Catch the Rain

What affects my infiltration?

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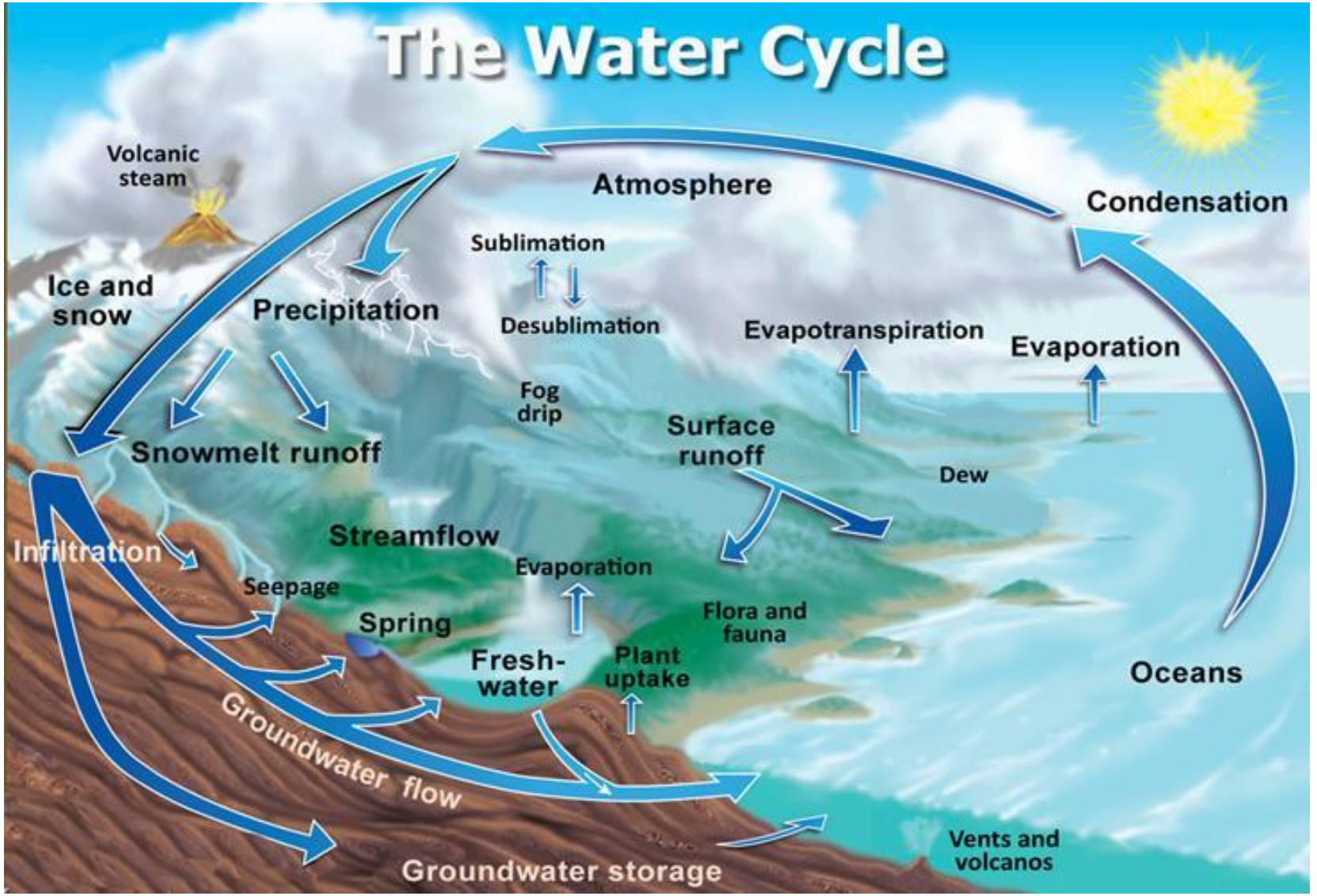
What affects my infiltration?

This presentation:

