

Using Carbon to Secure Soil and Water

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2030 Forecast: Perfect Storm

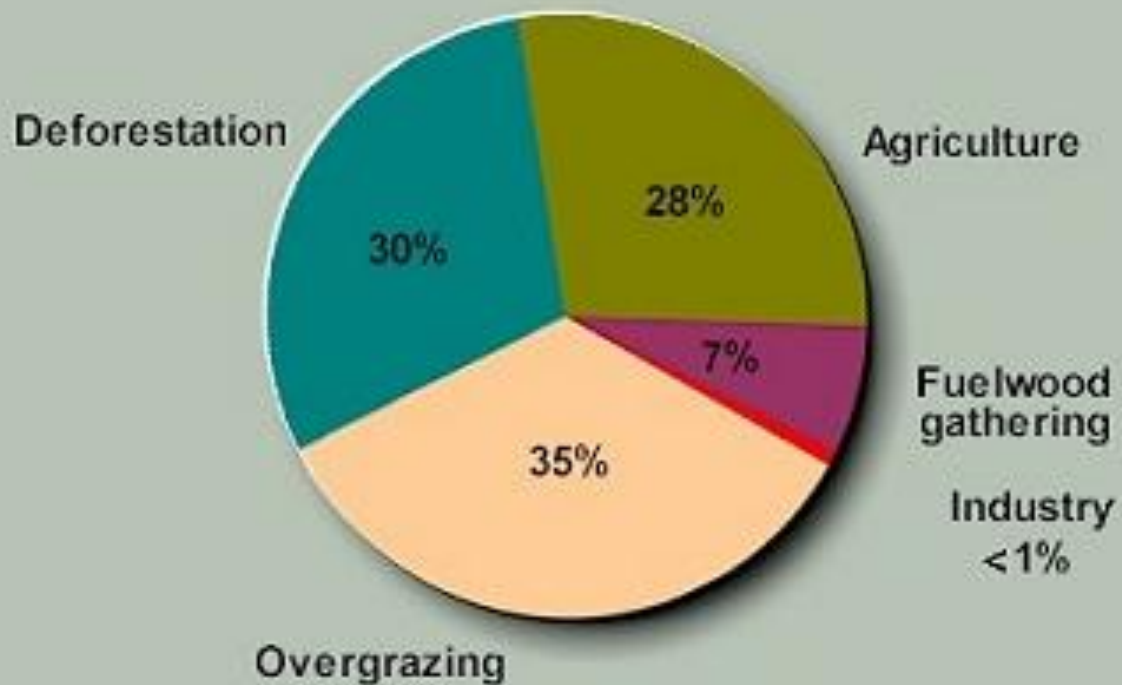
- Need 50% more food
- Less land will be available
- Far less water
 - Agriculture uses 70% of our fresh water and 30% of withdrawals will run out at current rates of use
- Less energy (= less inputs)
- Uncertain future climate

