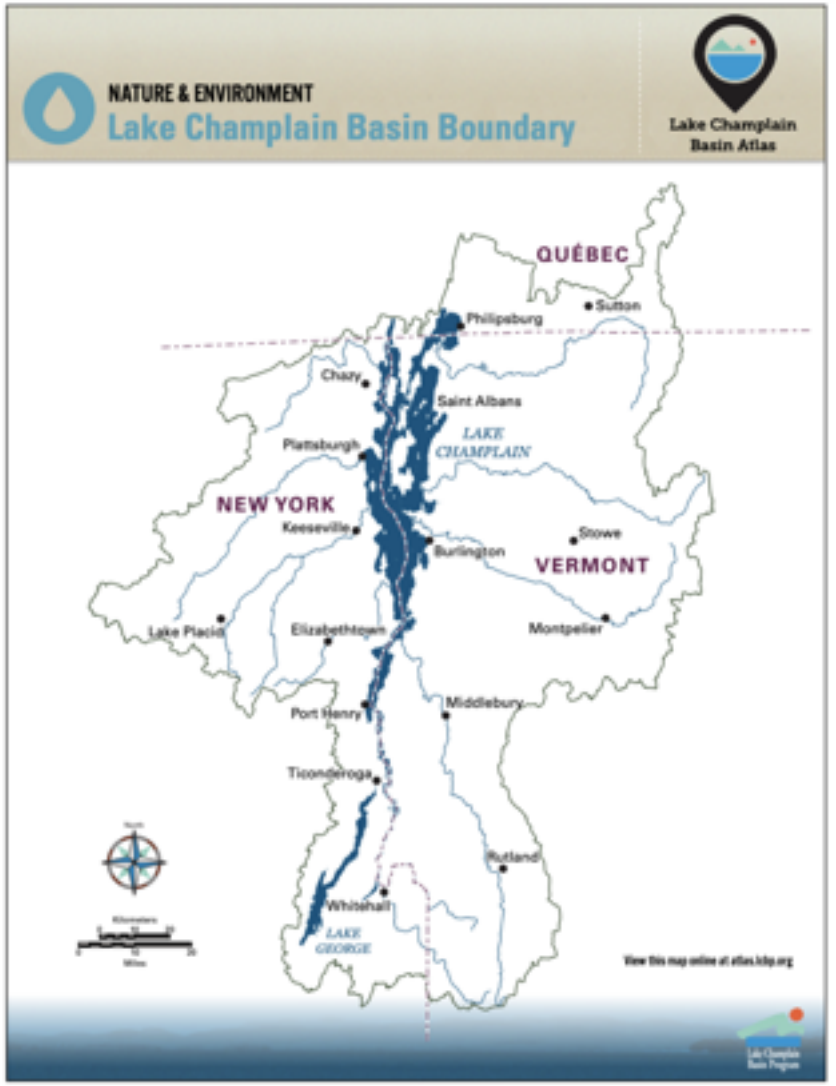
Soil Builders – Education in Action
Module 1: Soil Health & Water Quality

Soil Builders Workshops

Compost-related eco-literacy for Lake Champlain Basin decision-makers, professionals and advocates.

Compost increases soil stability, fertility, water infiltration, and moisture retention.

Using compost in land management practices is a critical strategy for climate adaptation.



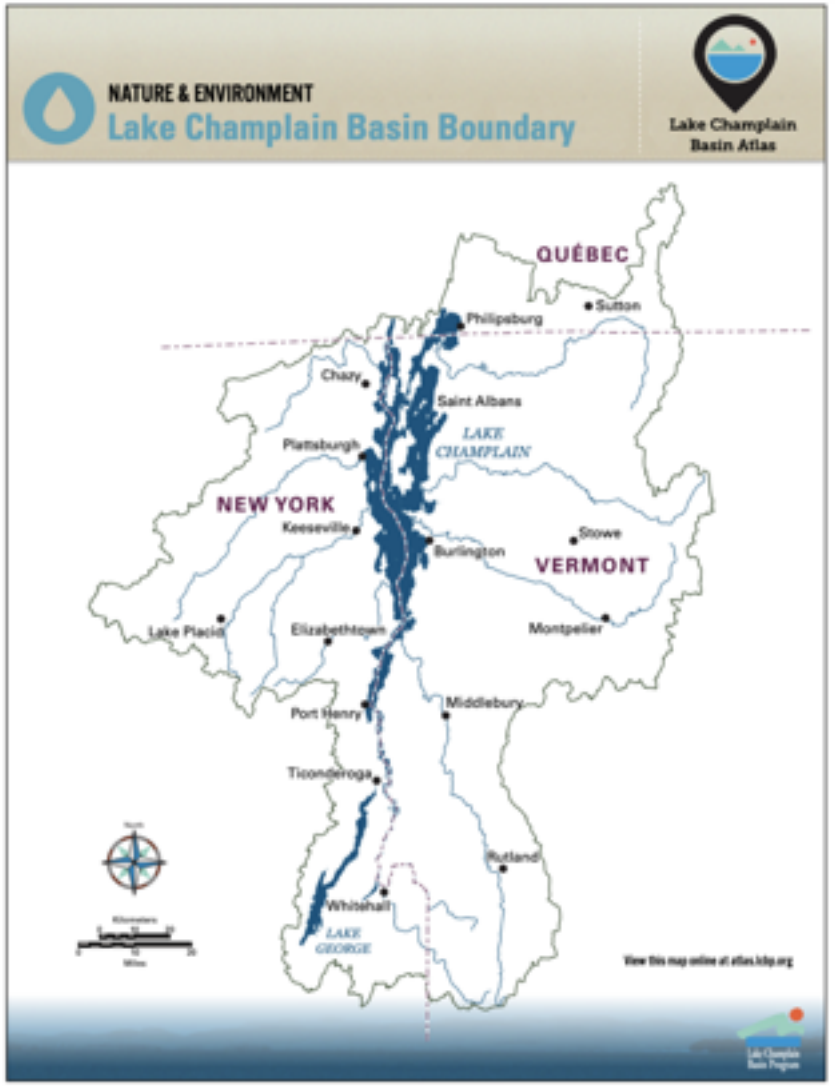
Soil Builders Workshop Topics

Soil health & water quality

Drivers for clean water & healthy soil

Best Management Practices for compost & compost-based products

Education in action – next steps



Project Partners

- Athena Lee Bradley, Compost Consultant, CAV Board Member
- Marc Companion, Lake Champlain Sea Grant
- Chuck Duprey, Naturcycle
- Brian Jerose, Agrilabs Technologies Inc., CAV Board Member
- Deb Neher, UVM
- Elly Ventura, Lamoille Regional Solid Waste Management District, CAV Board Member

Additional Thanks

- CAV Board of Directors

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Module 1: Soil Health & Water Quality

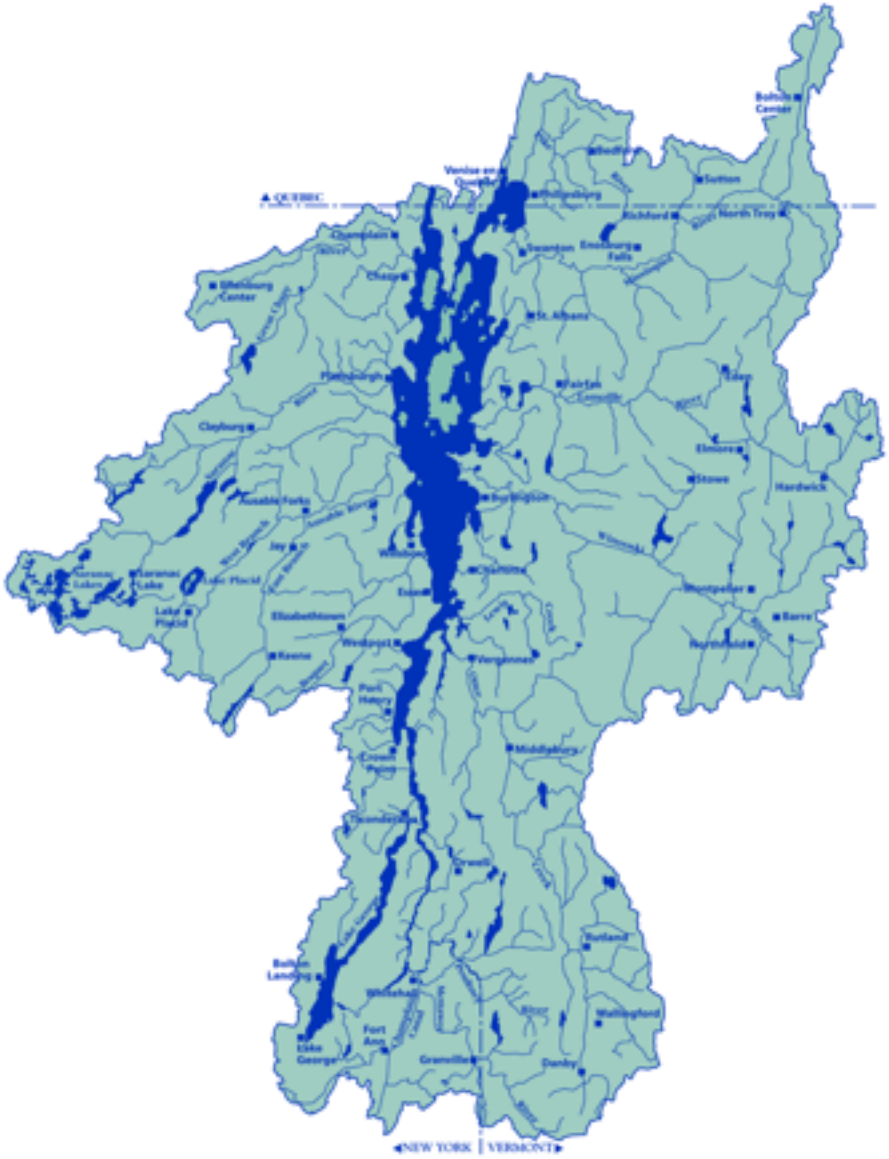
- Marc Companion, Lake Champlain Sea Grant
- Athena Lee Bradley, independent compost consultant