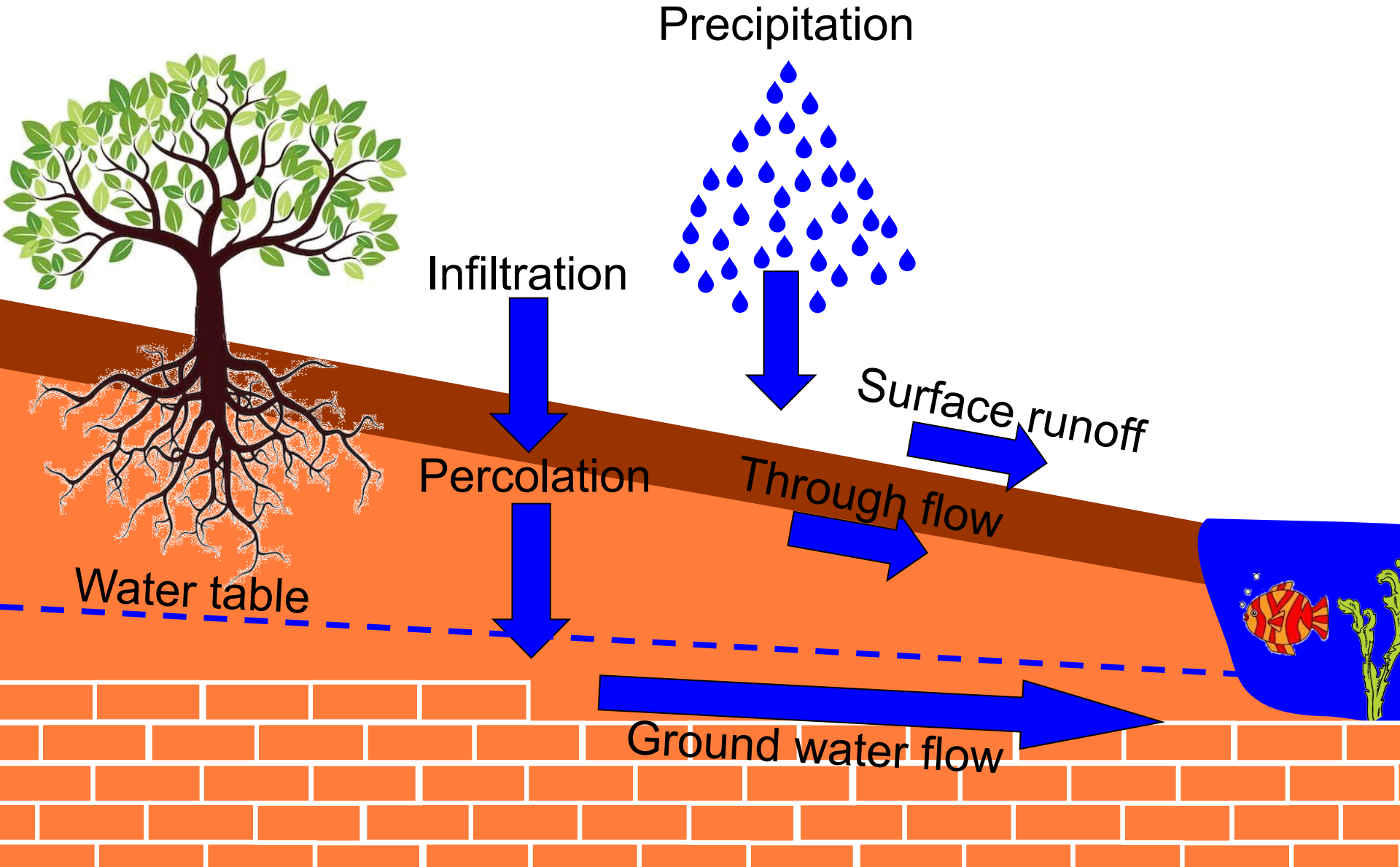
- Briefly backgrounds the role of soil in the water cycle
- Defines some terminology
- Explains the revolution in soil organic matter formation – and the impact on infiltration
- Lists the key factors that affect infiltration of water into your soil from the scientific literature