We are going to need to get far more out of our soil

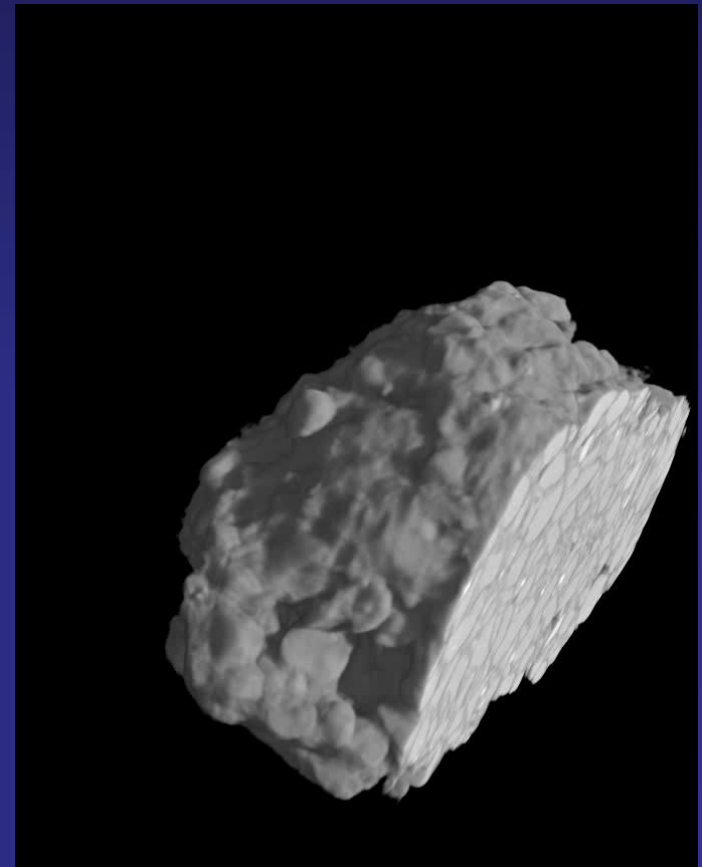
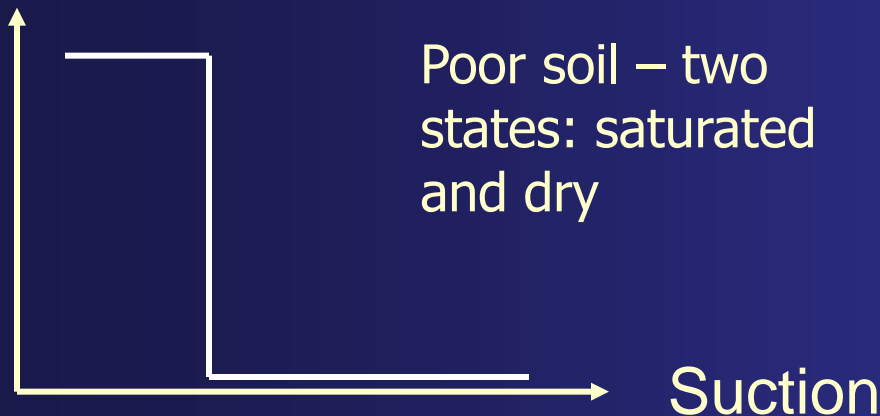
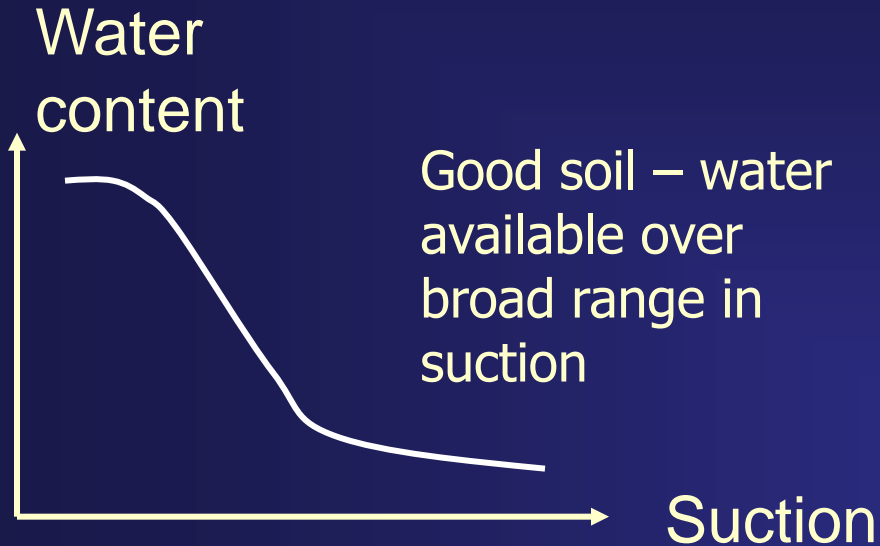
The Productivity of our Soil is Running Out?