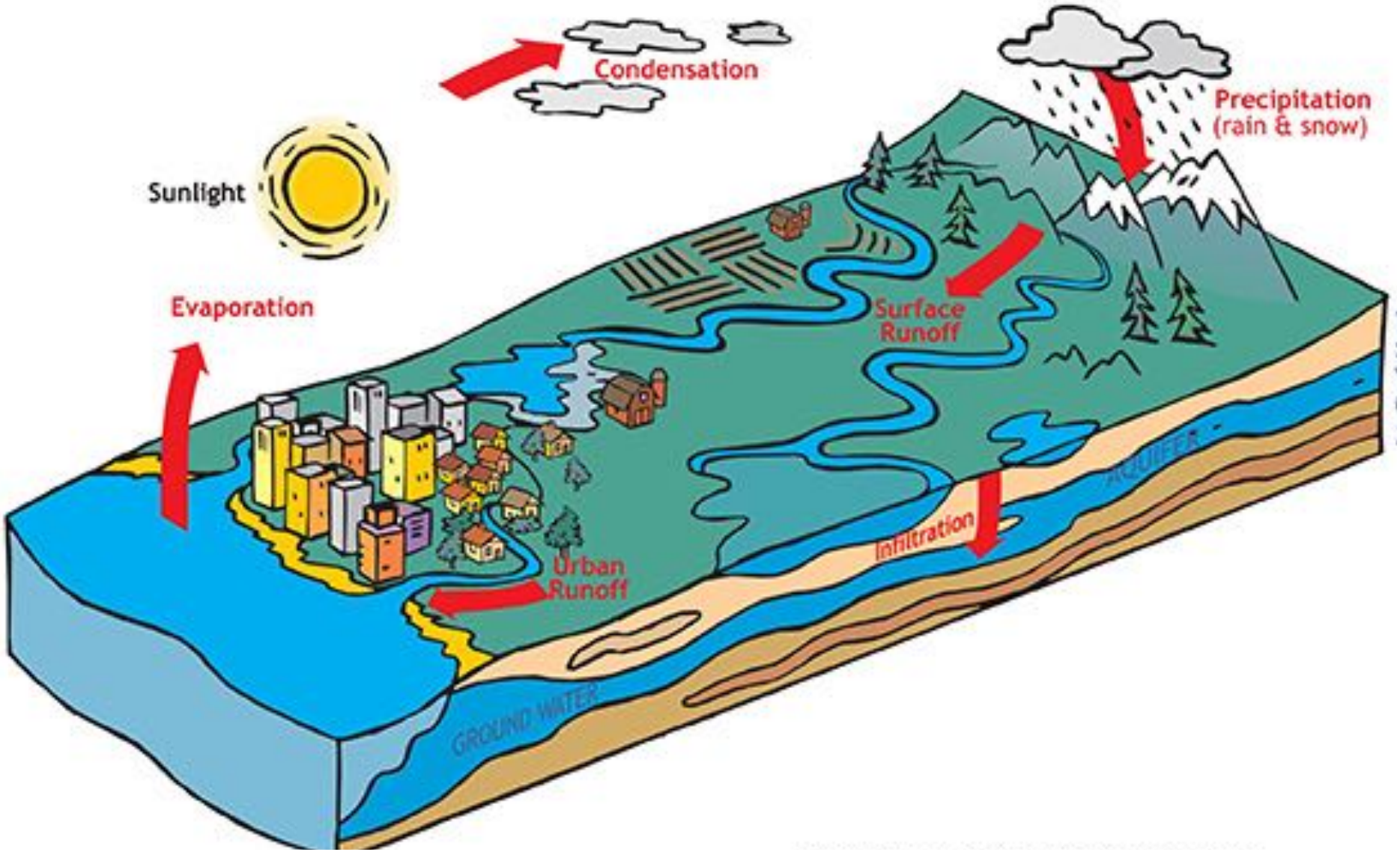
What we'll cover today:

soil health, compost & water quality

- Introduction to stormwater
- Healthy ecosystems and water quality
- Introduction to soil
- Compost, soil health and water quality

Stormwater and water quality




Condensation
Precipitation
(rain & snow)
Sunlight
Evaporation
Surface
Runoff
Urban
Runoff
Infiltration
AQUIFER
GROUND WATER

Composting Association of Vermont (CAV)

Reclaiming Organic Residuals For Good

Composting Association of Vermont (CAV)

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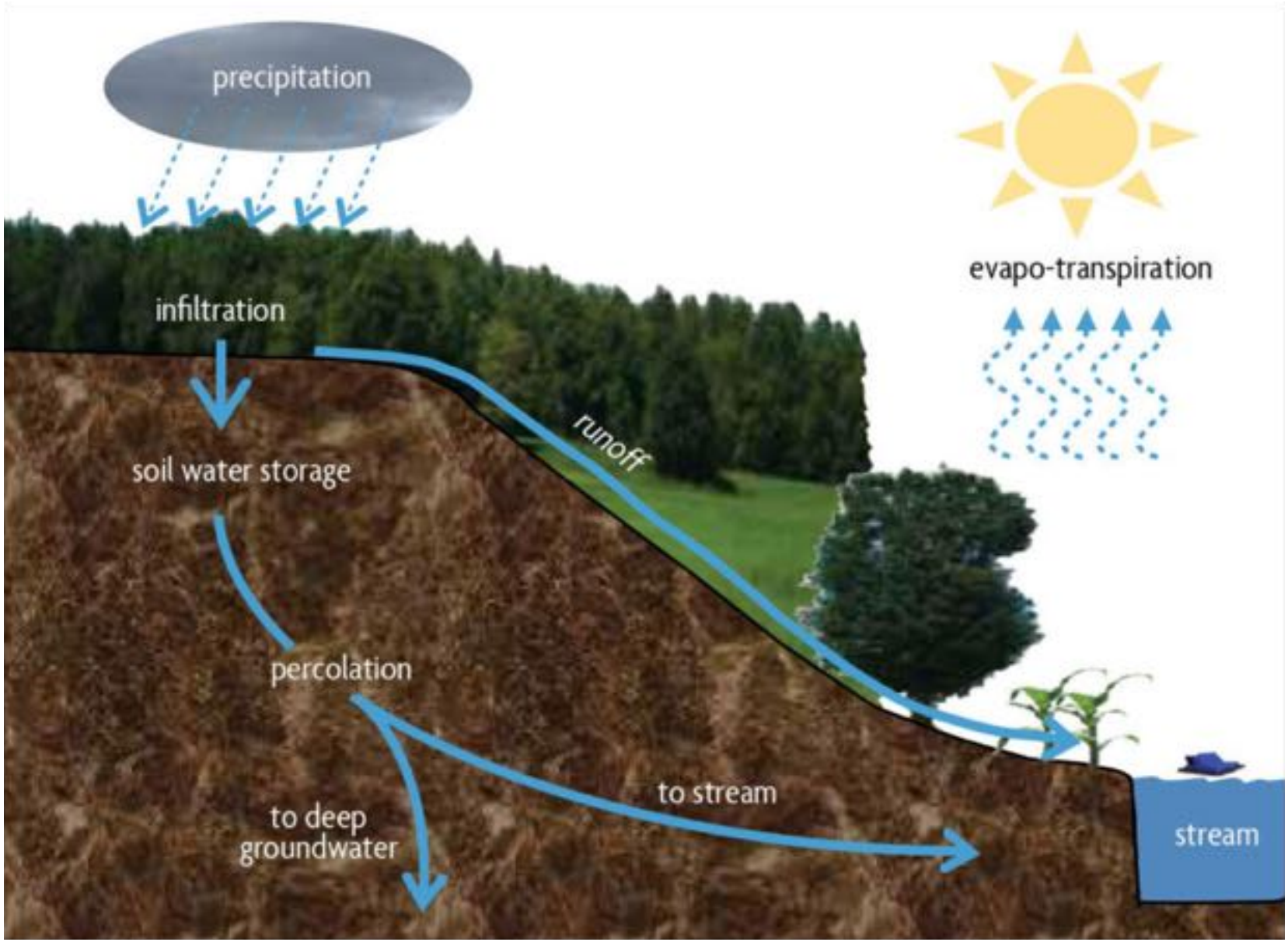
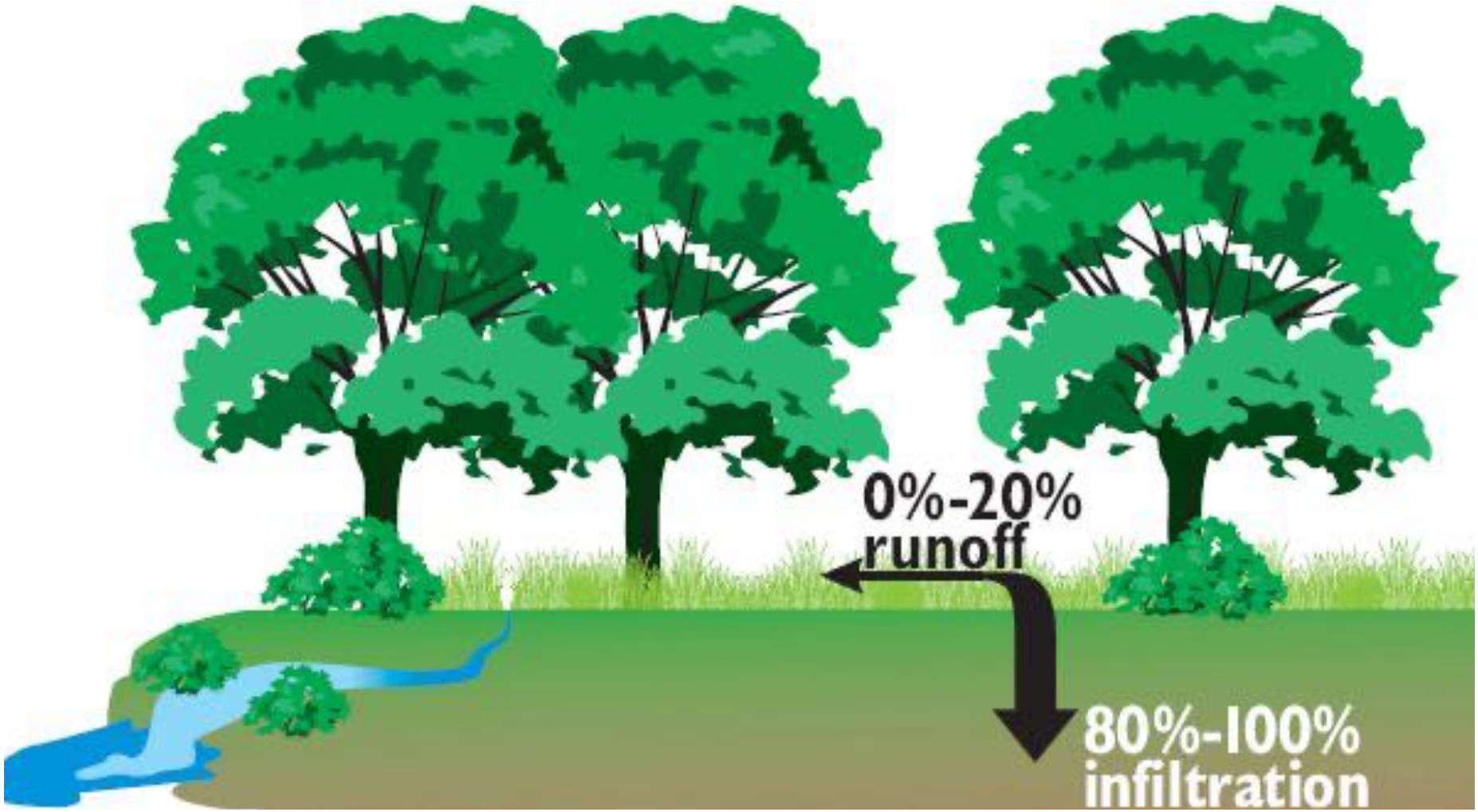
Reclaiming Organic Residuals For Good


precipitation
evapo-transpiration
infiltration
runoff
soil water storage
percolation
to stream
to deep
groundwater
stream