Hydrosphere cycle



https://ga.water.usgs.gov/edu/watercycle.html

Water cycle and soil - key concepts



Key concepts

Soil water holding capacity

- The maximum amount of water able to be stored in the soil

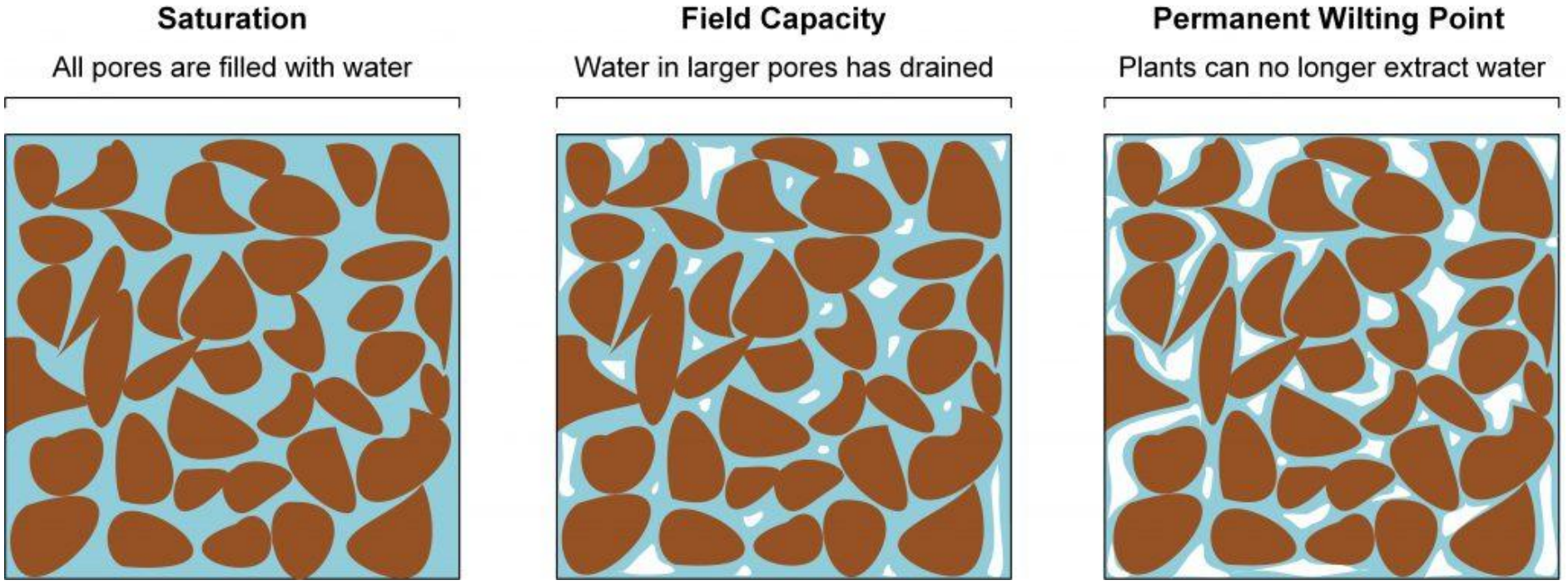
Field capacity

- The amount of water stored in the soil after gravitational drainage has slowed to <= 1 mm a day

Permanent wilting point

- The water content at which plants can't get any more water out of soil (varies with species)

Key concepts



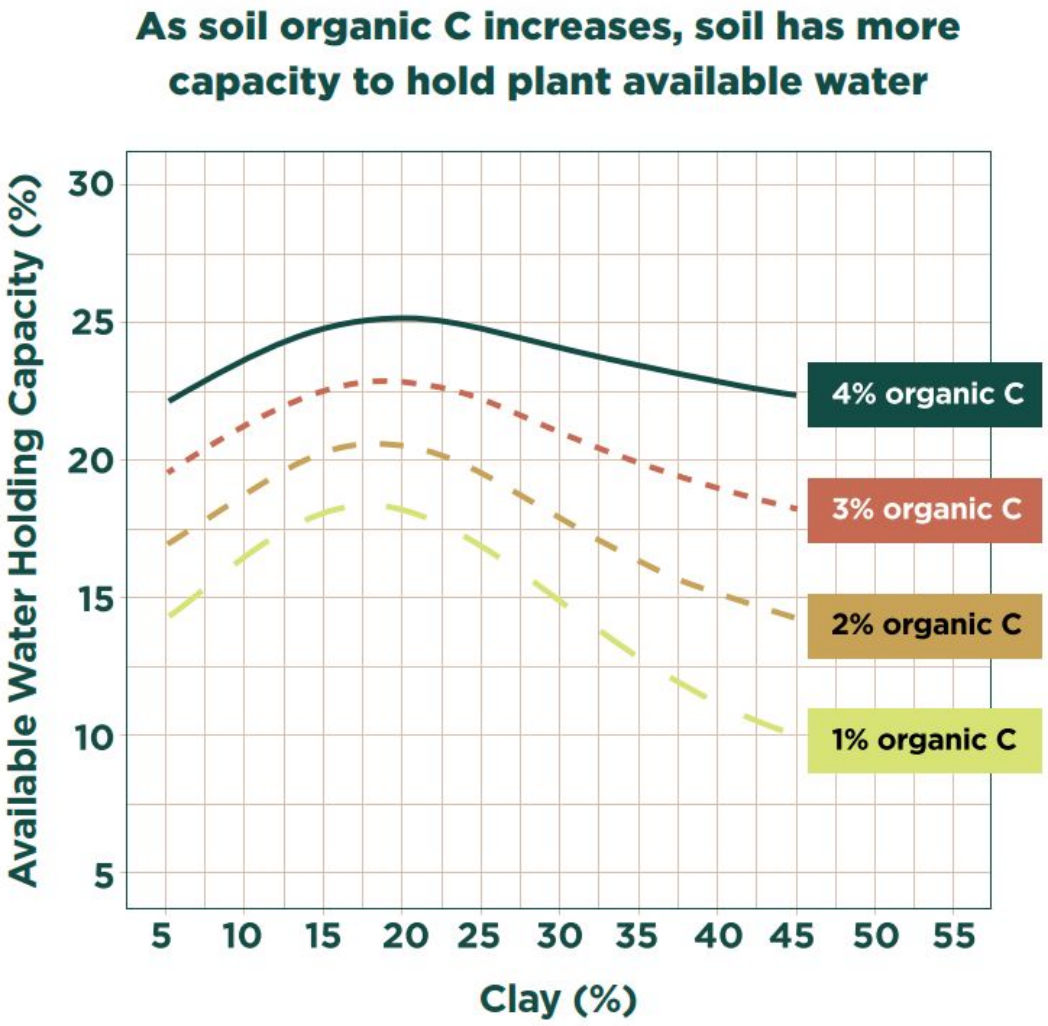
Soil water content at saturation, field capacity and permanent wilting point thresholds.
https://extension.okstate.edu/fact-sheets/understanding-soil-water-content-and-thresholds-for-irrigation-management.html

