date modeled projections available, and 3) potential impacts on Vermont agriculture.

OBSERVED

- It is getting wetter. There has been a 9" increase in average annual precipitation over the past century[1]
- Northern Vermont is becoming wetter at a faster rate than southern Vermont[1]
- Very heavy precipitation events are more common, increasing 71% from 1958-2012 in the Northeast[2]
- There was a 2.5°F (approx.) increase in annual average temperature in VT over the past century[1]
- The VT growing season has increased by 3.7 days/decade[3]
- Winter extreme minimum temperatures have become less cold across the Northeast[1]

PROJECTED

Projections are all for the Lake Champlain Basin for the 2040-2069 time span[4]:

- Increase in annual precipitation by almost another 3 inches
- An increase in annual mean temperature of 5.6°F, with average winter temps increasing by 6.7°F
- Heat index will increase by almost four-fold (degree days)
- Growing season will increase by four weeks
- Expect 18 more days per summer that are over 90°F, and 32 fewer days where the avg. temperature is below freezing
- During the month of July, crop water needs will regularly be greater than incoming rainfall
- A decrease in maple sap production by seven days per year

POTENTIAL IMPACTS

- Increased erosion and loss of nutrients from fields
- Increased likelihood of damaging floods
- Wet soils resulting in reduced yields, increased compaction, and sub-optimal timing of field operations
- Increased need and demand for irrigation
- Increased pest and weed pressure
- Reduced yield/quality of cool season crops
- Increased risk of heat stress in livestock
- Increased risk of spring frost damage for fruit growers
- New opportunities and crops with extended growing season

- **Wetter springs**
- **More common very heavy rains**
- **longer summer dry spells and droughts**
- **warmer winters**
- **longer growing season**

Farming and Climate Change Program
UVM Extension Center for Sustainable Agriculture
23 Mansfield Ave.,
Burlington, Vermont 05401
10/14 Catalog #: SAFS 2

Soil Health Principles

1. Living roots In the ground
2. Maximized diversity
3. Minimized disturbance
4. No bare soil
5. Animal contact with soil
6. Slow and sink water

Healthy Soil: Holding Landscapes and Communities in Place

Creating conditions for healthy soil will decrease flooding and drought, increase transpiration affecting the small water cycle and global cooling, and increase the nutrient density of food for humans and wildlife.

Soil carbon is the living (soil organic matter [SOM] including plants & animals)**, the dead** (decaying SOM) **and the very dead** (stable humus, glomalin, fossil fuels, coal).

SOM holds 18-20 times its weight in water and recycles nutrients for plants to use.

One teaspoon of soil can contain a billion organisms: 75K species of bacteria,10K protozoa, scores of nematodes and a mile of fungal filaments.

The first meter of soil contains three times as much carbon (in SOM) as is found in either the atmosphere or in living plants.

Living soil can absorb and store greenhouse gases AND retain and cycle water.

A 1% increase of organic matter in the top 6 inches of soil per acre can hold over 20,000 gallons of water.

All data from NRCS and Soil Food Web.com Cat Buxton www.growmorewasteless.com

Principle 1: Living Roots In the Ground

Grow More Deep-Rooted Perennials. Nurture photosynthesis.

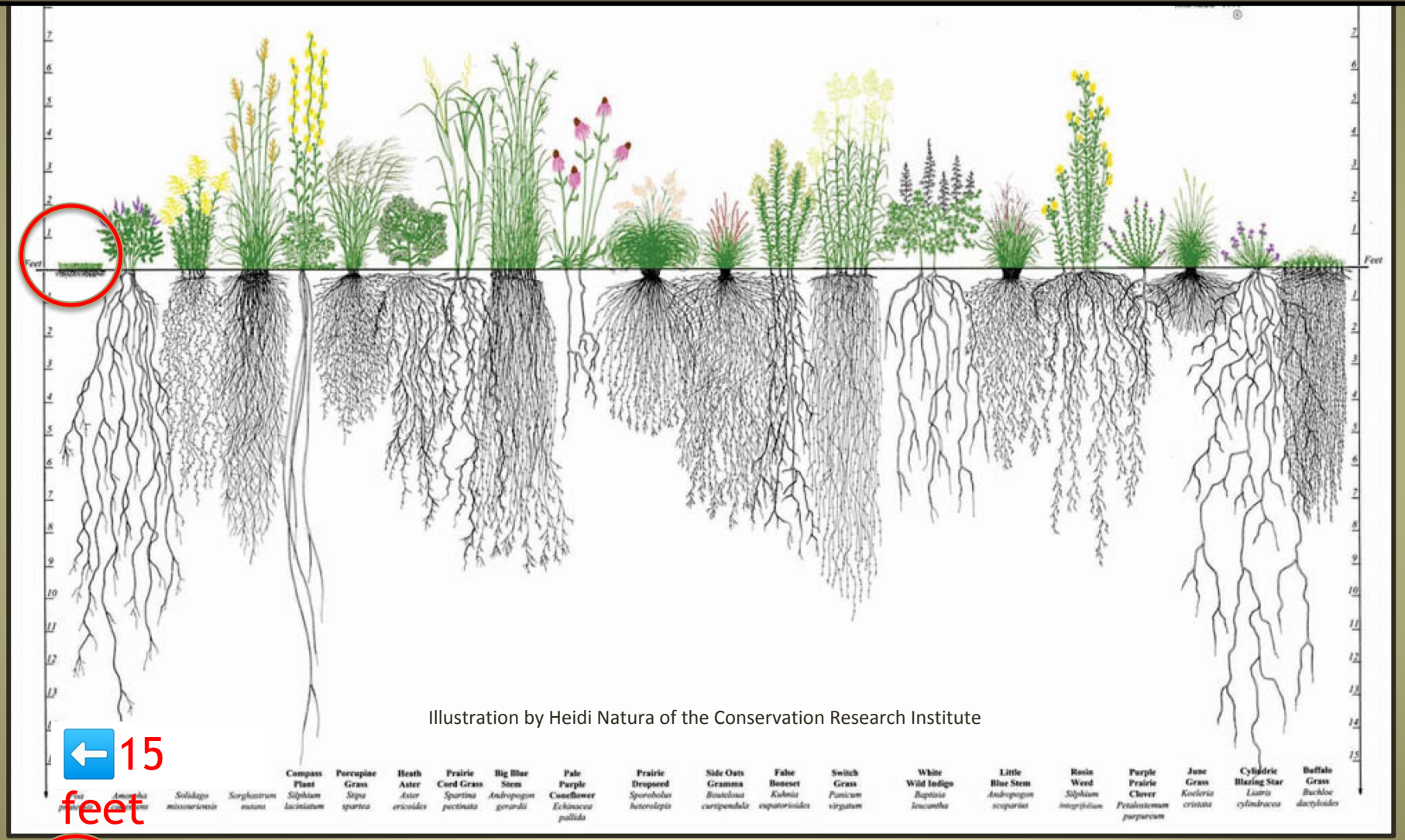
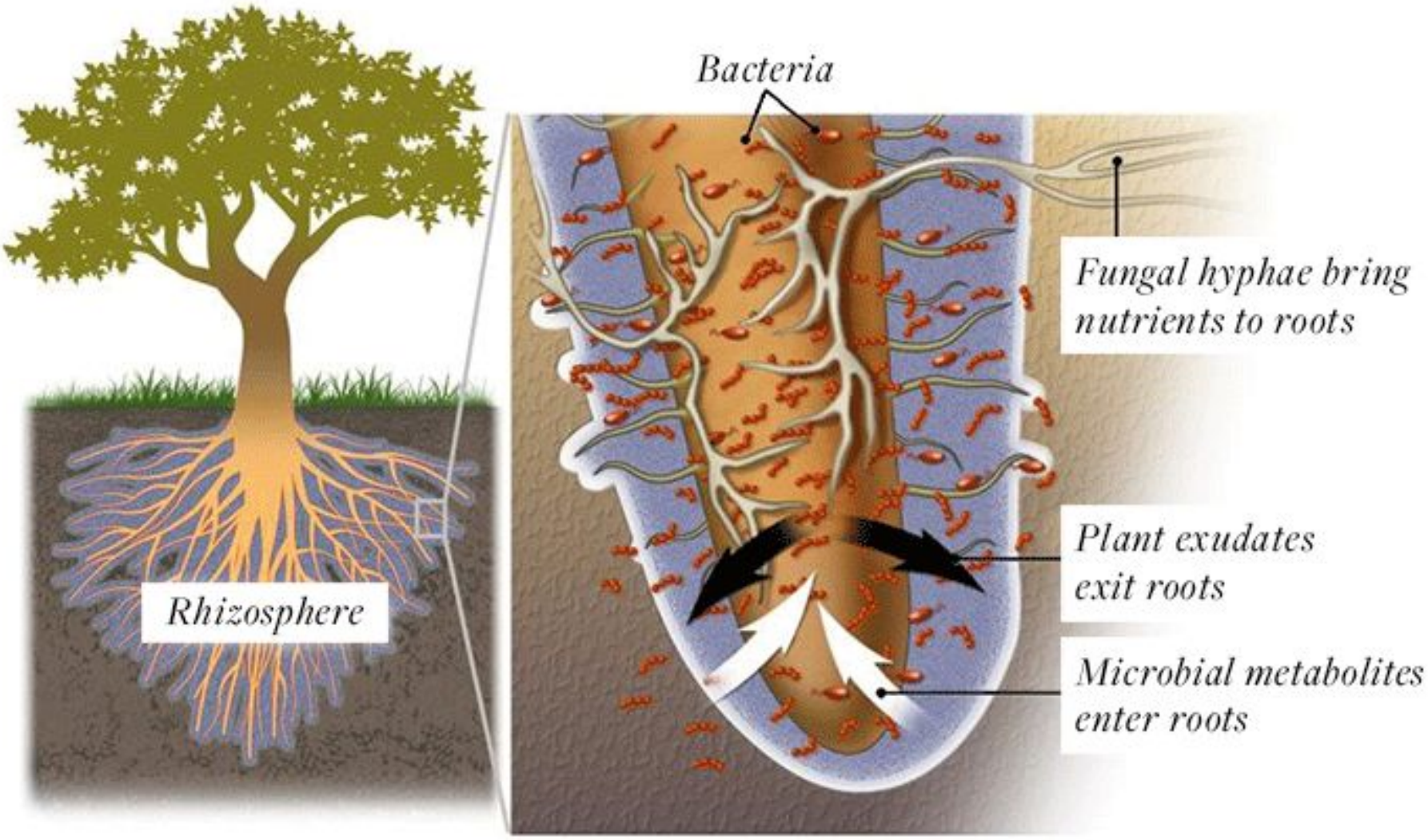