- Global soil bank account
 - USA and Europe losing productive soil at a rate of $17 \text{ T Ha}^{-1} \text{ yr}^{-1}$
 - Replaced at a rate of $1 \text{ T Ha}^{-1} \text{ yr}^{-1}$
 - Using it at 17 times the rate it is being replaced
 - In China soil is being used 57 times faster than it is being replaced
 - In NSW it is being used at 5 times the rate it is being replaced
- We don't know how long soil will last
 - Could be 60 years
 - We don't know

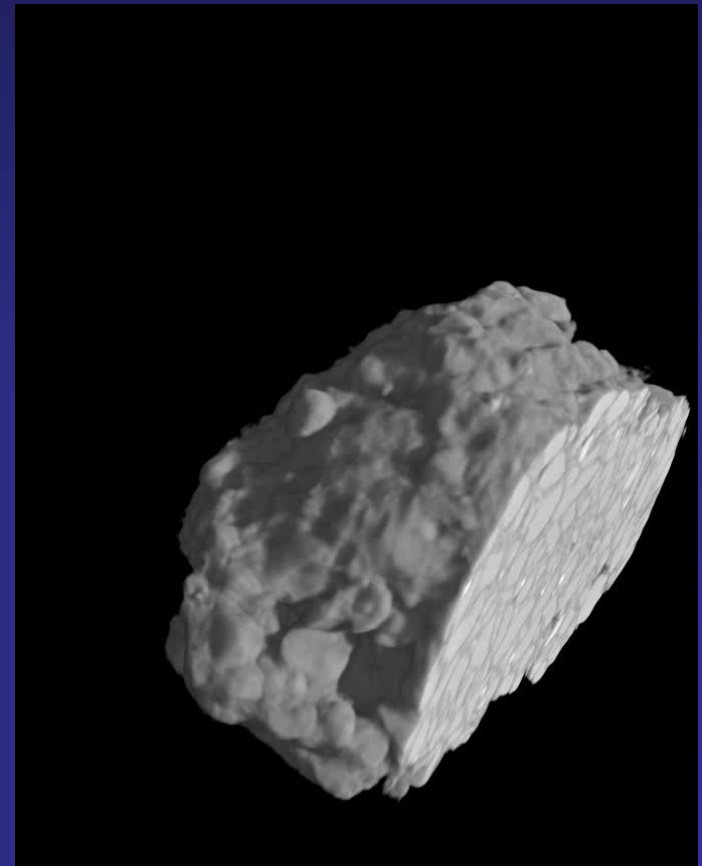
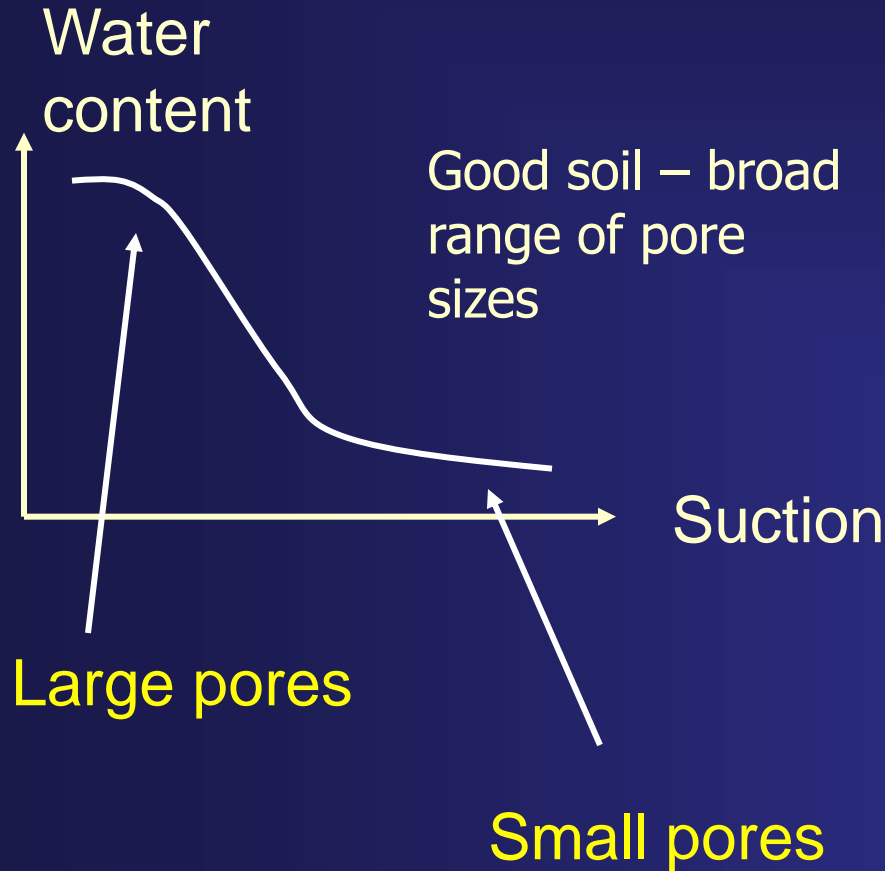
Human Activities Causing Soil Degradation