0%-20%
runoff
80%-100%
infiltration

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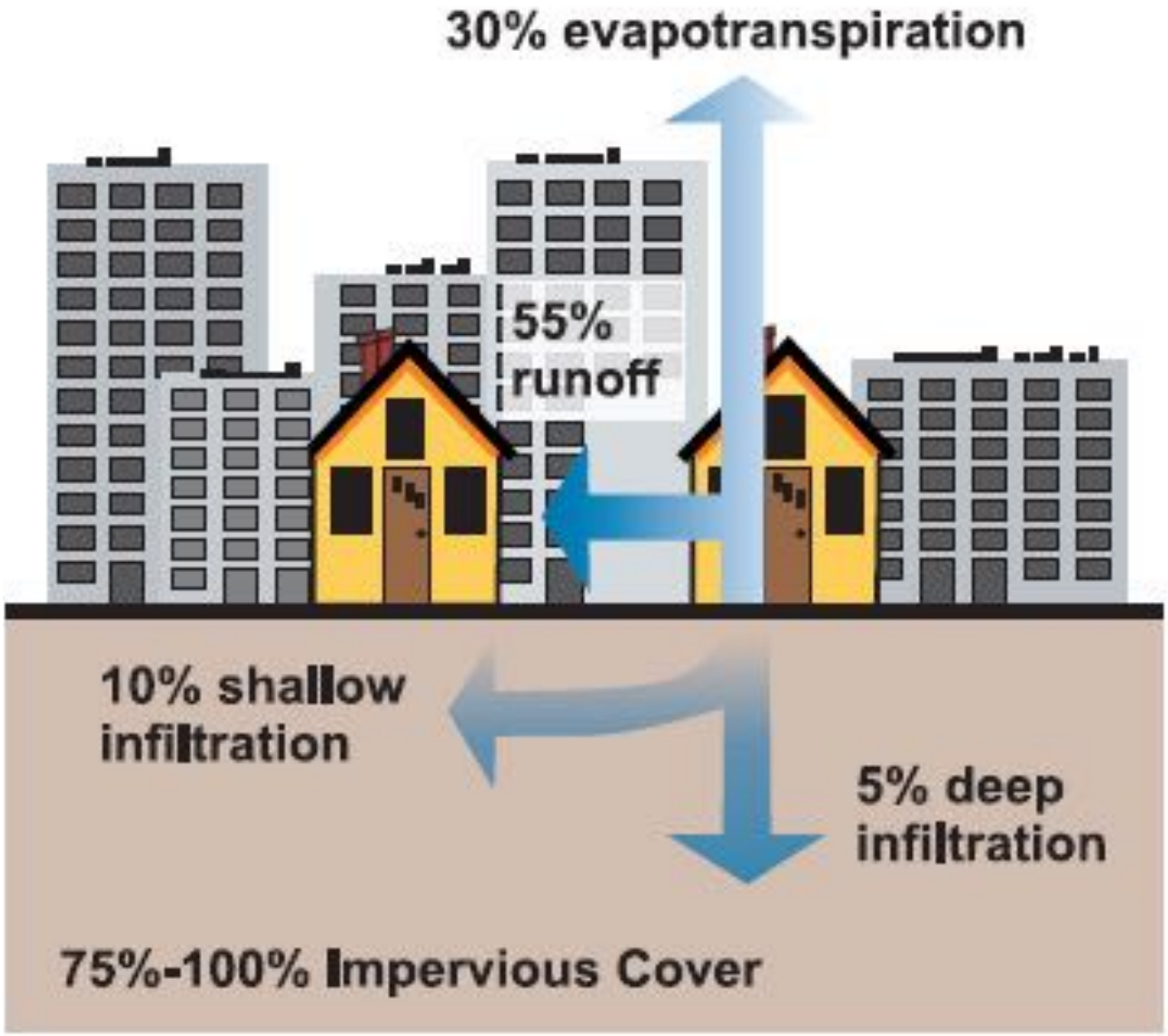
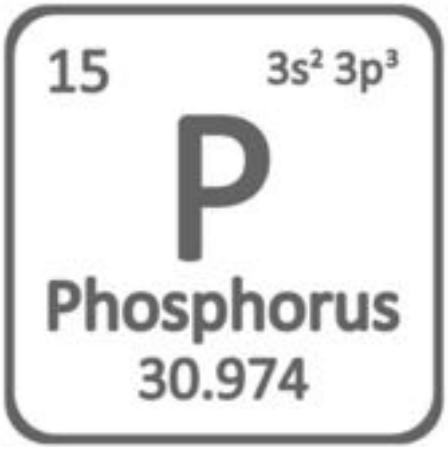
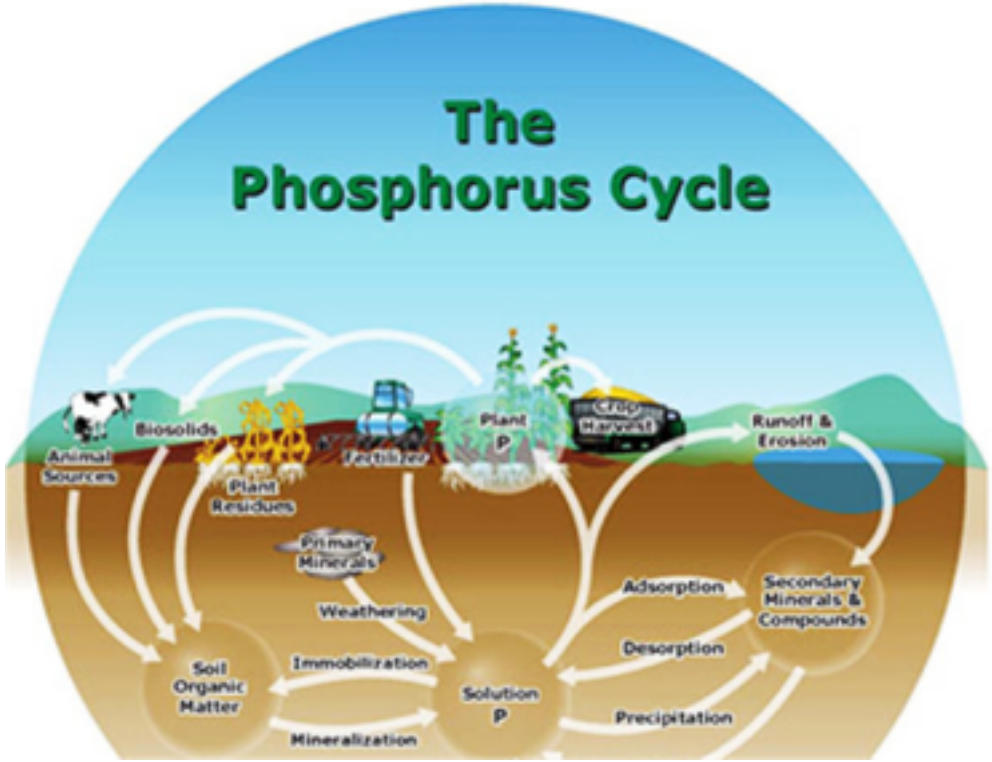

30% evapotranspiration
55% runoff
10% shallow infiltration
5% deep infiltration
75%-100% Impervious Cover

Phosphorus as “pollutant of concern”