Key concepts

(Plant) Available water holding capacity

- The maximum amount of water a soil can provide to plants – i.e., above permanent wilting point

(Plant) Available water holding capacity



https://soilhealthinstitute.org/app/uploads/2022/10/SHI_SoilHealthMeasurements_factsheet.pdf

Key concepts

Transpiration

- The water 'lost' from plants – depends on the amount of foliage

Evaporation

- The water lost from the soil surface
- Can be partly managed through surface residues and system changes, e.g., agroforestry

Evapotranspiration

- Transpiration + evaporation

Soil health revolution

There has been a paradigm change / revolution in soil science in how soil organic matter (SOM) forms and what drives soil biology and health!

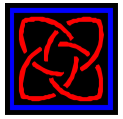
This has a major impact on infiltration

The old paradigm

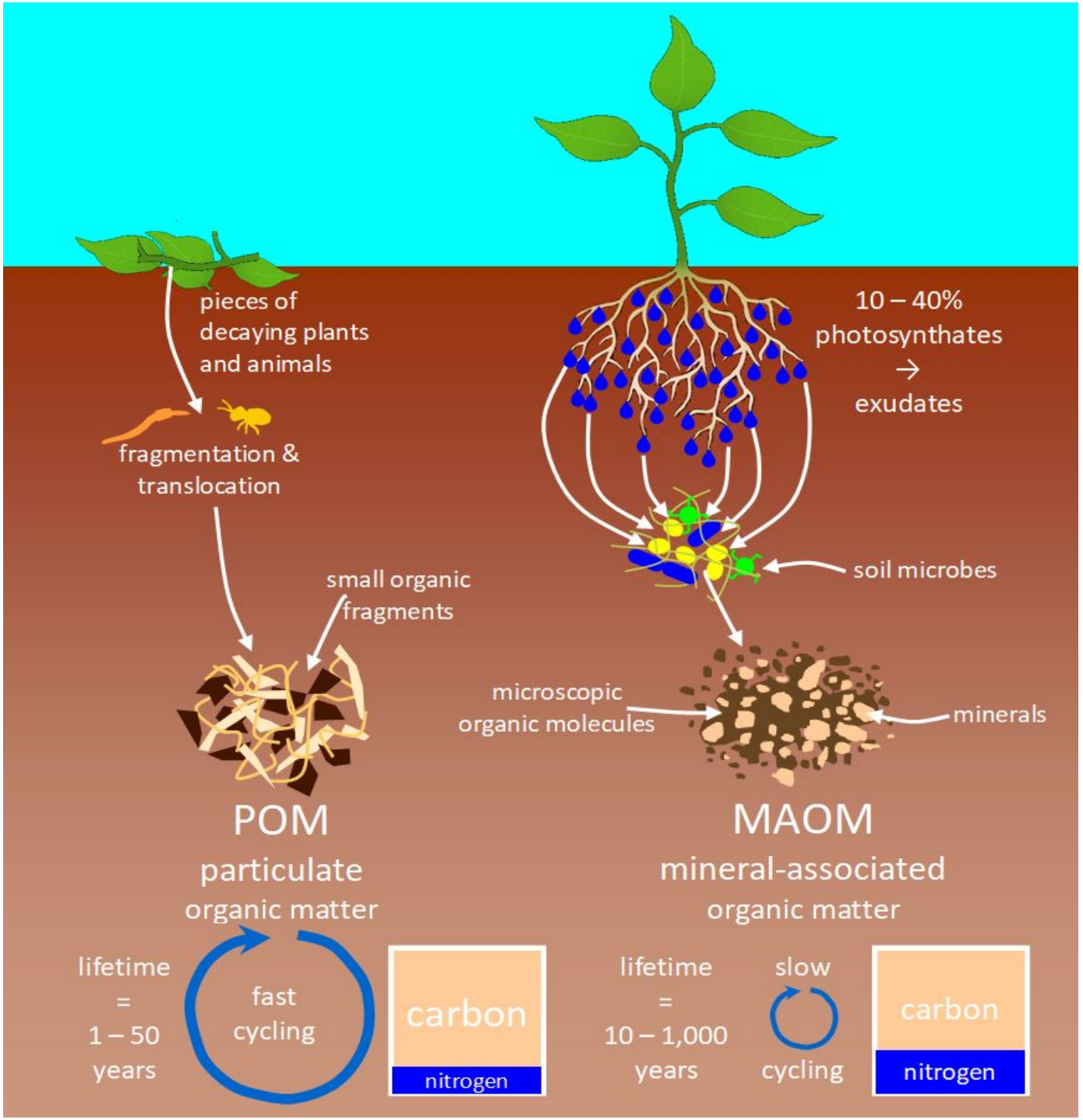
Plants die, manure, compost deposited on soil

SOM decomposes / mineralises back to inorganic compounds

- Simple compounds e.g., sugars, proteins, lipids decompose in hours to weeks
- Medium complexity compounds e.g., cellulose, decomposes in weeks to years:
- High complexity compounds, e.g., lignin decompose over years to centuries even millennia i.e., become humus
- Text book info, but wrong!