Illustration by Heidi Natura of the Conservation Research Institute

← 15 feet

Standard lawn

USA: 32 million acres of lawns (residential, commercial, and institutional lawns, parks, golf courses and athletic fields)



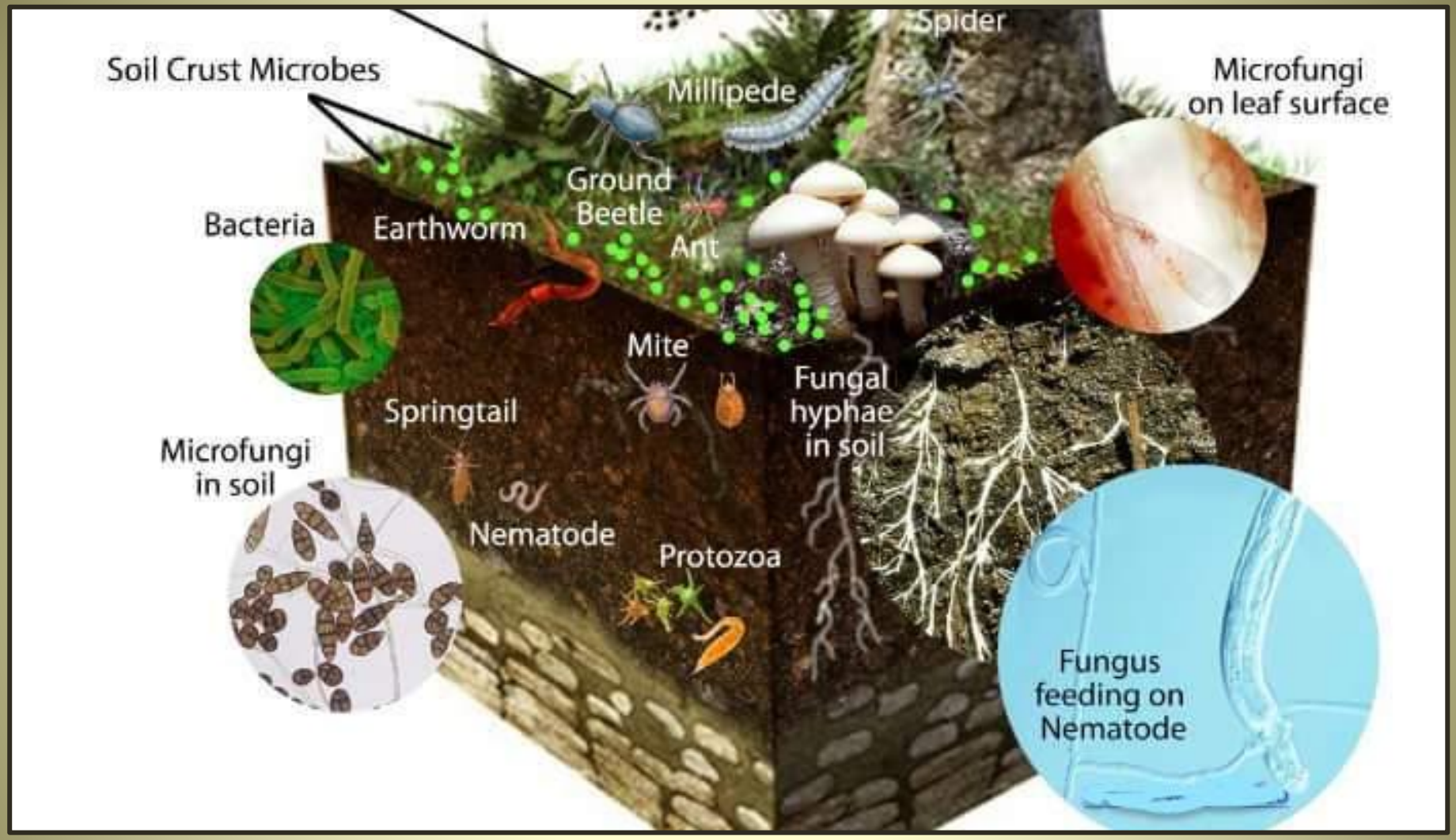
The rhizosphere can be vast!

RETHINKING LAWNS

32 million acres Lawns (residential, commercial, and institutional lawns, parks, golf courses and athletic fields)

50 million acres cropland (only counting irrigated crops)
- **11 million acres corn**
- **4 million acres of cotton**
- **3.6 million acres of pastureland**
- **3.3 million acres of wheat**
- **3.2 million acres of non-alfalfa hay**

Lawns cover 1.9 percent of the total land surface compared to 3.5-4.9% estimated to be devoted to urban development.