15 $3s^2\ 3p^3$

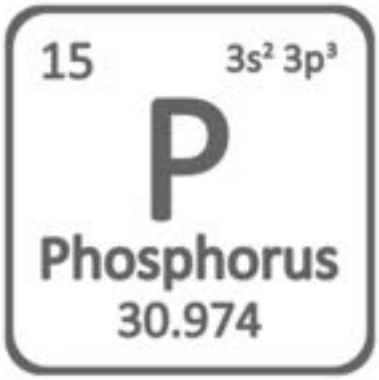
P

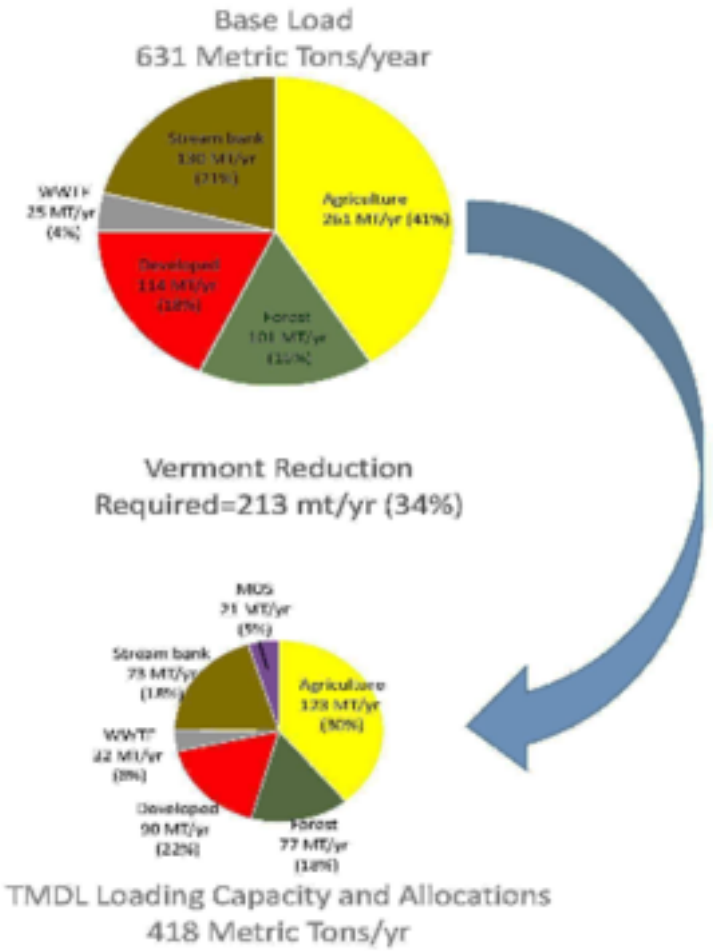
Phosphorus

30.974

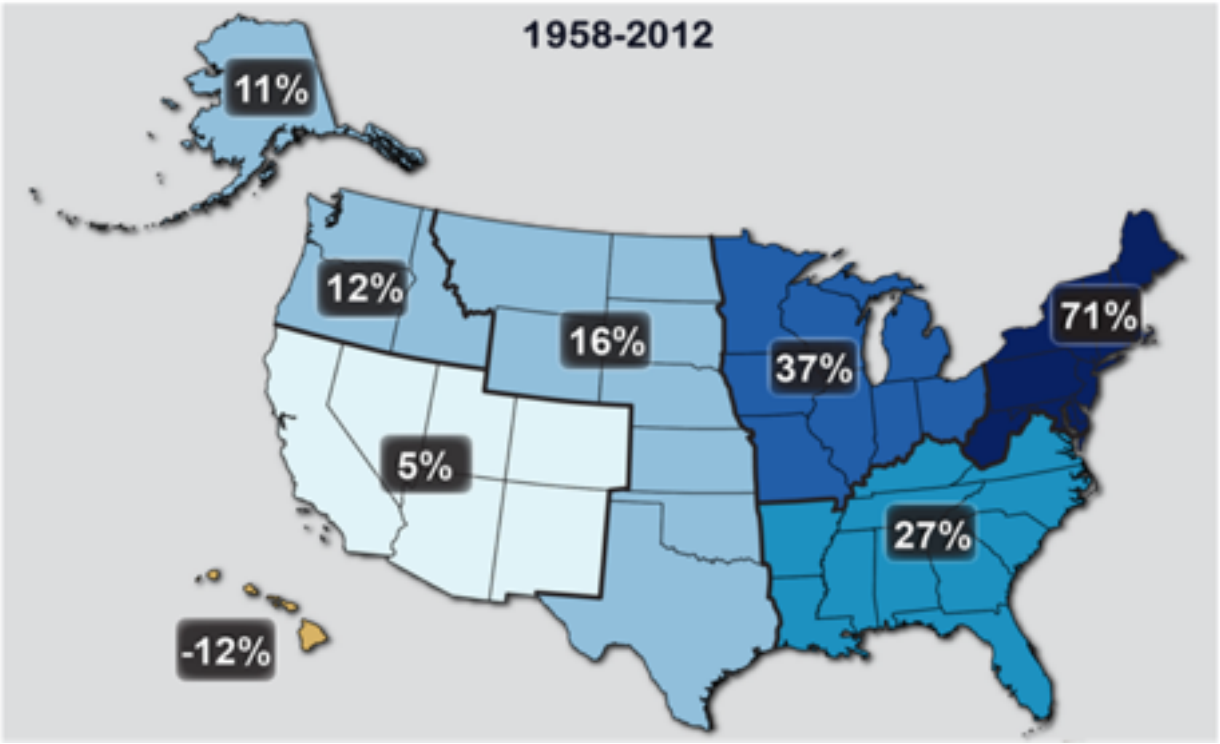
TMDL (Total Daily Maximum Load)

“How much of pollutant needs to be reduced to attain water quality goals?”





Climate change: more extreme events have resulted and are predicted



National Climate Assessment @GlobalChange.gov

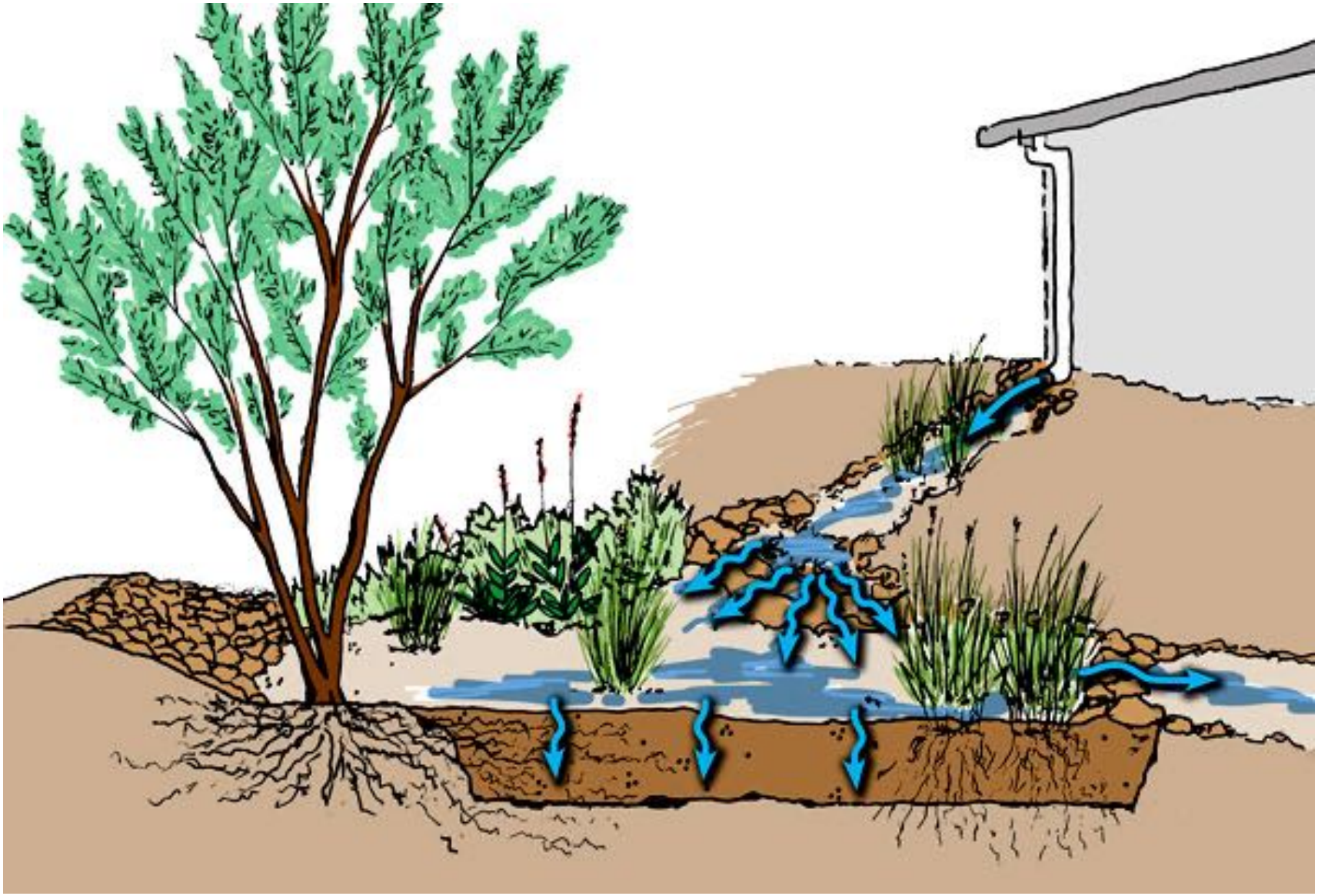
Source: National Oceanic and Atmospheric Administration (NOAA) Climate at a Glance

Composting Association of Vermont (CAV)

Reclaiming Organic Residuals For Good


COMPACTION
Before


After



Healthy Soils

"Healthy soil" means soil that has a well-developed, porous structure, is chemically balanced, supports diverse microbial communities, and has abundant organic matter." (from VT Act 64, Clean Water Act, 2015)

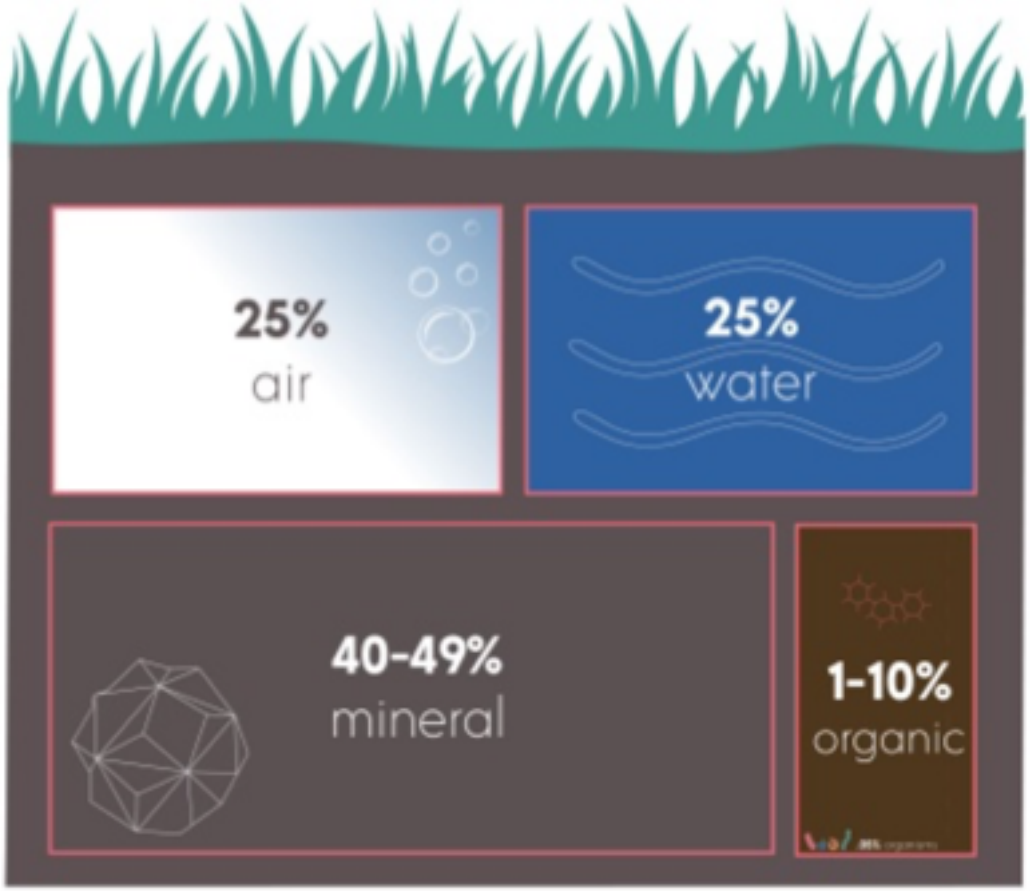
What is a Healthy Soil?