The new soil paradigm



After Cotrufo, M. F., Lavallee, J. M. & Sparks, D. L. (2022). Soil organic matter formation, persistence, and functioning: A synthesis of current understanding to inform its conservation and regeneration. In Advances in Agronomy (Vol. 172, pp. 1-66): doi:10.1016/bs.agron.2021.11.002

The new soil paradigm

Humus is dead: Long live MAOM!

Biological / ecological soil health

The **main driver** of soil biology / health is a

- **diversity of living plants,**
- **year round,**
- maximising biomass production,
- **particularly from roots**
- on a foundation of physical and chemical health

It is **not** compost and other externally applied amendments

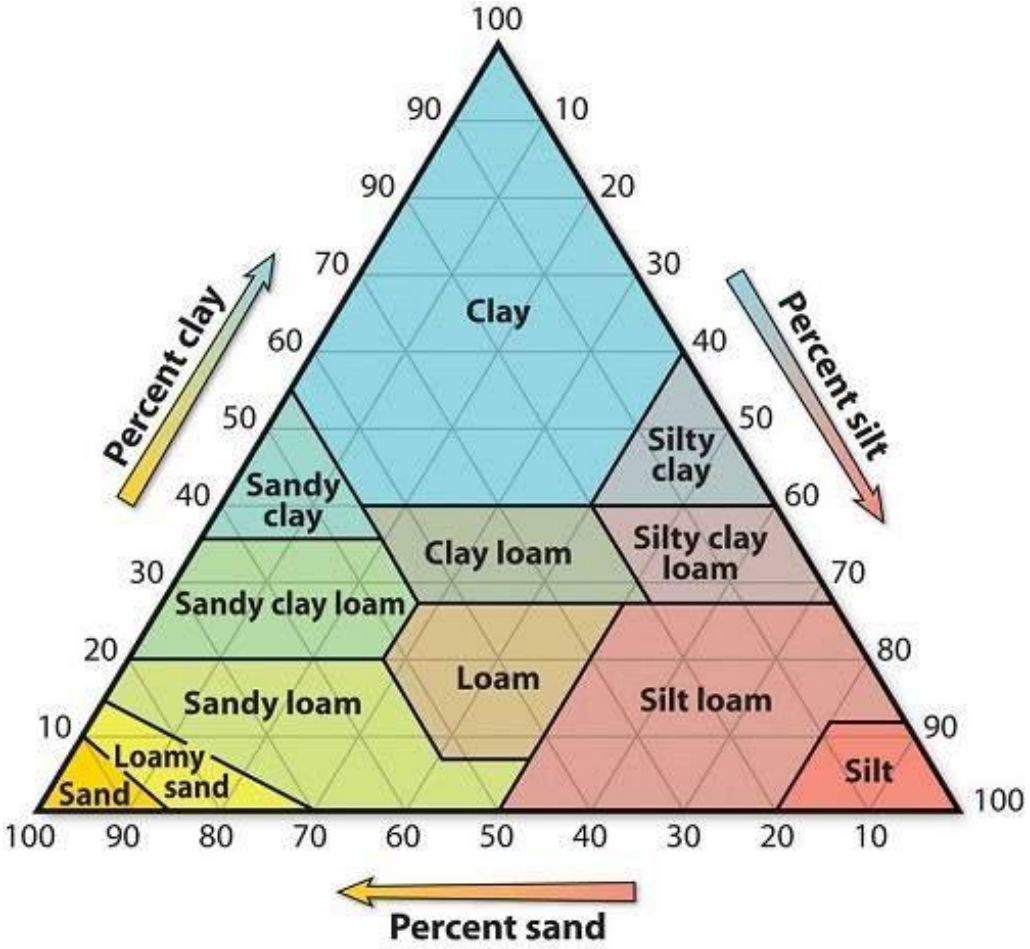
- though they can help, esp. in unhealthy soils

Soil properties that impact infiltration

The following are the key soil properties that impact infiltration:

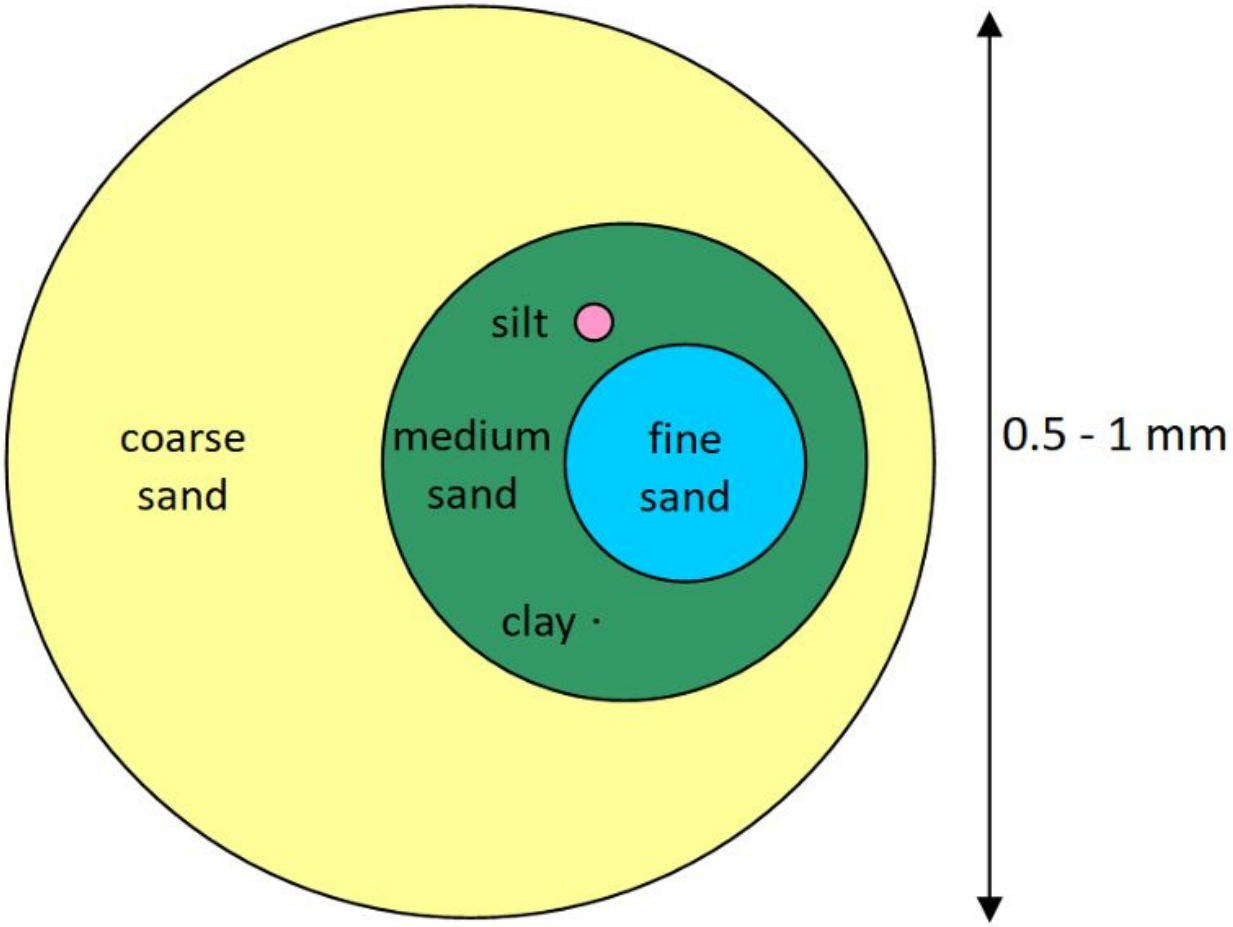
Soil type / texture

The mix of sand silt and clay



Soil type / texture

The relative sizes of sand, silt and clay particles!



Soil type / texture

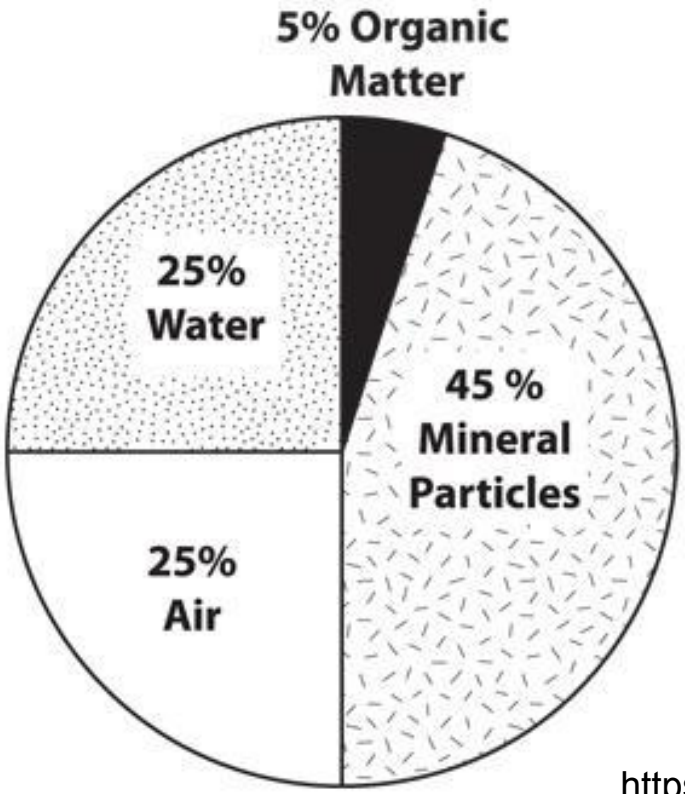
Soil texture influences infiltration (I) rates