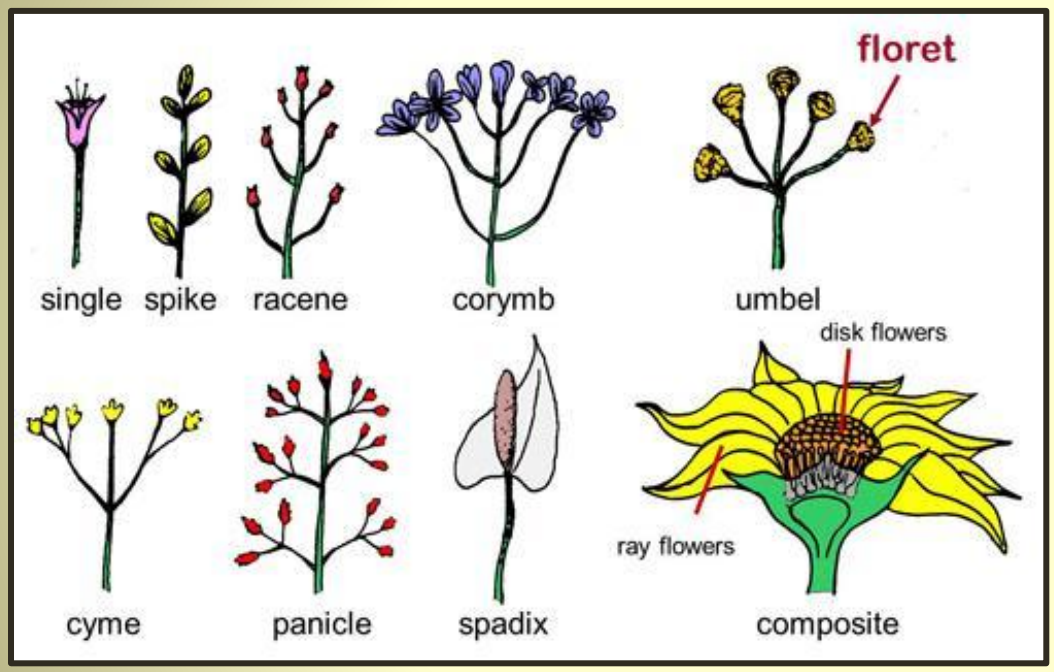
Principle 2: Maximized diversity

Cat Buxton www.growmorewasteless.com

Diversity attracts diversity, promoting balance.

Species, heights, textures, structure, color, timing, food for all, micro climates, biomass, crops, livestock …

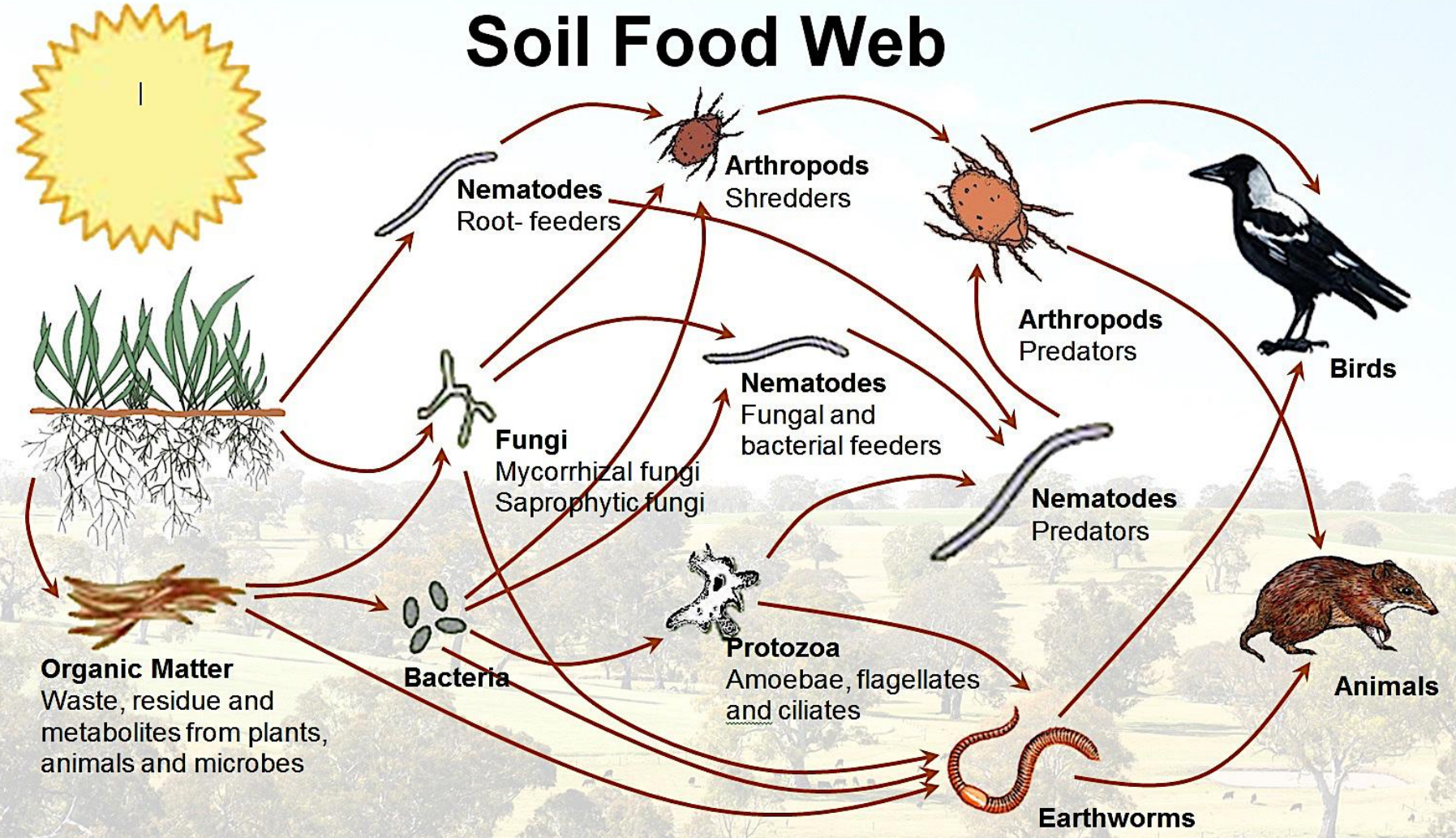
Some insects are specialist feeders



Some insects require plenty of good places to rest, or to hunt from.

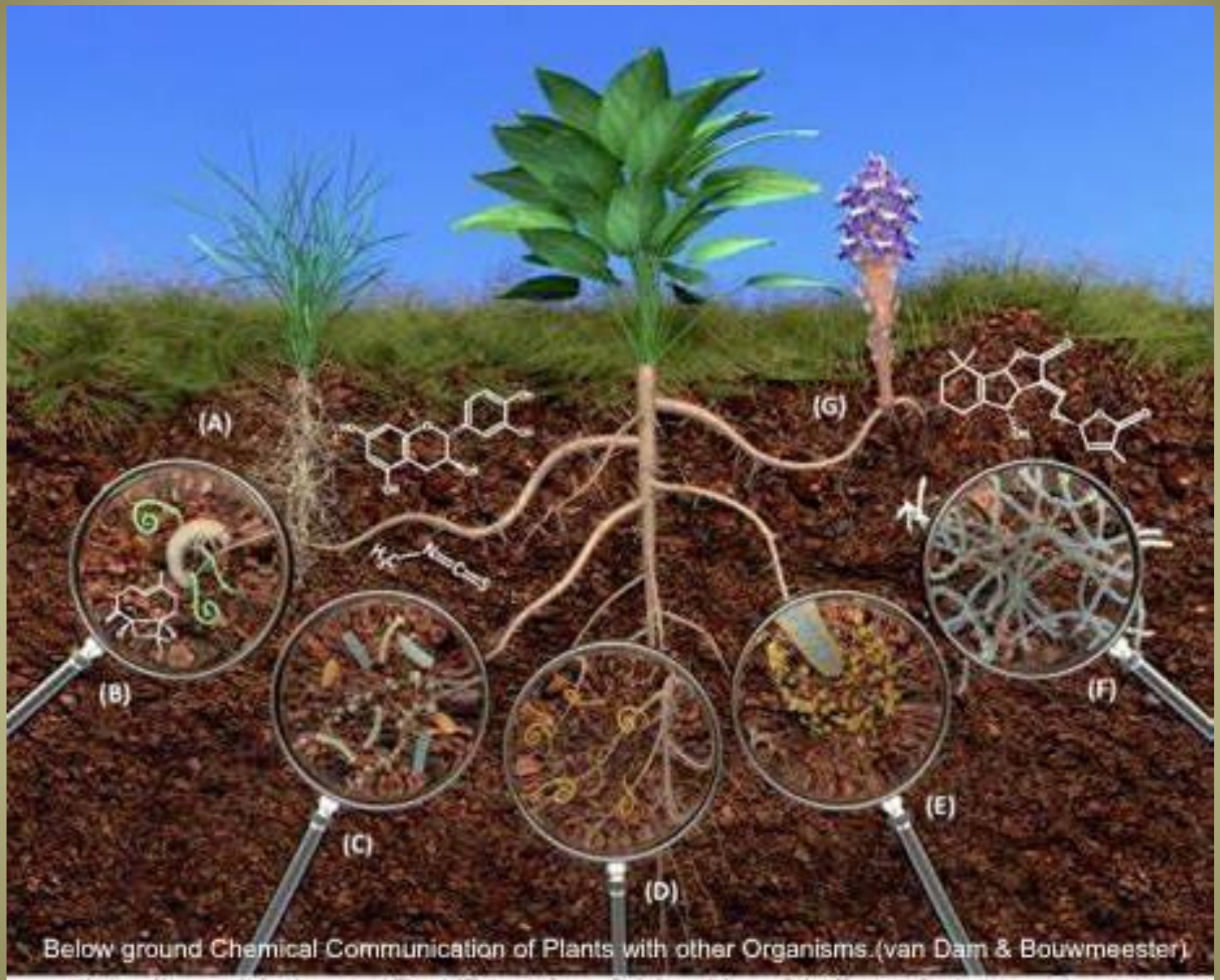
 All photos from Wiki

Soil Food Web



First trophic level	Second trophic level	Third trophic level	Forth trophic level	Fifth trophic level
Photo synthesisers	Decomposing Mutualists, Pathogens, Parasites, Root-feeders	Shredders Predators Grazers	High level predators	Higher level predators