- Drains well, good infiltration, resists diseases & erosion

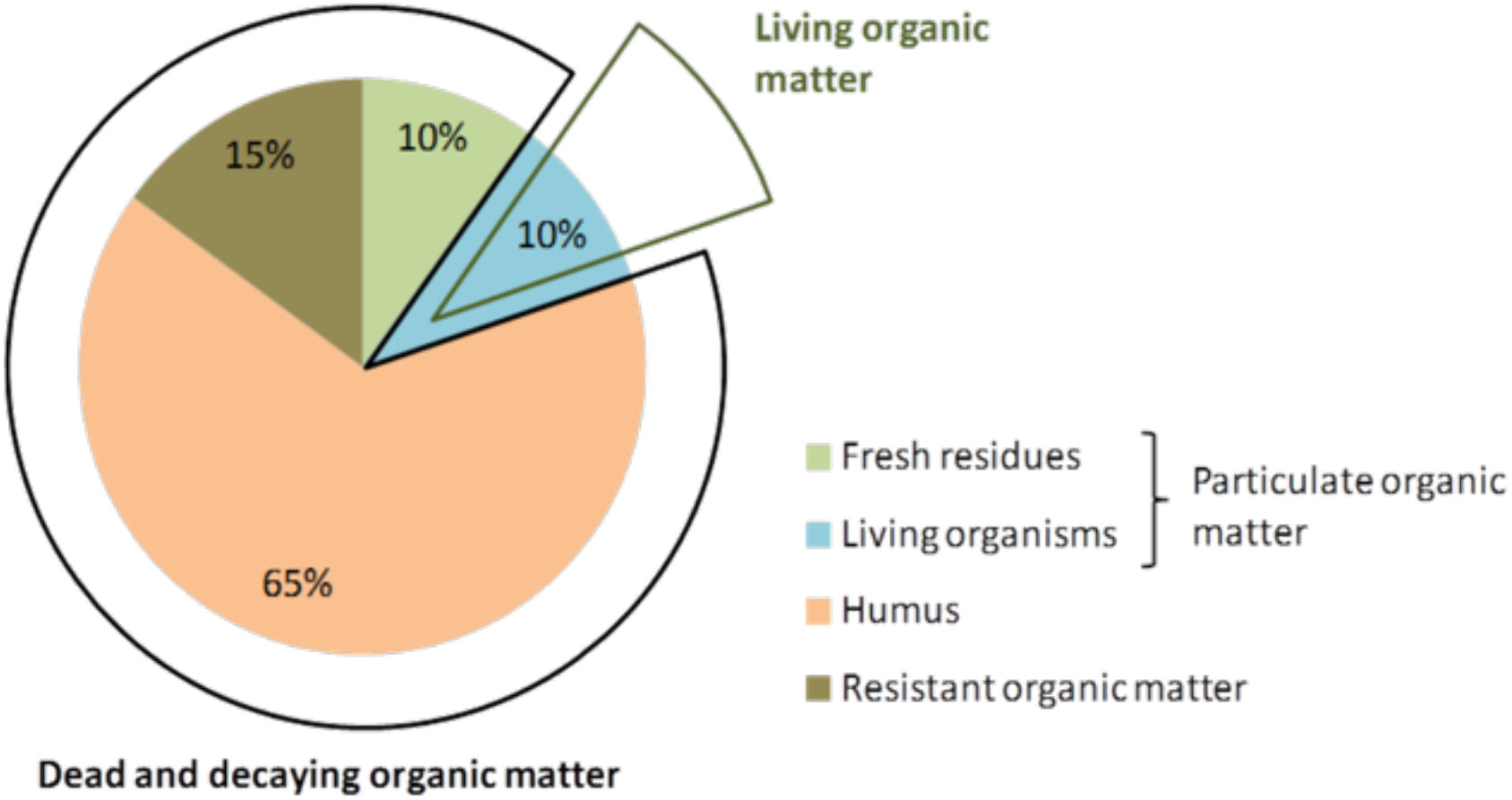
- Soils with good tilth are crumbly

  →Good tilth depends on aggregation

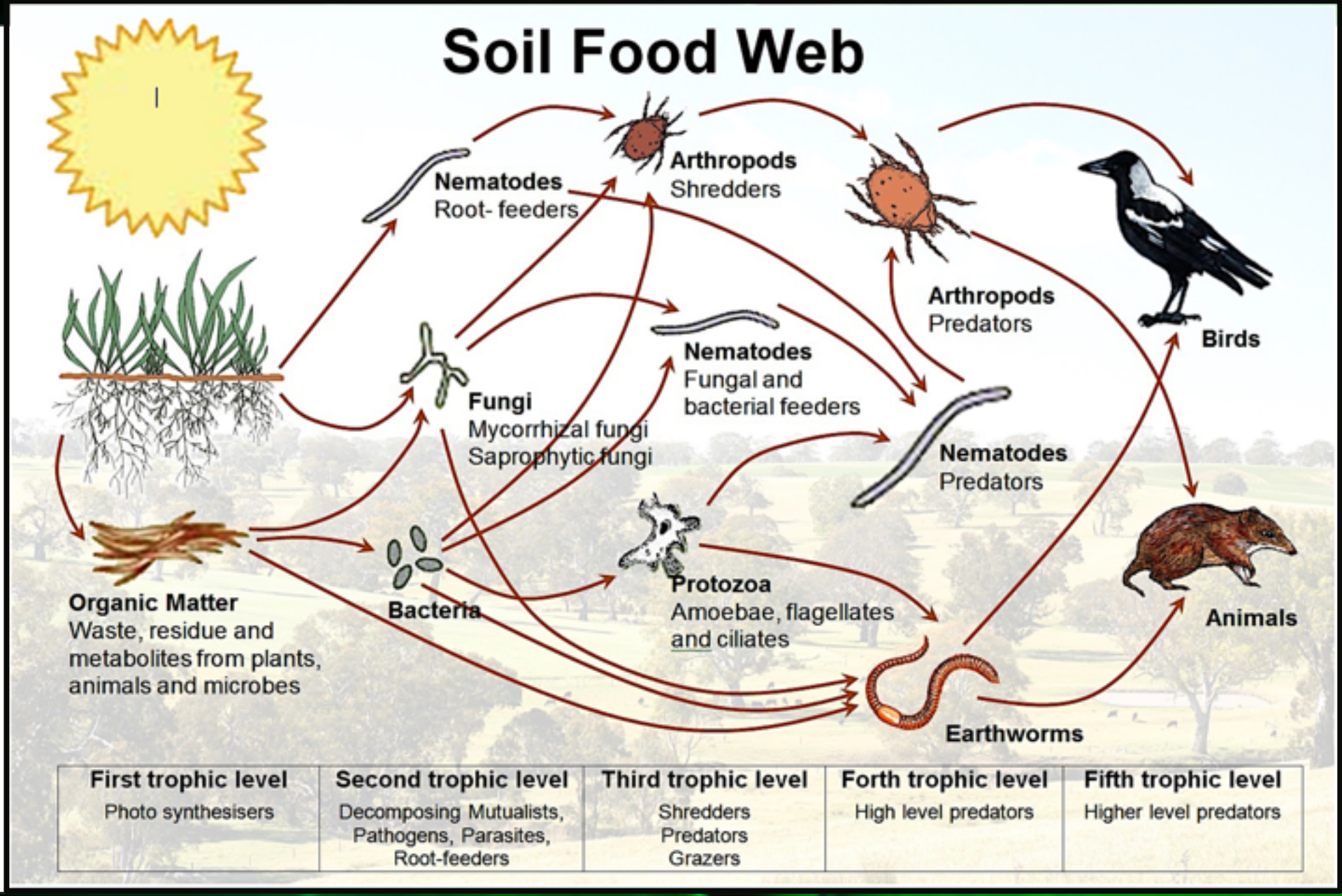
What is soil?



What is organic matter?

