

FUNDING PROGRAM FOR NEXT GENERATION WORLD-LEADING RESEARCHERS

Project Title: Enhancing infiltration and introducing organic carbon by artificial macropores for restoration of degraded soils

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1. Background of research

Soils are the largest terrestrial carbon body. They store rainfall and buffer environmental impacts. However, these days, poor land management and climate change cause land degradation. Organic matter accumulates at the land surface but less so in the deeper soil profile. Usually, cultivation is a practical technique to enhance infiltration but it breaks soil aggregates and the resulting small soil particles may be easily removed by heavy rain. Cultivation also causes undesired decomposition of organic matter through aeration.

2. Research objectives

X-ray radiography reveals the dual-porosity characteristics of the soil pore system, namely macropores and micropores. Solute infiltration has been successfully controlled by pressure control using this pore system. The objectives of this study were to create this pore system artificially to enhance infiltration, and store water and organic matter within the soils to make a carbon storage zone, a buffer zone for climate change, and a medium for plant growth.

3. Research characteristics (incl. originality and creativity)

The unique technique of this research involves a solute transport control system based on the natural soil pore structure. It has low impact on the environment. The soil layer is considered as a carbon storage zone, and even small carbon storage at individual sites may make a great contribution over large land areas.

4. Anticipated effects and future applications of research

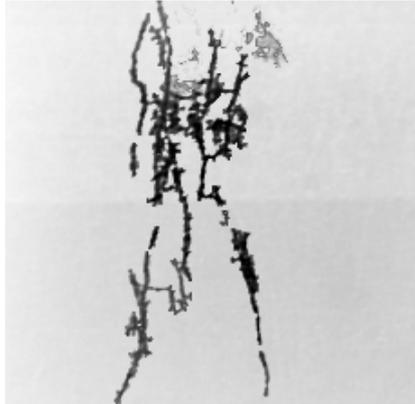
Preliminary experiments showed the importance of vegetation recovery as part of land restoration. Consideration of total carbon increments showed that, if this was extended to large land areas, the technique could contribute up to 20% of the terrestrial carbon budget, which is equal to large-scale afforestation. The technique could be developed as a carbon offset.

Dual Porosity Characteristics of Natural Soils

-Radiography of Macropore-Matrix system-

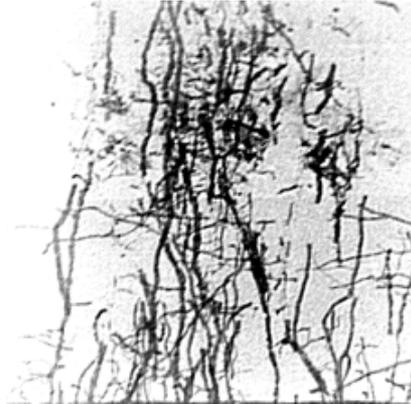
Saturated water flow

Drainage process



$\theta = 0.554$

Cylindrical macropore flow



$\theta = 0.542$



$\theta = 0.487$

Time lag



$\theta = 0.374$

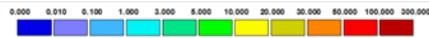
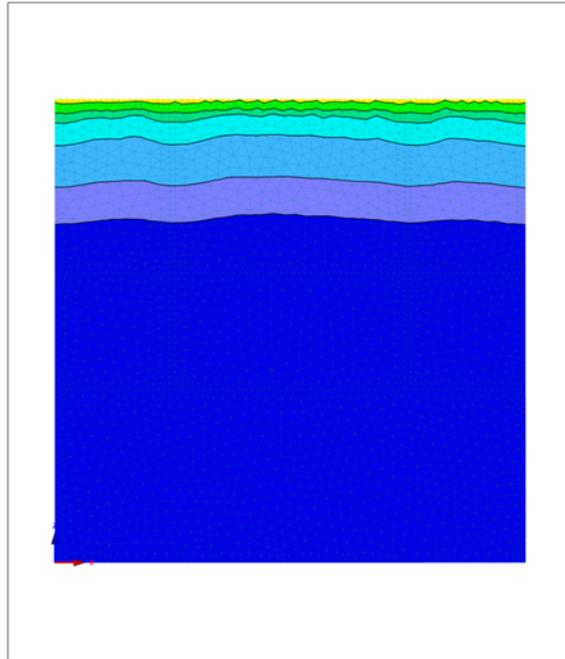
Matrix flow

Gray Lowland soils (paddy field) 30cm in depth

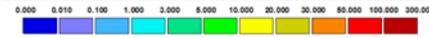
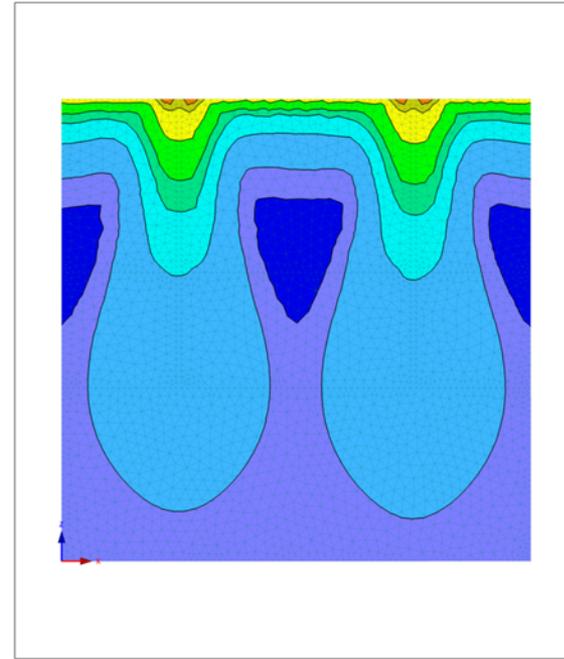
There are distinct differences in flow domain in soils according to matric potential. Preliminary experiments showed convection and dispersion are controlled by a simple technique. It is quite beneficial for cost effective use of fertilizer in agriculture or remediation chemicals in environmental engineering.

Mori et al. Clay Science for Engineering, Balkema: 297-302. 2001

Cost effective restoration of degraded soil environment



Control area



Artificial macropore area

When artificial macropores were created in soils (right), they showed advantages to control area (left) for water storage as well as vertical solute infiltration. The soil layer is considered as a carbon storage zone, and even small carbon storage at individual sites may make a great contribution over large land areas.