IMAGE is widely available online. https://www.healthysoils.com.au/soil



Below ground Chemical Communication of Plants with other Organisms.(van Dam & Bouwmeester)

https://www.slideshare.net/DavidEnoma/beneficial-and-harmful-effects-of-microorganisms

https://www.theatlantic.com/health/archive/2013/06/healthy-soil-microbes-healthy-people/276710/

Principle 3: Minimized Disturbance

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Excessive Tilling and Use of Chemical Pesticides and Fertilizers Kills Soil Life

DISTURBANCE TO BIOMASS

50% to 70% of the world's 'original' soil carbon content has been lost to land cultivation.

Center for Food Safety

DISTURBANCE TO INSECTS

- 1 million insect species identified.
- 200 million insects for every human.
- 40 million insects for every acre of land.
- 1% are known to be harmful to humans.
- A sliver of those are agricultural pests.

https://www.endangeredspeciesinternational.org/insect
https://www.hindawi.com/journals/psyche/2010/207570/s
https://biocontrol.entomology.cornell.edu/bio.php

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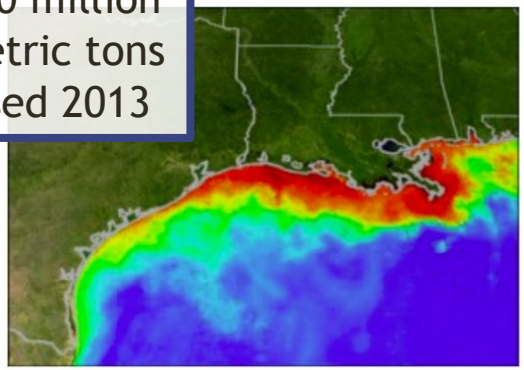
Downsides of Conventional Agriculture

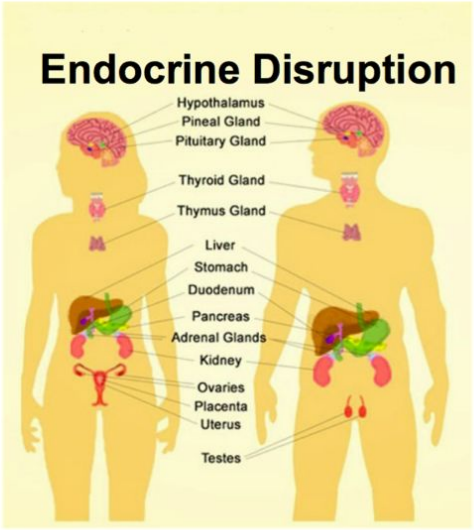
Steve Diver, Farm Superintendent UK Horticulture Research Farm

Nitrogen fertilizer

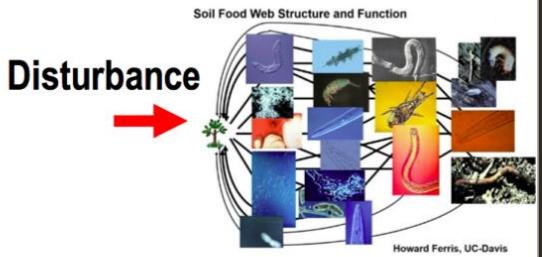
- 80 million metric tons used 2000
- 110 million metric tons used 2013



Hypoxia — Dead Gulf Zone

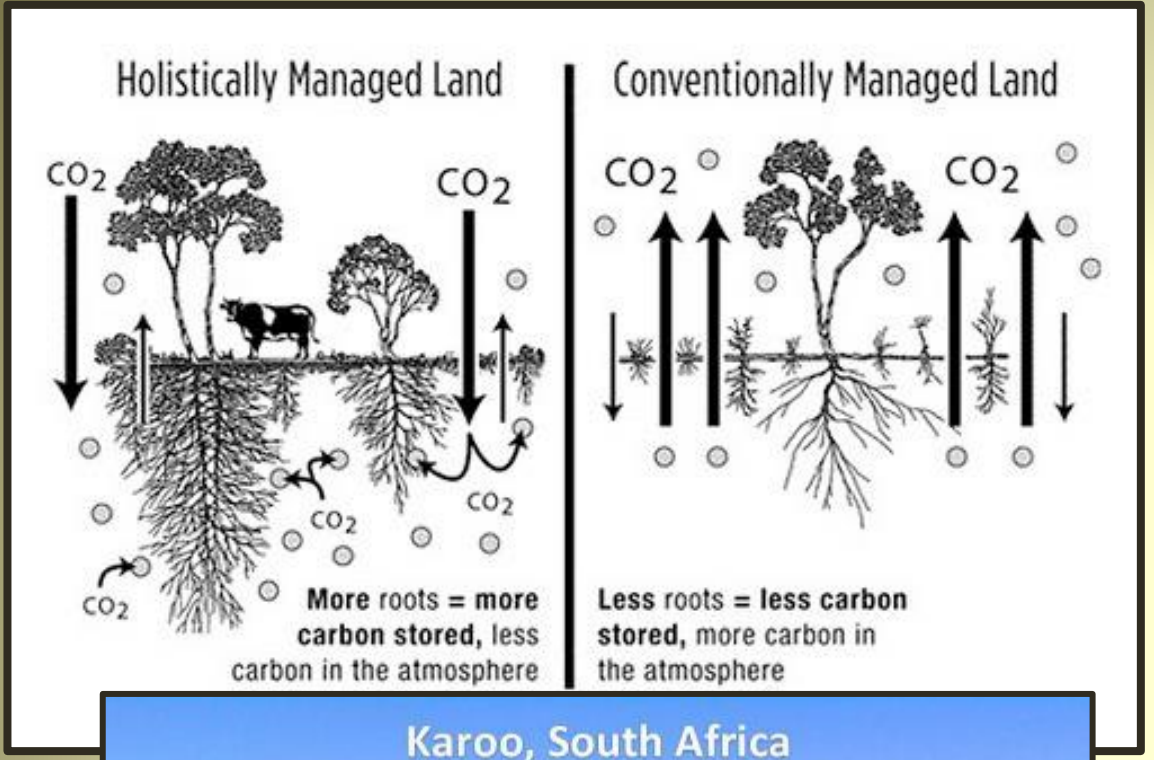


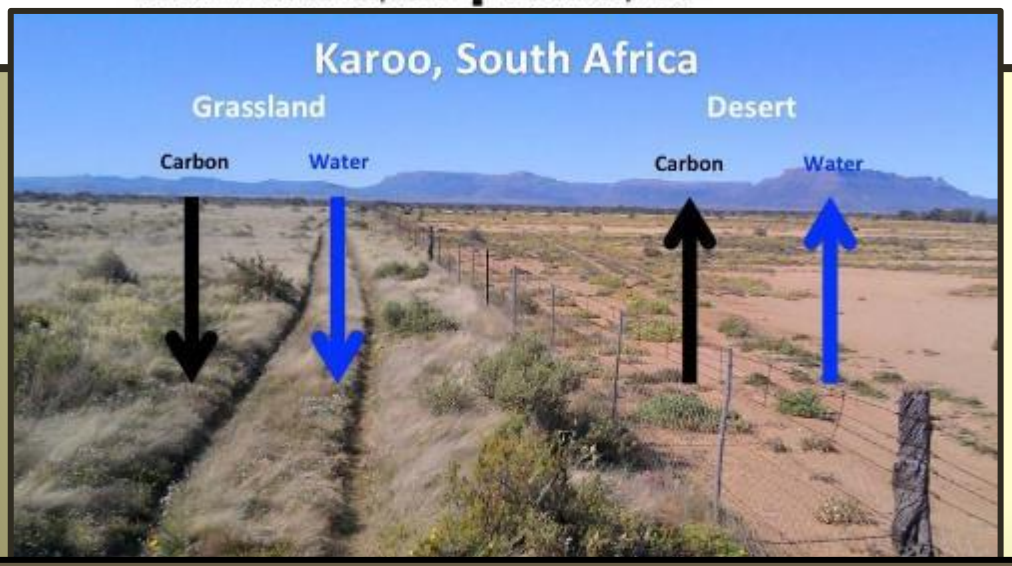
Population



Monarch Butterfly & Soil Biology

*Between 44% and 57% of all GHG emissions come from the **global food system** not just agriculture*