Structure – the link between soil and water

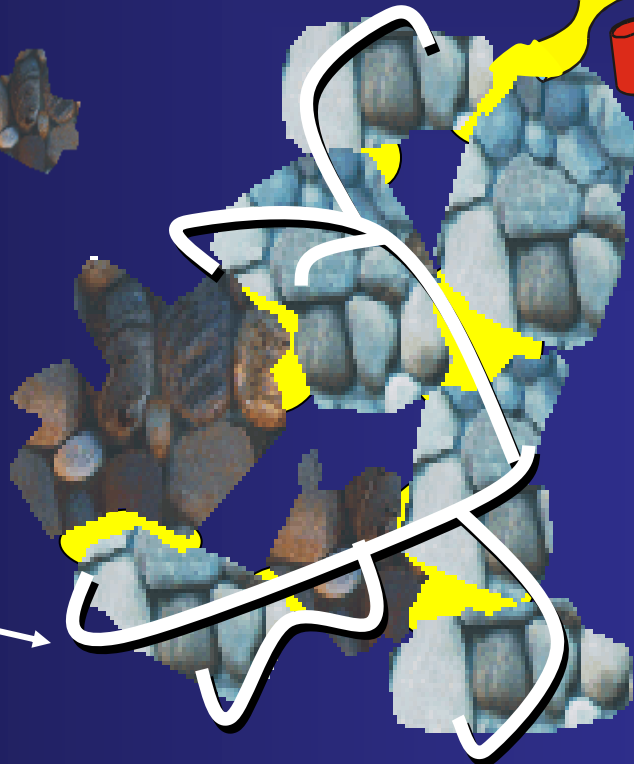


Structure – the link between soil and water

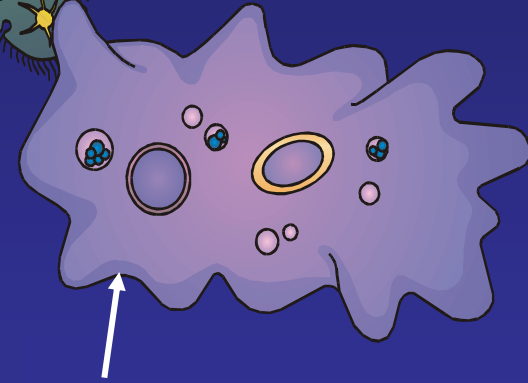


Soil Microbes, Carbon and Structure

Carbon chemistry binds soil particles together to make micro-aggregates



Fungi bind aggregates and release carbon that affects water



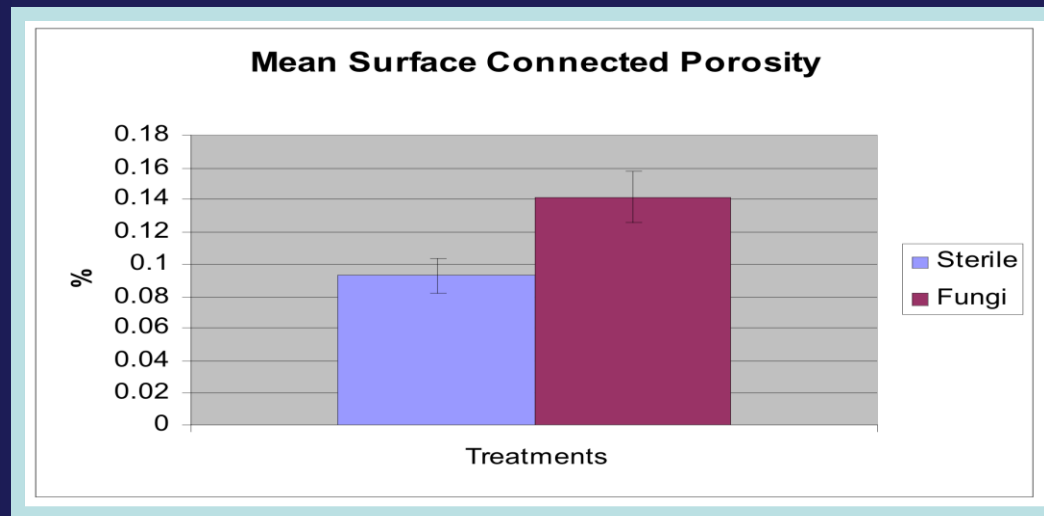
Bacterial release carbon that binds micro-aggregates to make aggregates