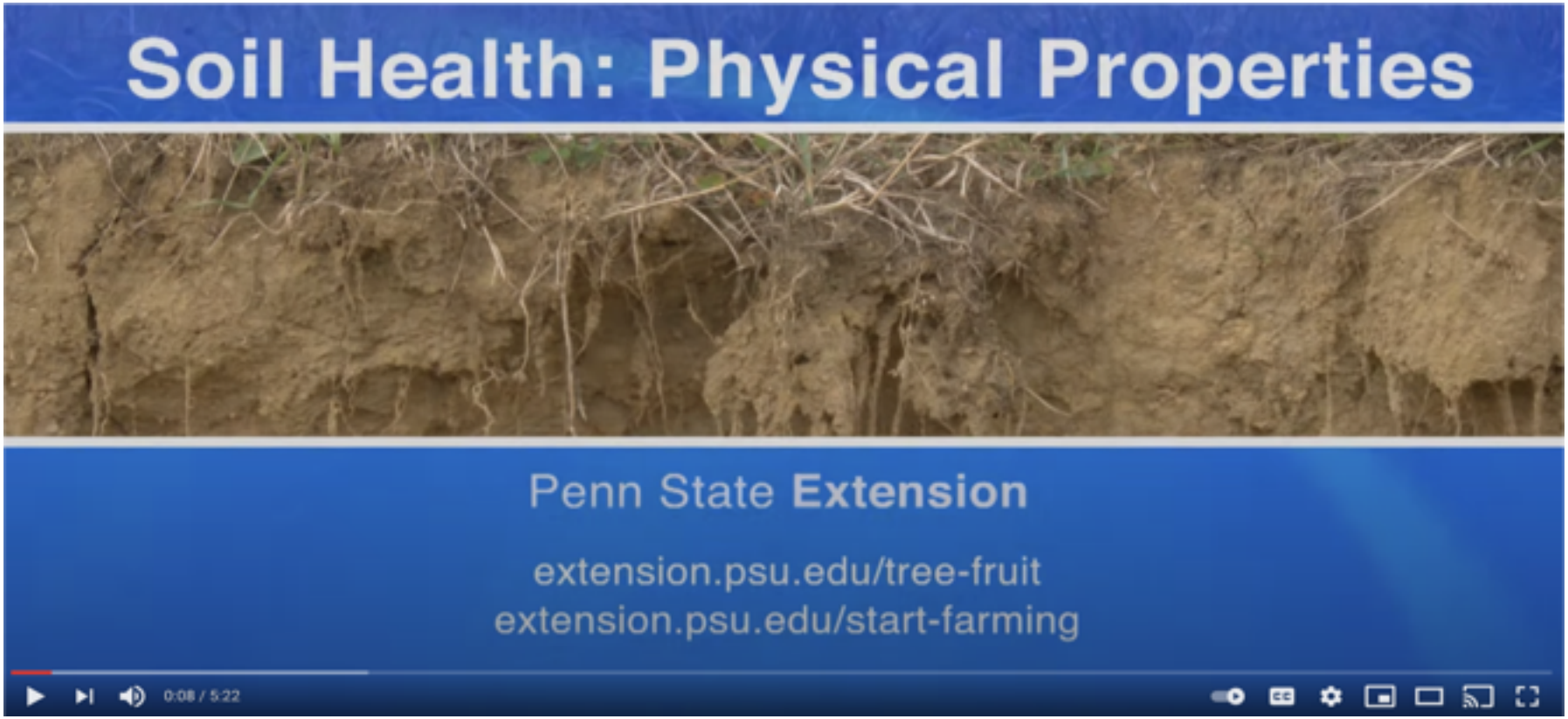


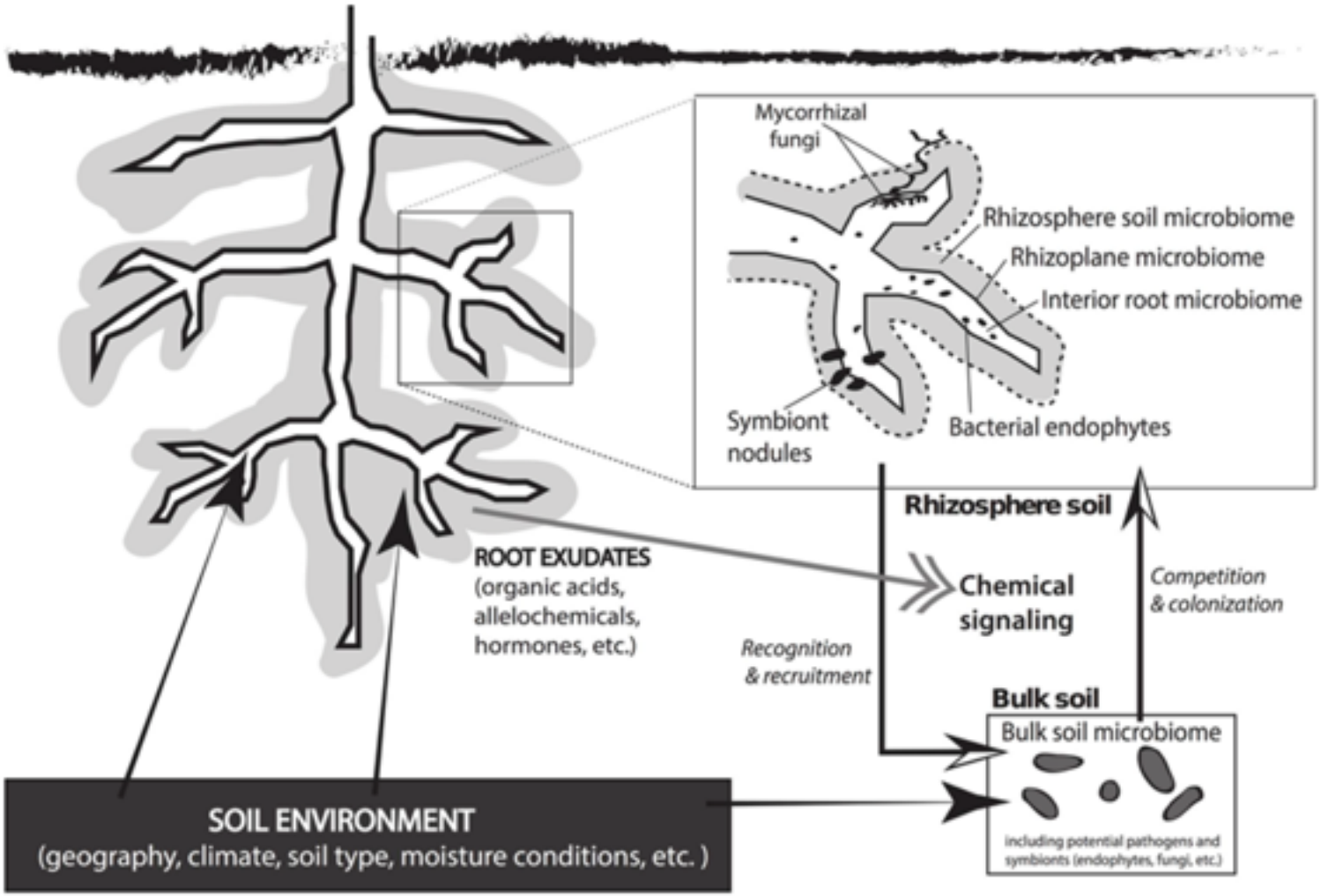
Soil Food Web



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

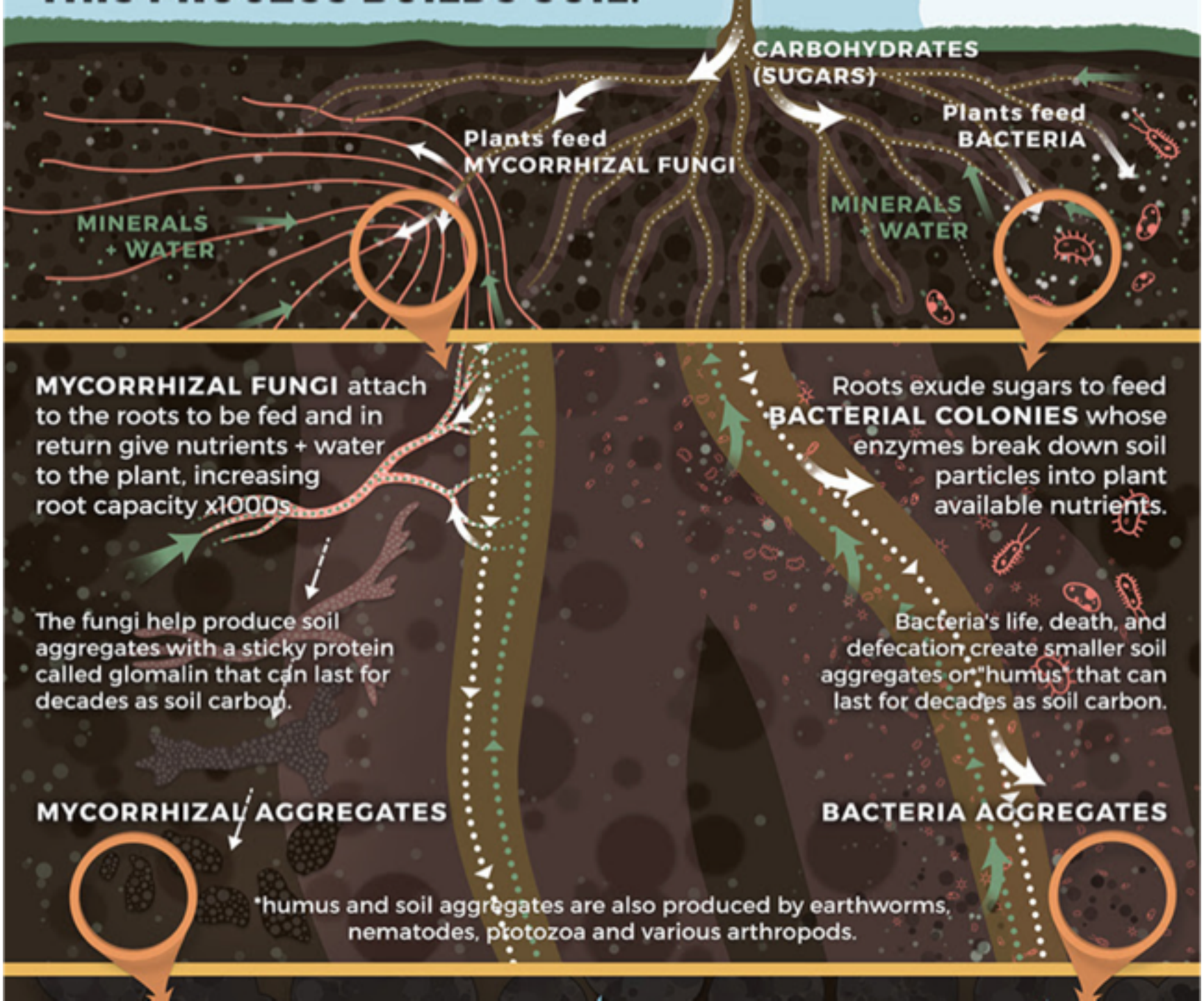
Soil physical properties are influenced by biological properties





REVIEW ARTICLE
Front. Microbiol., 23 July 2014 | https://doi.org/10.3389/fmicb.2014.00368
The rhizosphere microbiota of plant invaders: an overview of recent advances in the microbiomics of invasive plants
_Vanessa C. Coats[1] and _Mary E. Rumpho[2*]


8. 17. 2000


CARBOHYDRATES (SUGARS)
Plants feed MYCORRHIZAL FUNGI
Plants feed BACTERIA
MINERALS + WATER
MINERALS + WATER
MYCORRHIZAL FUNGI attach to the roots to be fed and in return give nutrients + water to the plant, increasing root capacity x1000s.
Roots exude sugars to feed BACTERIAL COLONIES whose enzymes break down soil particles into plant available nutrients.
The fungi help produce soil aggregates with a sticky protein called glomalin that can last for decades as soil carbon.
Bacteria's life, death, and defecation create smaller soil aggregates or "humus" that can last for decades as soil carbon.
MYCORRHIZAL AGGREGATES
BACTERIA AGGREGATES
*humus and soil aggregates are also produced by earthworms, nematodes, protozoa and various arthropods.

How do we build healthy soil?

Building Healthy Soil

Compost = Organic matter rich in soil biology = Soil health

"The Living Skin of The Earth"

What is Composting?
What is compost?