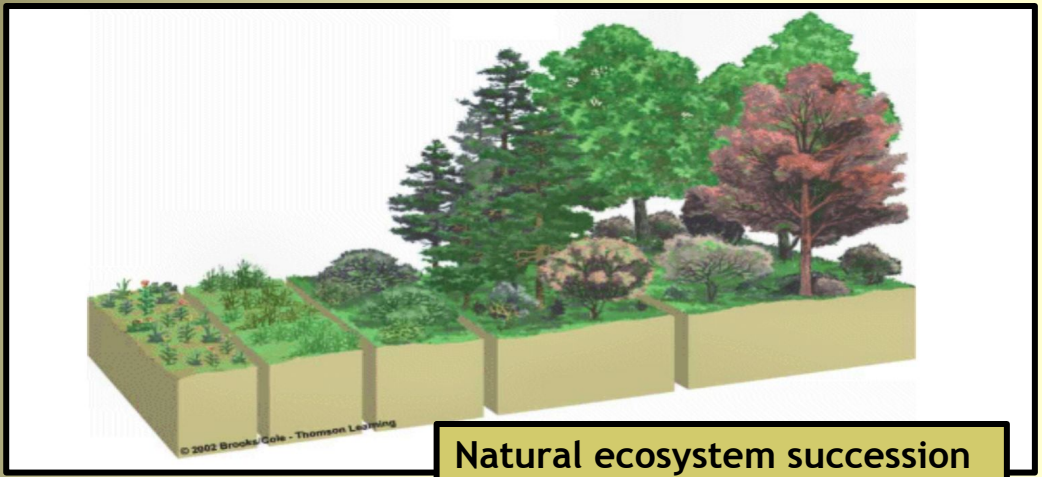
How we manage land affects carbon cycling.

Can we learn to work within natural systems to mitigate climate change?

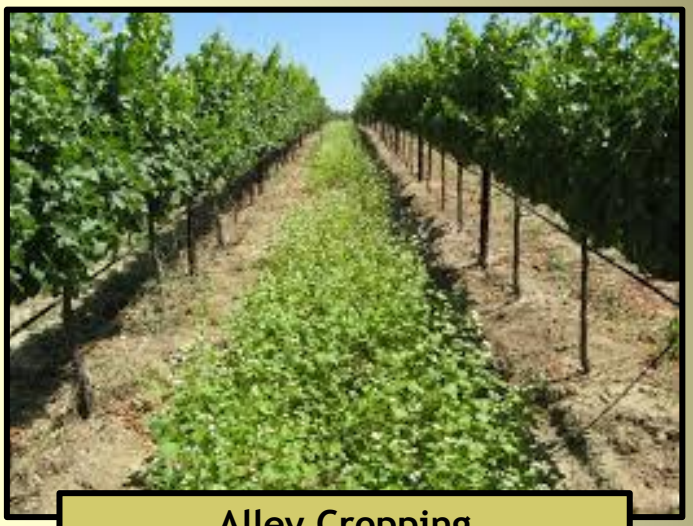
Principle 4: No Bare Soil - keep it covered!

Keep Soil Covered On Every Scale.

Mimic Natural Systems. Implement Polycultures, Cover Cropping and Mulching.



Natural ecosystem succession



Alley Cropping

Mulching is better than bare

Cover Cropping

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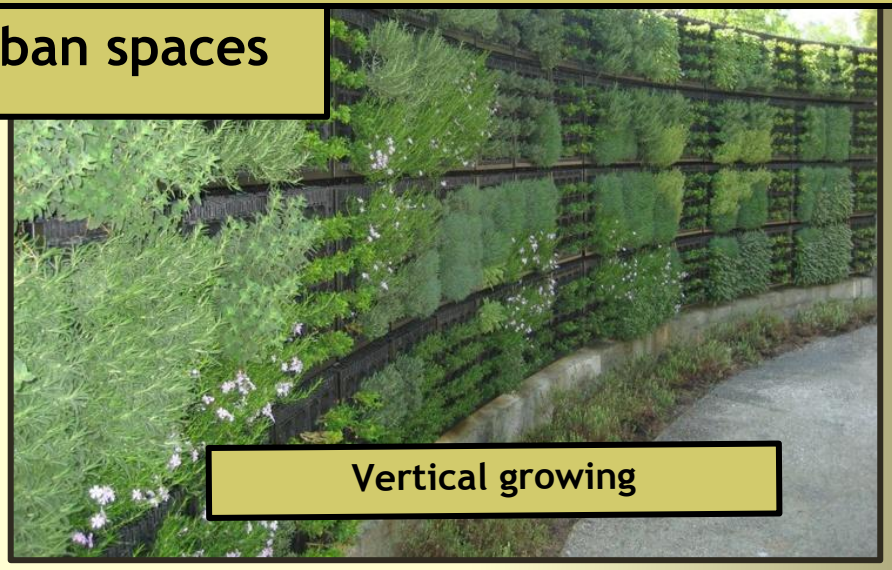
Cover Surfaces with Green Growing Plants to Maximize Photosynthesis

Maximize diversity, root depth and living roots for as long as is possible

Rethink urban spaces

Rooftop growing



Vertical growing

Community growing

Get the livestock back outside, adjust the herd size, and move them.