Experimental Microcosm

- The microcosm
 - Control soil water
 - Maintain microbial status
 - X-ray scan-able



Results



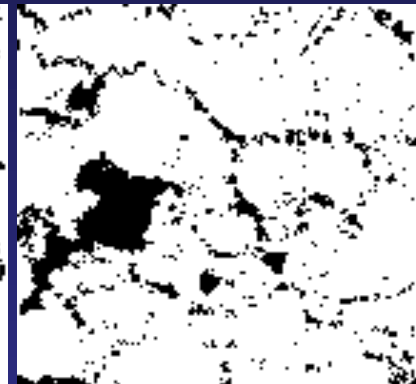
- Microbes significantly increase the porosity of soil
- They change the pore structure at scales that control water movement

Consequences

- Interaction between microbes and structure increases rate of water flow

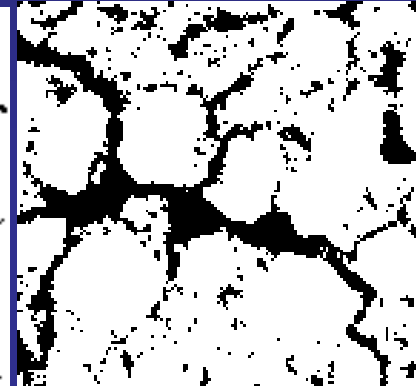
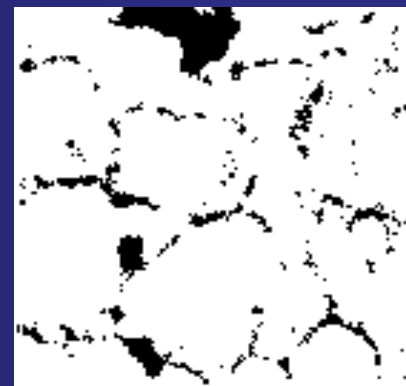
sterile