Soil texture	Representative, I (mm hr^{-1})	Normal range of I (mm hr^{-1})	Category
Sandy	50	20 – 250	Rapid
Sandy loam	20	10 – 80	Moderate rapid
Loam	10	10 – 20	Moderate
Clay loam	8	2 – 15	Moderately slow
Silty clay	2	0.3 – 5	Slow
Clay	0.5	0.1 – 8	Very slow

https://www.researchgate.net/publication/349428786_A_Training_Manual_for_Training_of_Trainers_on_Crop_Water_Requirement_and_Irrigation_Scheduling_for_Vegetable_and_Fruit_Crops_Production_Volume_1_By_Tilahun_Hordofa_PhD_Gobena_Dirirsa_Training_Organize/figures

Soil porosity

Porosity or void fraction is a measure of the void (i.e. "empty") spaces in soil



https://pubs.nmsu.edu/_circulars/CR672/

Soil porosity

Divided into macropores and micropores

- In NZ macropores are > 0.06 mm (60 microns) micropores are < 0.06 mm
- Macropores can be really tiny!

Soils with good macroporosity have better infiltration

Aggregates / aggregation

Soil aggregates are the basic unit of soil structure

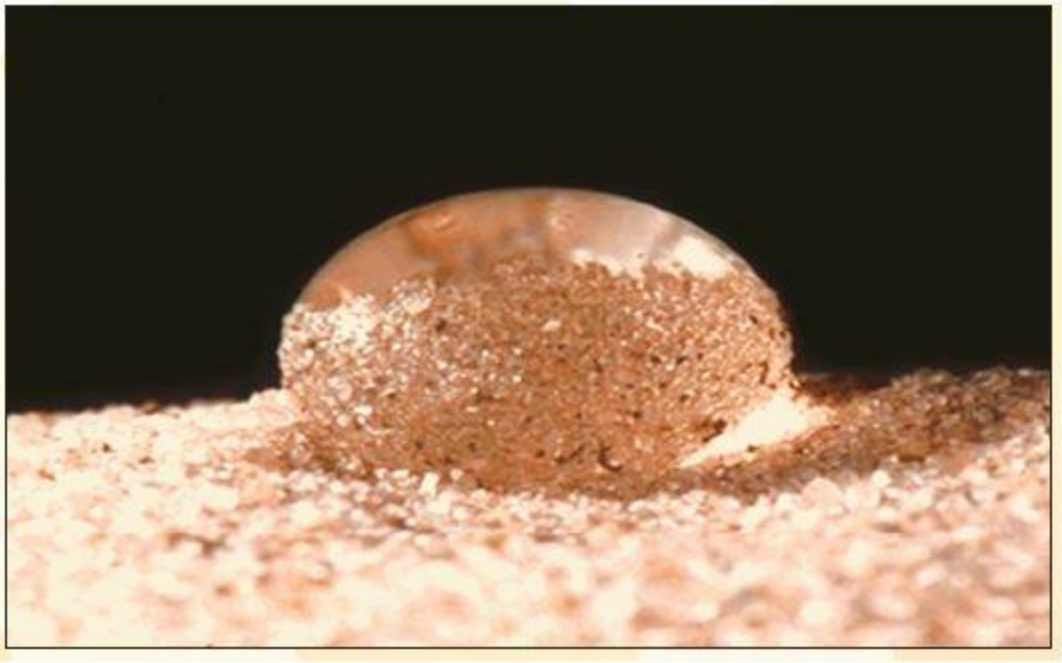
Soil particles (sand, silt, clay) + soil organic matter

Well aggregated soil has better structure and infiltration

Soil water repellency (SWR)

Also called hydrophobicity - ‘fear of water’

Makes the soil surface water repellent – like a Gore-Tex rain jacket – water beads off



https://www.soilquality.org.au/factsheets/water-repellency

Soil water repellency (SWR)

Complex and poorly understood mechanisms

Has positive and negative impacts, e.g.,

- Negative – reduces infiltration so increases runoff
- Positive – reduces erosion

Soil water repellency (SWR)

Normally soil fills though capillary action and gravity, small pores fill first, large pores fill last

