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How biologically formed macropores influence subsurface flow

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Introduction

• Water flow in soil influences heavily erosion, pollution and/or agronomic issues. However, subsurface flow processes still need further research.
• Subsurface flow is described as preferential uniform or non-uniform flow occurring in interconnected macropores (diameter > 2mm).
• Biological macropores formed by plant root systems and pedofauna influence largely this preferential flow.

Aims

• How do different forest cover types influence preferential flow by root morphology and pedofauna activity?
• Is there any evident relationship at this scale between preferential flow and biotic parameters?

Methods

Tropical climate
Field work Xishuangbanna, Yunnan province, China

Treatments

• Rubber tree plantation (Hevea brasiliensis) vs endemic tree forest
• Understory fine root effect vs weak fine roots bare soil
• Sites have a similar soil texture

Fig. 1: Sites presentation. 1 site = 1 treatment. (i) ‘Bare soil trees’: Tree plantation and bare soil; (ii) ‘Clear-cut trees’: clear-cut tree plantation with understory; (iii) ‘Forest’: Secondary forest with understory.

Experiment

1) Dyed infiltration simulation
   3 experimented plot per site
2) Soil excavation
   3.5 soil profiles per plot
3) Measurements for each soil profiles

Measurements

Photo-description-sampling : spatialized with referenced grid (Fig.2)
• Patterns of water infiltration by blue dyeing
• Image analysis (Fig. 2)
• Roots impact by diameter classes
• Pedofauna activity: presence / absence
• Soil resistance to penetration

Fig. 2: Image analysing for preferential flow measurements. (a) Soil profile photo normalized, (b) Soil profile photo after colour segmentation: color classes are selected by color thresholding. Software : QGIS and EcoSummit.

Results

Site variability (Fig.3)

• Fauna was more present on clear-cut plantations.
• Fine roots were equally developed in clear-cut plantation and forest, and less developed in bare soil.
• Coarse root were significantly more developed in forest.
• Resistance to penetration is much less important in forest.

Fig. 3: Variability between treatments. Measured for each grid cell. (i) Fauna activity described by cumulated presence/absence. (ii) Resistance to penetration is the pressure resistance: 0Pa = void ; 12kPa = maximum resistance for the penetrometer. (iii) Coarse roots (>2mm) and fine roots (<2mm) impact are counted in function of coloration.

PCA (Fig.4)

• ‘Blue dye’ is related to roots and ‘concentrate blue dye’ is mostly explicated by coarse roots.
• Coarse root effects on subsurface flow was more observed in forest.
• Fine root effect on subsurface flow was more observed in clear-cut trees with the most amount of grass (Fig. 3).
• Bare soil trees with less roots is affected by fauna activity.

Fig. 4: PCA (Principal component analysis) on the first projection (axis 1,2) representing 48.99% of projected inertia.

Conclusions

• Preferential flow is driven by roots.
• The effect of fauna on preferential flow is not evident as fauna was present in the most of the cases.
• In the forest, preferential flow is mainly influenced by coarse tree roots.
• The influence of grass is lower in the forest than in clear-cut plantations.

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