- Controlled biological decomposition of organic materials
- Management of microorganisms to create an aerobic heating & curing process
- Produces a biologically stable & mature product
  - Rich in organic matter
  - Product nutrient profile depends on the compost “recipe”

Image Cr.: BioCycle

Compost Nutrient Profile

- A compost recipe impacts:
  - ✓ The nutrient profile of the finished compost
  - ✓ The species of bacteria and fungi
- An analysis of the finished compost can indicate:
  - ✓ The amount of organic material or carbon
  - ✓ Phosphorus, nitrogen, and other nutrients

Activity:
What does compost do for the soil?

Improves Biological Conditions

- Nutrients
- Live microorganisms
  - ✓ Fully functional organisms with respect to nutrient cycling
  - ✓ Organisms produce plant growth stimulating compounds
- Reduces pest populations

Improves Chemical Characteristics

- Provides nitrogen (N), phosphorus (P) & micronutrients
  - ✓ Relative amounts depend on both compost feedstocks & composting practices
- Optimal pH for plants
- High cation exchange capacity (CEC)

Improves Physical Characteristics

- Adds soil tilth
  - ✓ Optimal seed germination, root growth, deeper soil penetration
- Promotes water infiltration & retention
  - ✓ Protection of soil surface
- Increases soil porosity
  - ✓ Enhanced air & water storage
- Aggregation & structure
  - ✓ Resistance to erosion, saturation, other stresses

Composting Enhances Soil and Protects Watersheds

Healthy soils are essential for protecting watersheds. Compost is the best way to add organic matter—which is vital—to soils.

When added to soil, compost can filter out urban stormwater pollutants by **an astounding** **60-95%**

Image Cr.: ILSR

IT'S ALL ABOUT THE SOIL

COMPOST improves biological, chemical, and physical characteristics of soil.

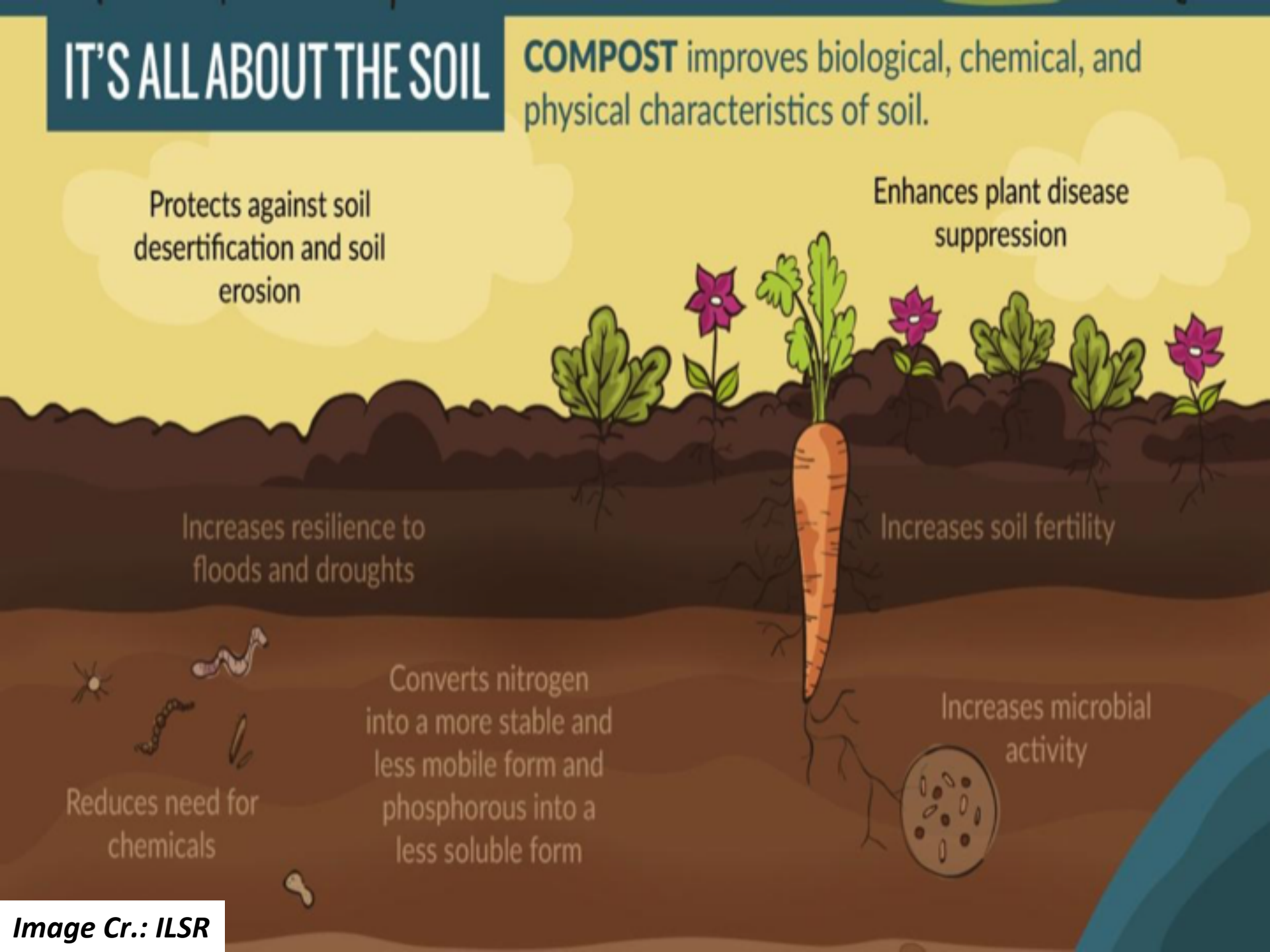


Image Cr.: ILSR

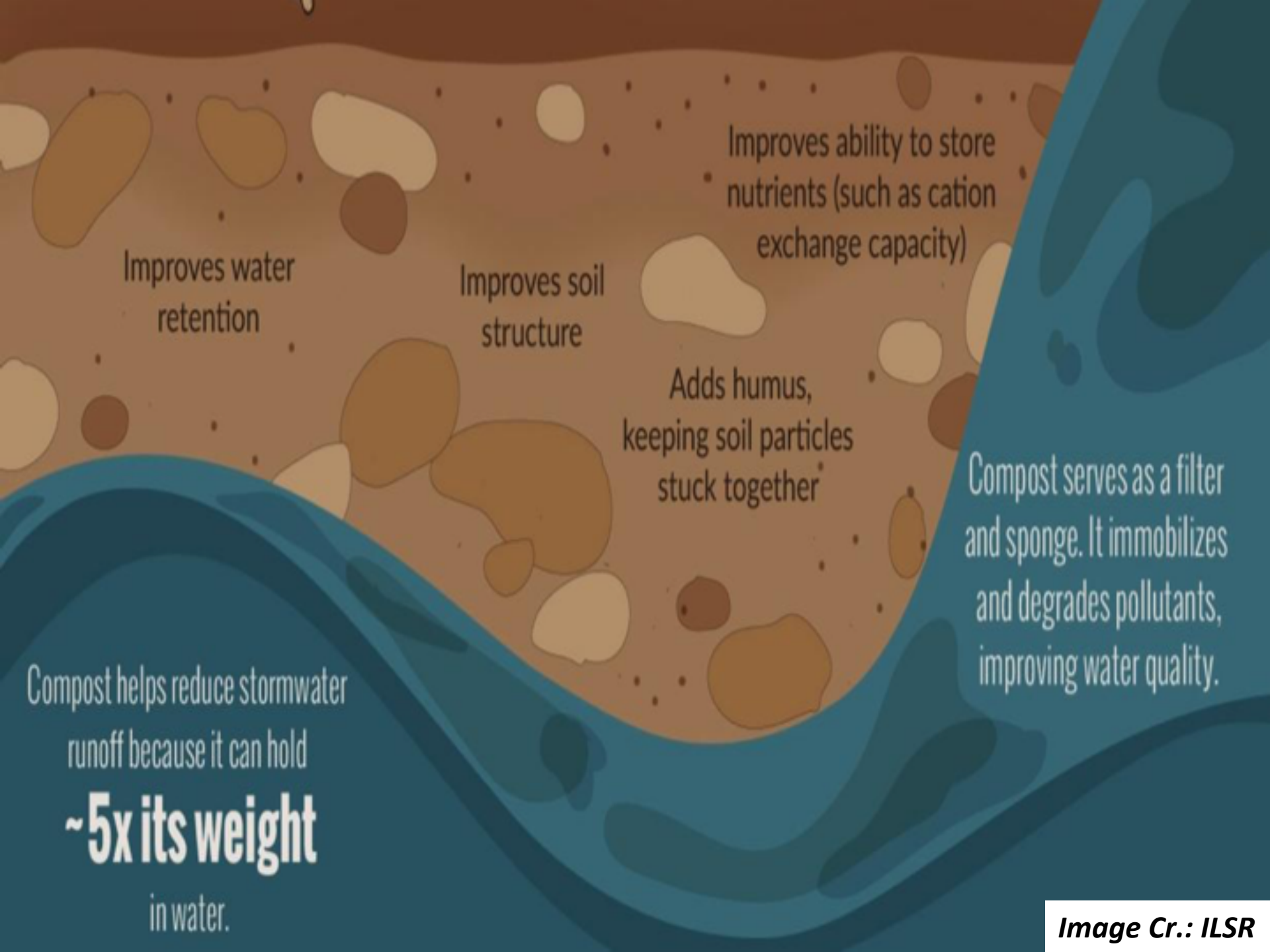


Image Cr.: ILSR

Soil As An Environment To Live In

Healthy Soils = Healthy Plants

- More Air & Better Root Growth
  - ✓ Soil is “looser”
- Better Water Management
  - ✓ Drought resistance & water storage
- Balanced Diet for Plants
  - ✓ Increased nutrient retention
  - ✓ Sustained release
- Less Pests
  - ✓ Biological resistance