Holistic Grazing Management is different than Rotational Grazing

Principle 5: Animal Contact with Soil

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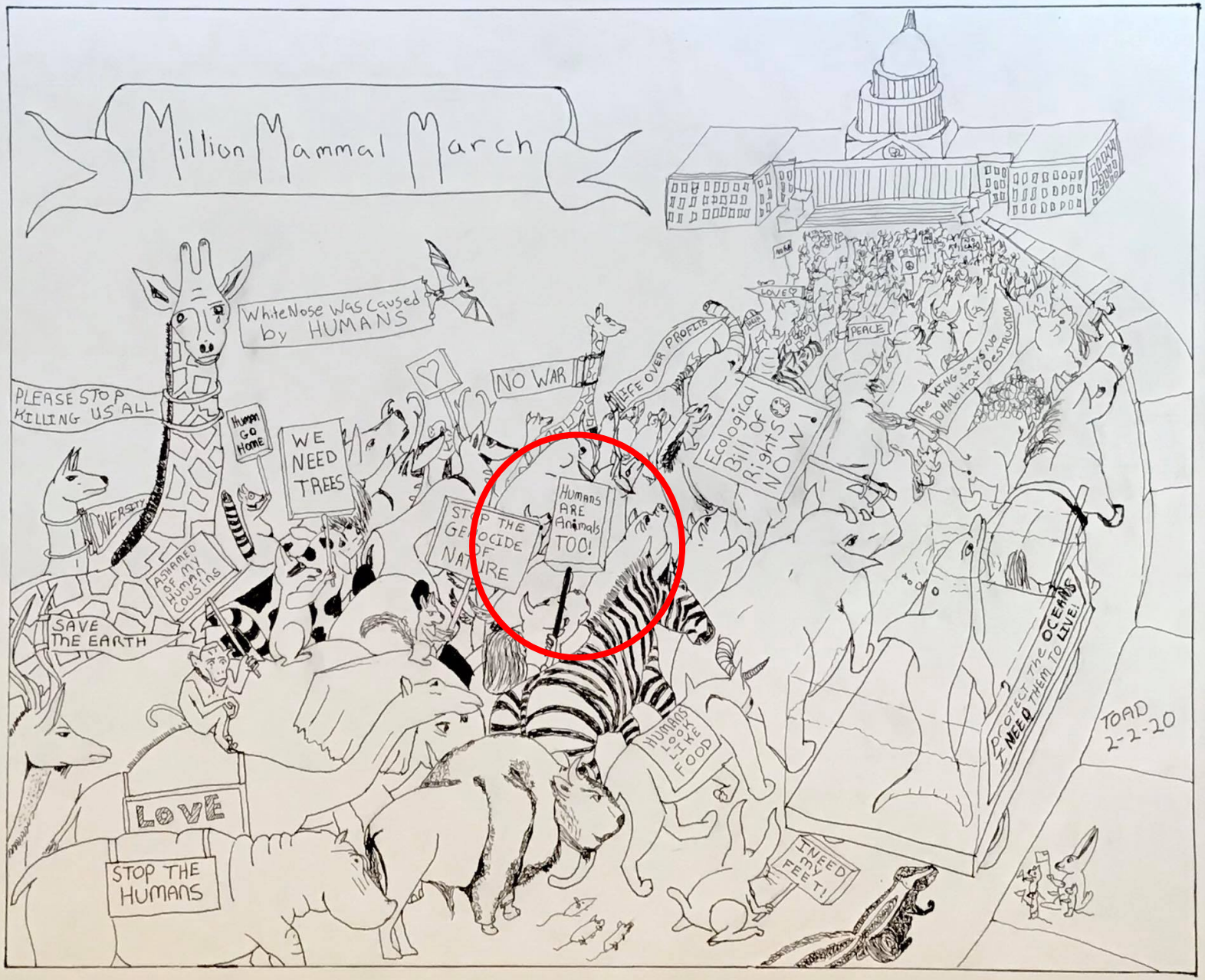

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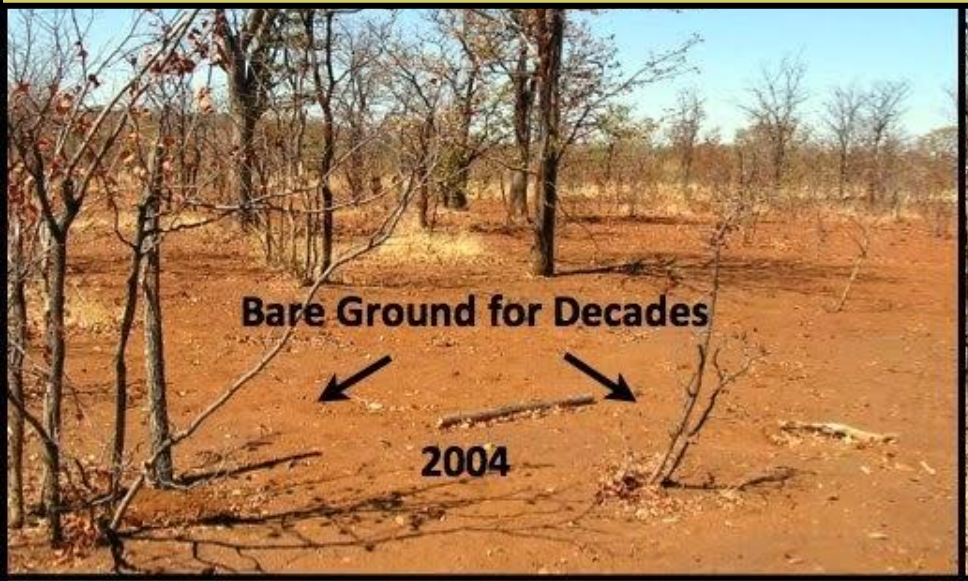
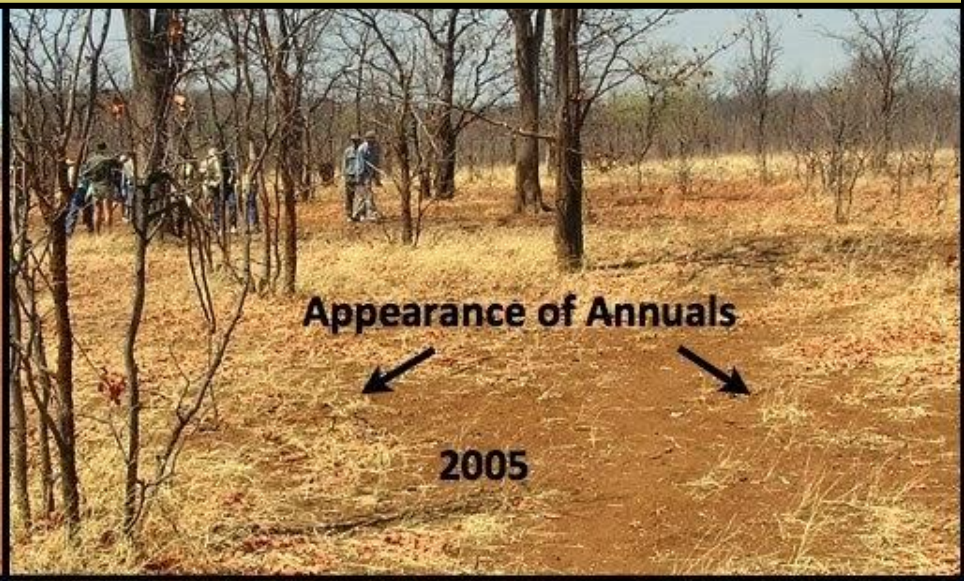
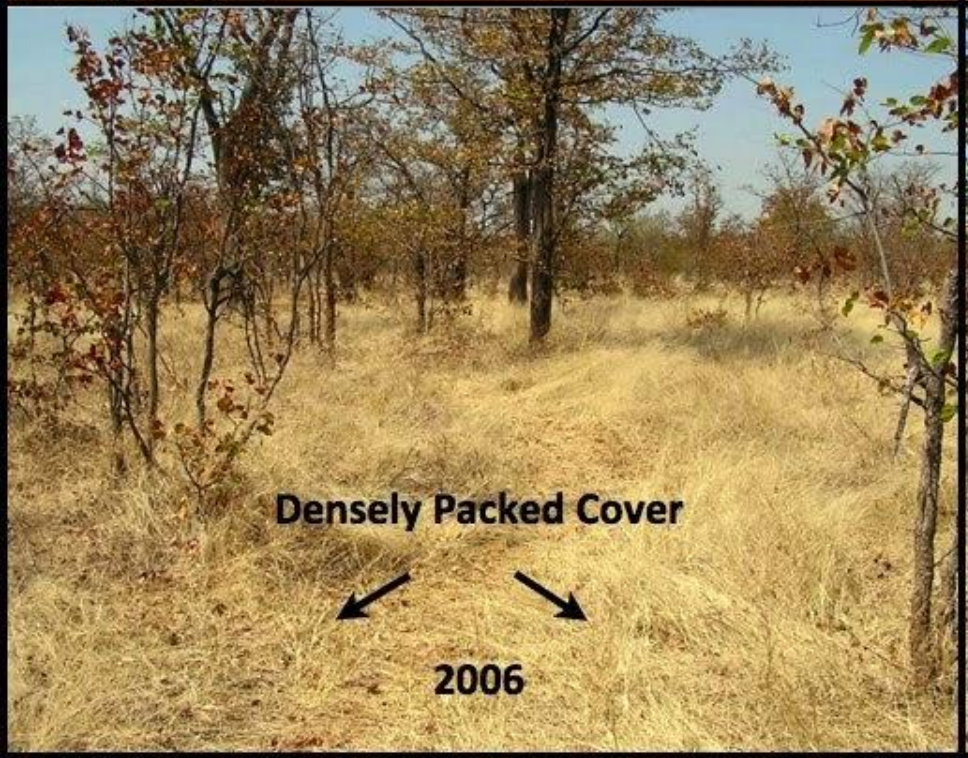
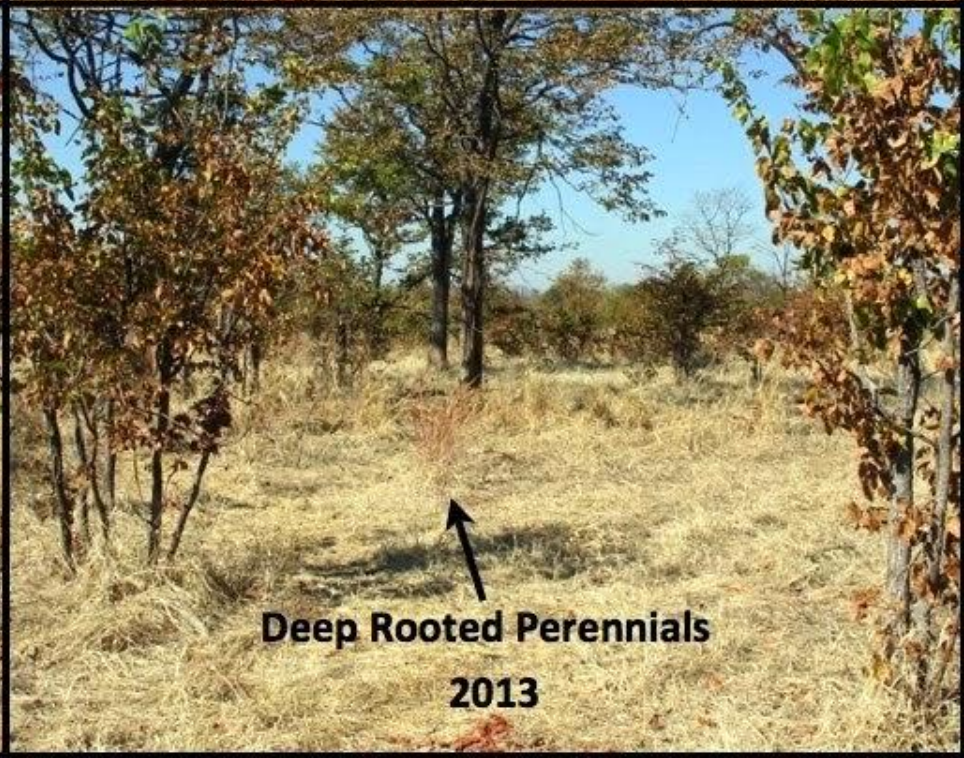
Land Regeneration Can Happen Quickly