SWR reverses this with largest pores filling first

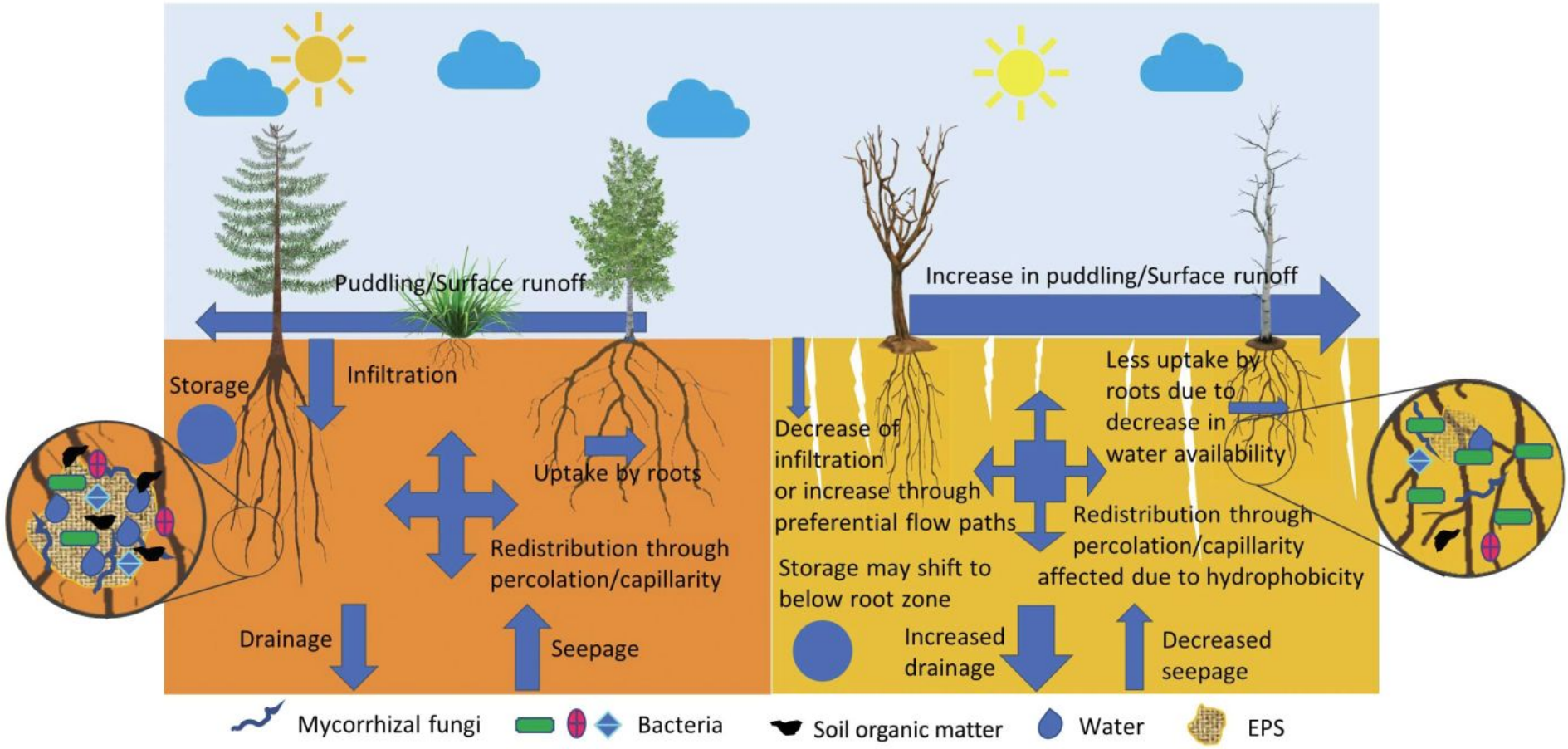
- Often causes ‘preferential flow’ and increased air trapped in soil

Soil microbiology

The role of microbiology on soil water as a whole is a new field

- It is suspected that it has a significant impact – mostly positive

Soil microbiology



Soil microbiota as game-changers in restoration of degraded lands 2022 Coban De Deyn van der Ploeg
https://www.science.org/doi/10.1126/science.abe0725

Living plants

Bare soil caps and suffers rapid infiltration reduction

Plant covered soil (hence cover crops) is protected (soil armour) and maintains / improves infiltration

Different root structure of different species improves infiltration though improved percolation and through flow

Plant residues – soil armour

Plant residues protect the soil surface from capping

Also increase biological activity – e.g., worms – that increase infiltration

Livestock surface compaction

Biggest issue to last

Surface compaction from livestock when soil is moist

Causes major reduction in macropores / macroporosity

Macroporosity is key to good infiltration

Excess water!

Soil is full of water – no space for more

- Due to lots of recent rainfall
- Proximity to water tables, water bodies etc

Rainfall rate exceeds infiltration rate

Thank you

Discussion & questions