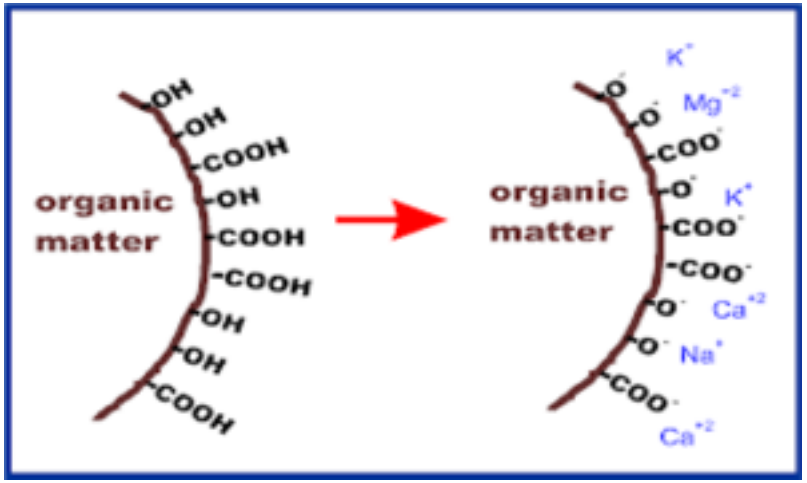
Image Cr.: Équiterre

Compost Regulates Nutrient Flows

Organic matter increases holding capacity

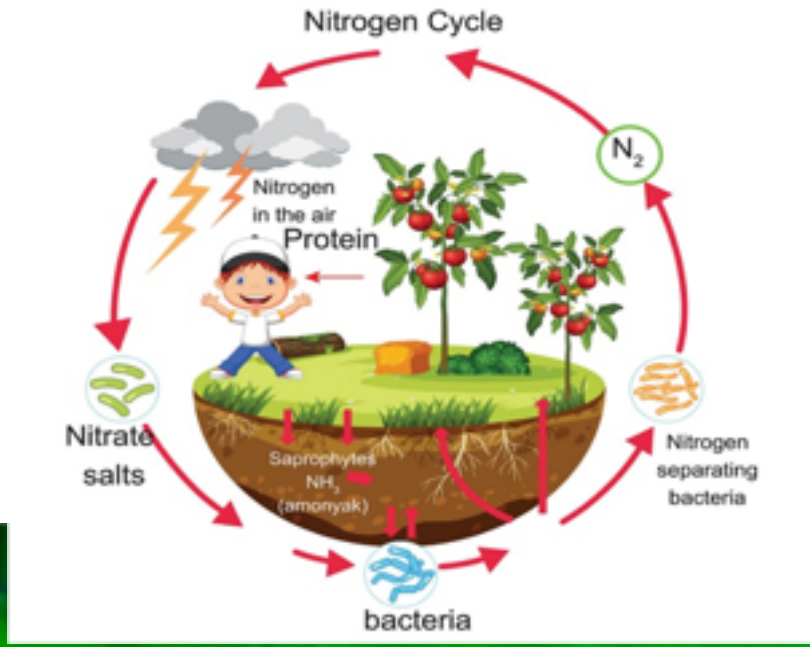
- *Chemically* increases binding sites
- *Biologically* immobilizes nutrients

until used by plants



Reduced water flow on landscape

- Reduces flow of dissolved nutrients, e.g., N
- Reduces loss of nutrients attached to soil (soil erosion), e.g., P



Eutrophication – Excess Nutrients result in Water Quality Degradation

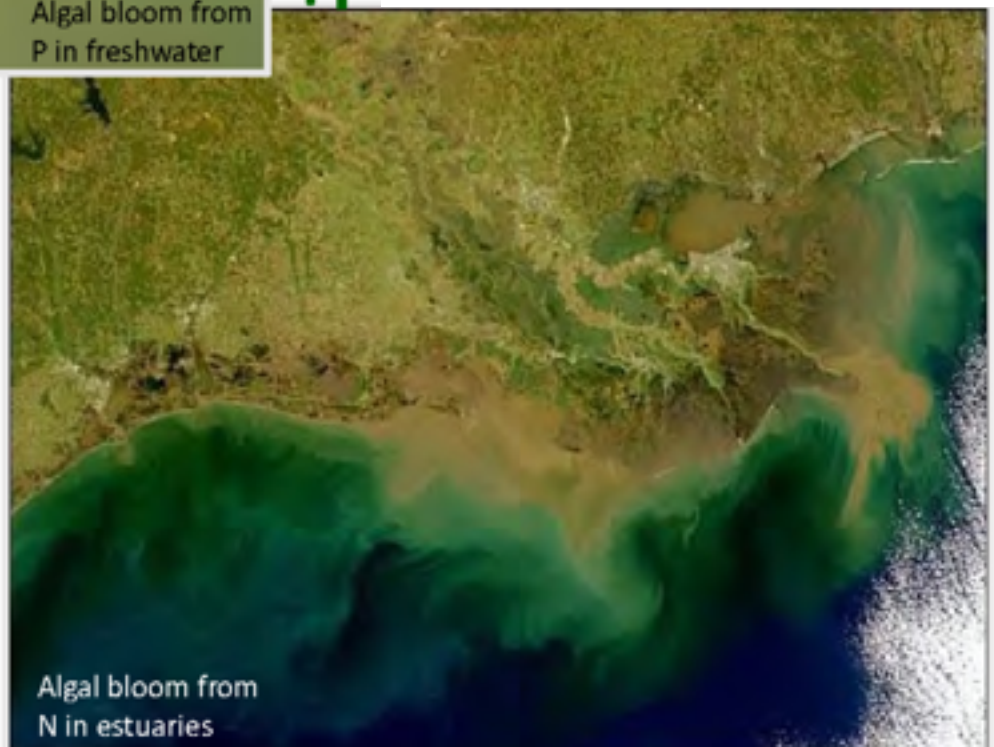
Excessive P and N use causes Pollution in Surface Waters & Greenhouse Gas Emissions…

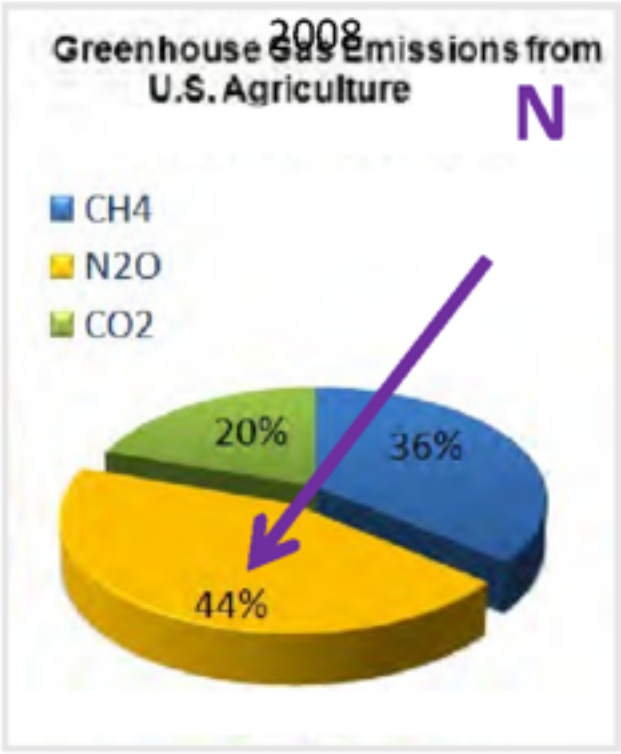
-P

Phosphorus is lost with soil erosion…

- *Attached to soil particles*

+P





High N losses occur through leaching and denitrification

Feed the Soil Some Compost!

Increases biological activity

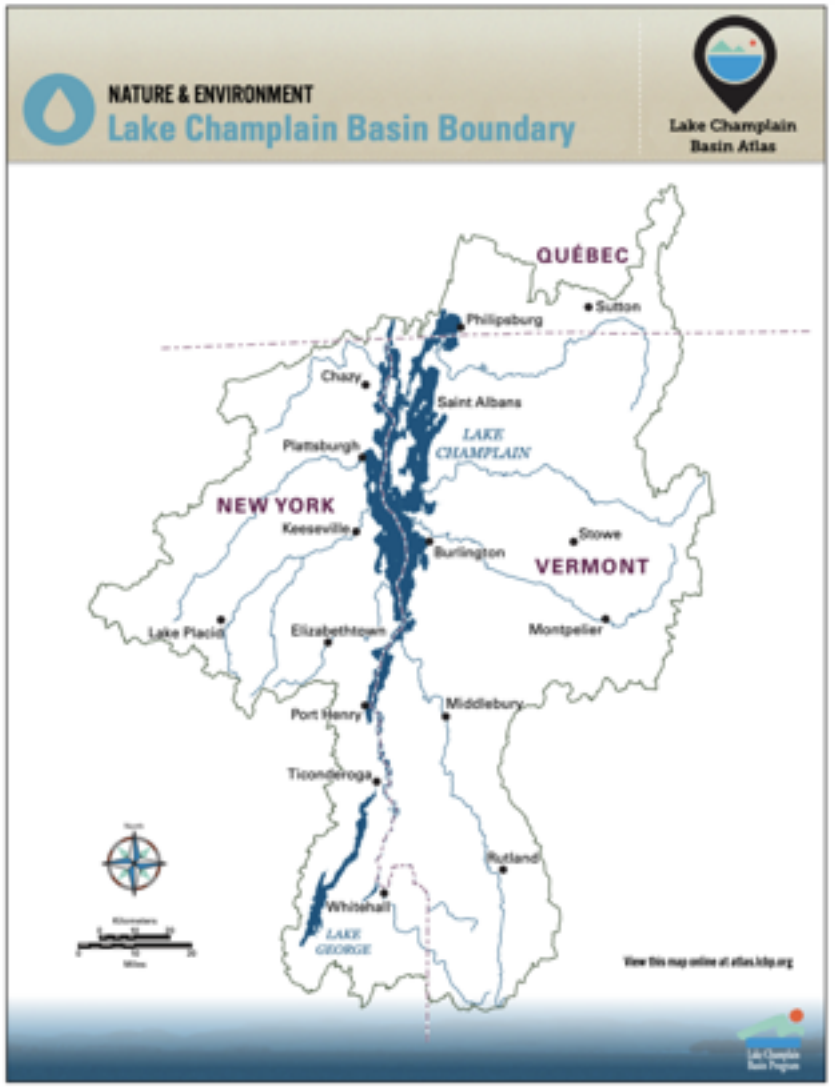
Increases decomposition

→ Increases soil aggregation → pore structure → tilth
→ Increases humus + other growth promoting substances
→ Increases nutrients
→ Decreases harmful substances detoxified

Decreases soil-borne disease

Soil Builders Workshop Topics

- Soil health & water quality
- Drivers for clean water & healthy soil (pre-recorded, available soon)
- Best Management Practices for compost & compost-based products (March 23rd)
- Education in action – next steps



Compost-based BMPs

Compost-based BMPs

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Streambank Stabilization
Compost socks and blanket demonstration

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