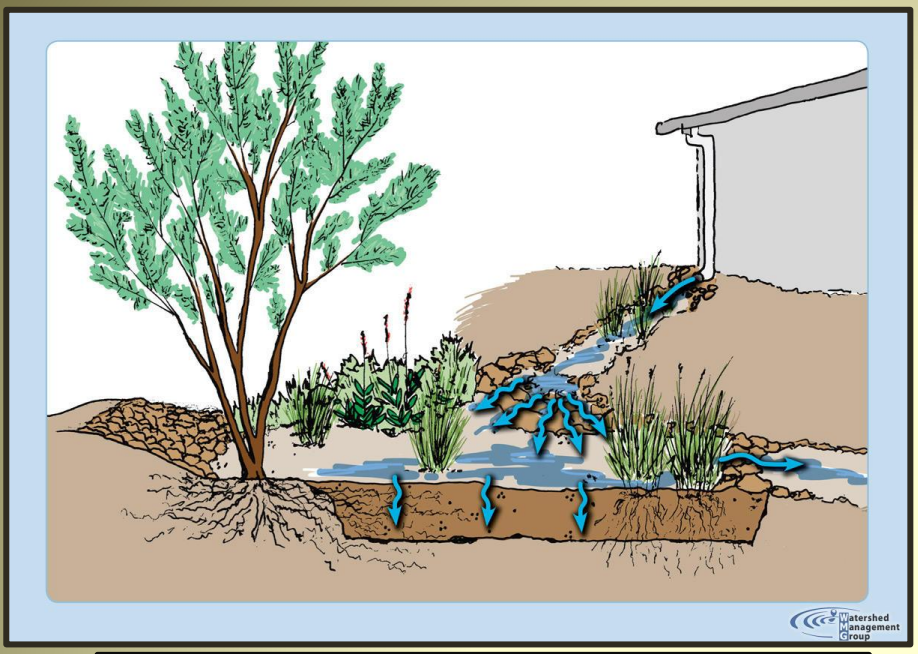
Zimbabwe











Principle 6: Slow and sink rainwater

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Infiltration and runoff

by type of management on agricultural land

How many soil health principles are being followed in each sample?

INFILTRATION - back row of jars

RUNOFF - front row of jars

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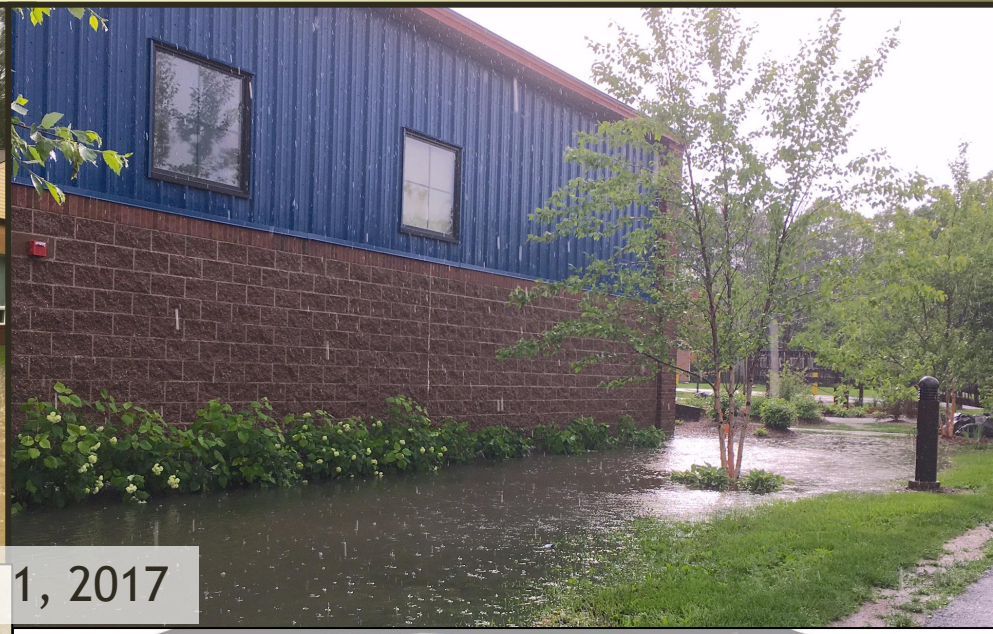
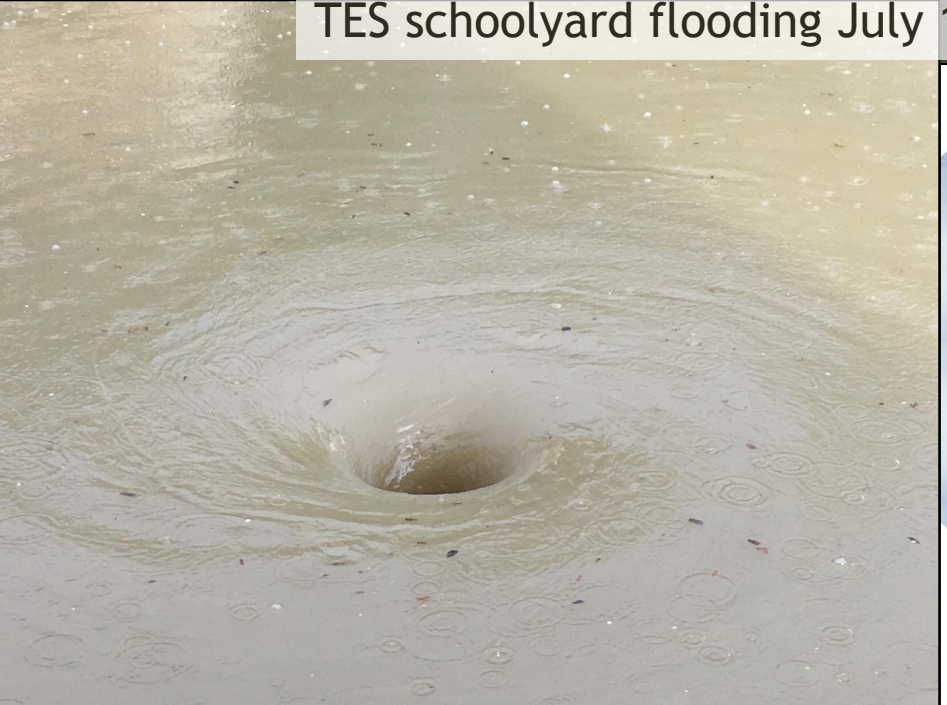
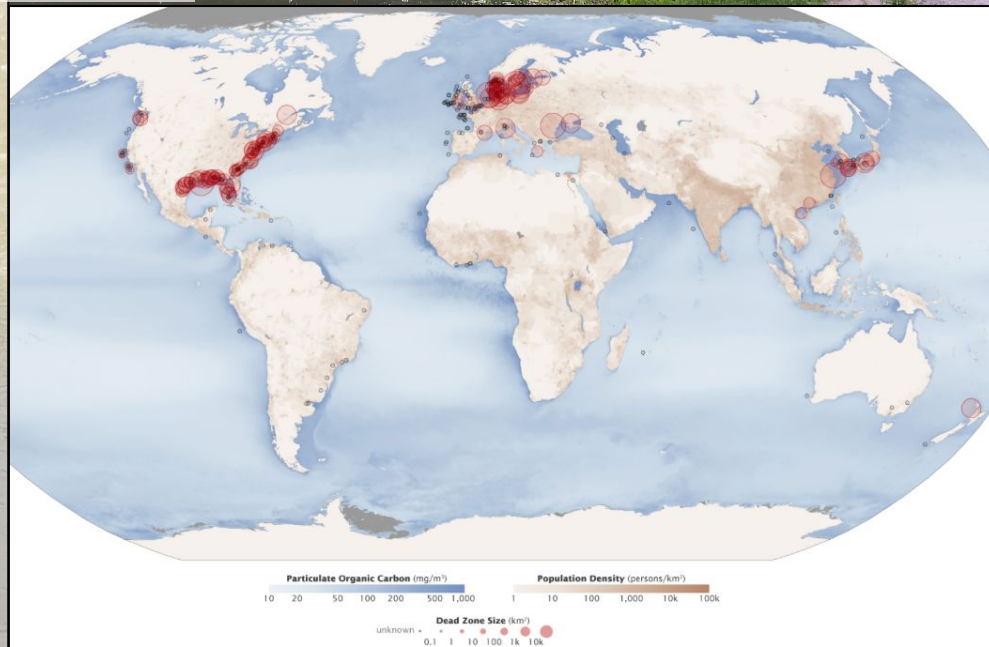
Water: to capture or to divert as waste?