non-sterile



6.2 cm/d

21.7 cm/d



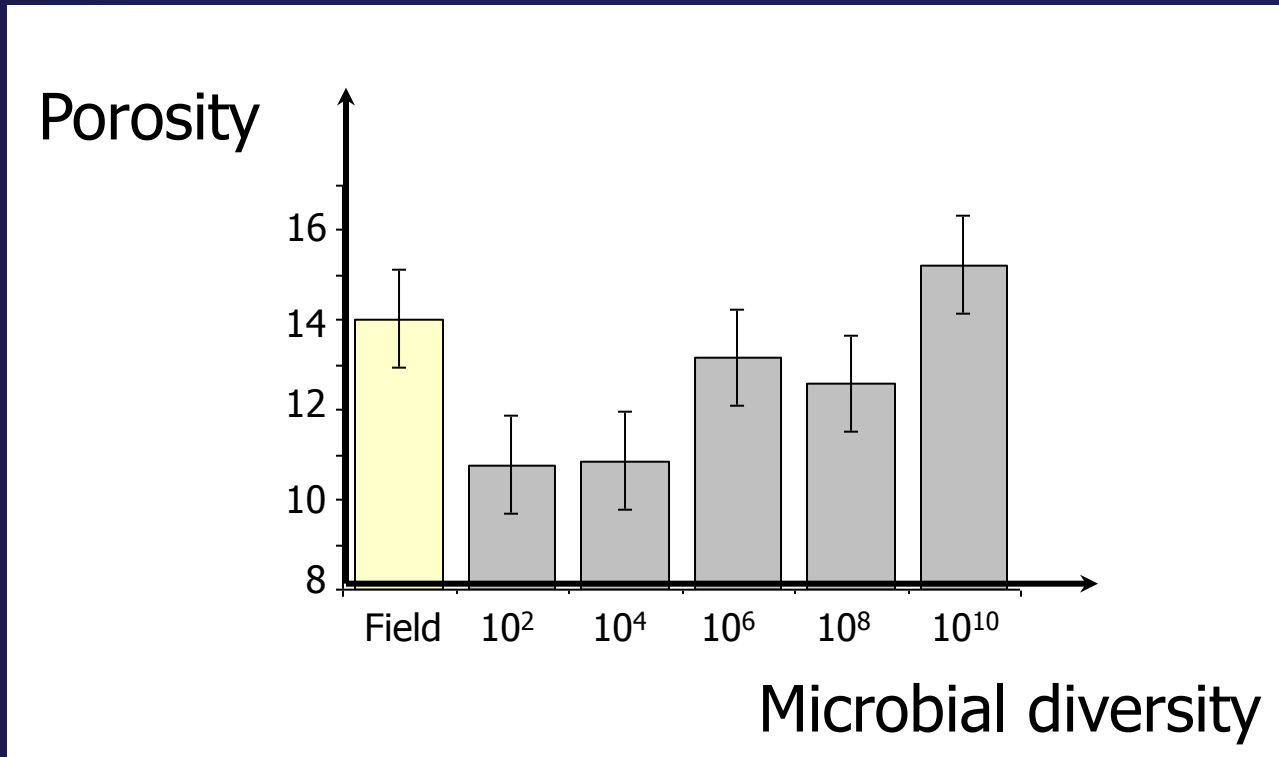
0.008 cm/d

300.0 cm/d

50um

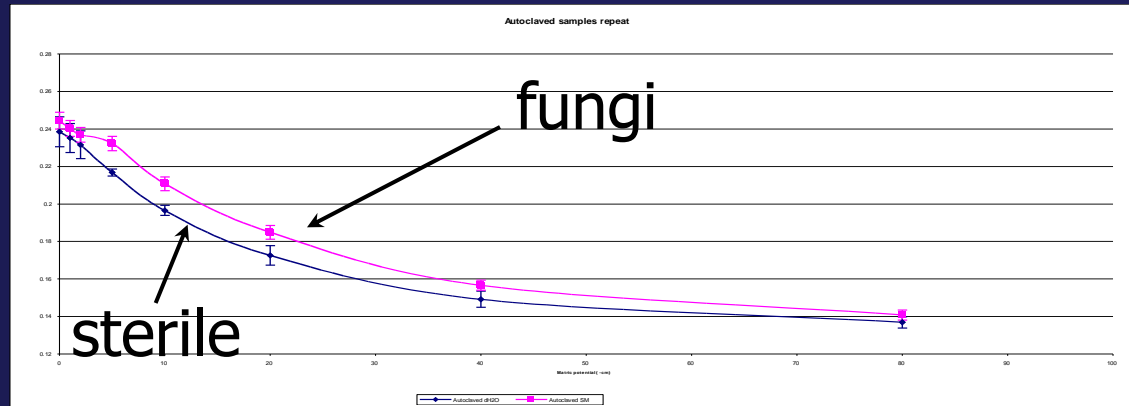
CT images

Effect of Disturbance



- More perturbed communities produced bigger restructuring effects

Water retention



- Fungal activity can help soil hold more water

Conclusions

- We will need >50% more from our soil with less inputs
- We don't understand how soil keeps working or how to make it work better
- Soil and the microbial community work together to organise structure
 - The soil-microbe complex is self-organising
 - Improves water availability and movement
- Carbon is the fuel for the self-organising engine