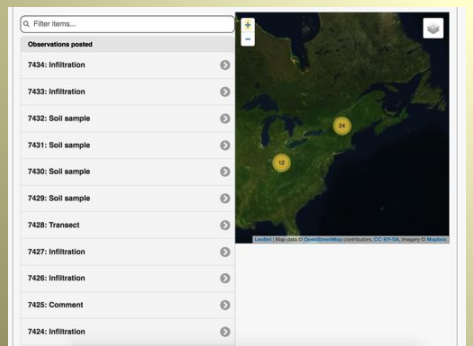
TES schoolyard flooding July 1, 2017





Measuring Landscape Changes Over Time

Charting schoolyard water infiltration rates,
observing species diversity and percent of bare ground.
Thetford Elementary School 6th grade



Open data at atlasbiowork.com

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Grade 6 - Compost Managers

Thetford Elementary School

6th graders monitor compost

5th graders turn compost

Windrows double as pumpkin patch for 1st graders.

Eaters can do a lot to direct the food system!

"Eating is an agricultural act"

– Wendell Berry

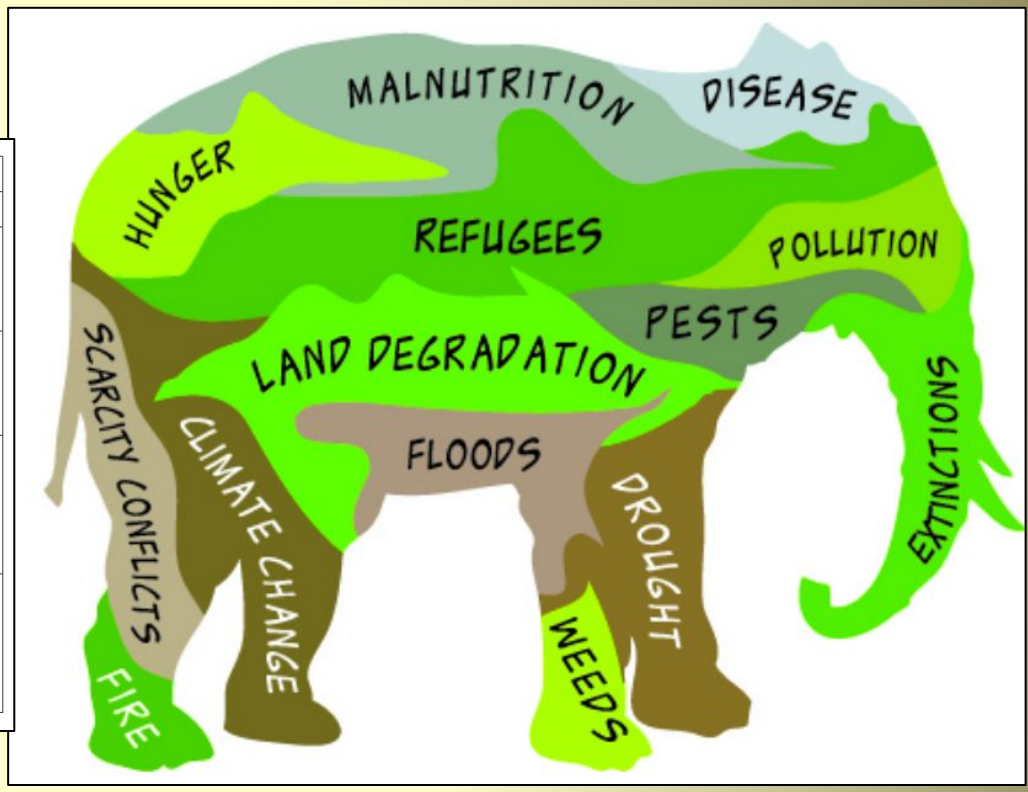
Soil Health & Soul Health

1. Living roots In the ground
2. Maximized diversity
3. Minimized disturbance
4. Keep soil covered. No bare soil.
5. Animal contact with soil
6. Slow and sink rainwater

1. Stay grounded. Live close to the land that feeds us.
2. Welcome physical and philosophical diversity. Eat well.
3. Keep conflict to a minimum.
4. Protect and nurture yourself.
5. Humans need soil contact for health and well being.
6. Water is life. Consciously embrace and embody the flows of energy.

The Elephant in the Room

common questions	better questions
Am I doing the right thing?	What results am I getting?
Is this species or practice good or bad?	What work does it do, and how does it function in the larger system?
How do I kill this weed?	What conditions could I create so that this weed is no longer a problem?
What best management practices are commonly associated with accomplishing *X*, and which appeal to me?	What conditions will enable *X* to occur?
What's my soil type? Is it good or bad?	How long does it take an inch of water to infiltrate? How might I improve that so my soil can accept and store more water?



How can we model asking better questions that reflect thinking in whole systems?

Courtesy of Peter Donovan of the Soil Carbon Coalition

Opportunities Abound!

Humans CAN adapt and change our behaviors to align with natural systems.

Nothing short of fundamental change, from social culture to agriculture, can address and mitigate climate change.

In right relation to the land, humans can allow for the rehabilitation of global land surfaces and the liberation of all beings.

Connecting communities to affect positive food system change from the ground up

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Consultant • Presenter• Vermont Master Composter • Garden & Compost Manager at Thetford Elementary School • Coordinator for Upper Valley Apple Corps • Project Manager for the Hartford Riverwalk Trail • Vermont Healthy Soils Coalition • Soil Carbon Coalition • Co-director Soil4Climate-Vermont