SOIL AND WATER IMPACTS OF REFORESTING FIRE-CLIMAX GRASSLAND ON LEYTE ISLAND (PHILIPPINES)

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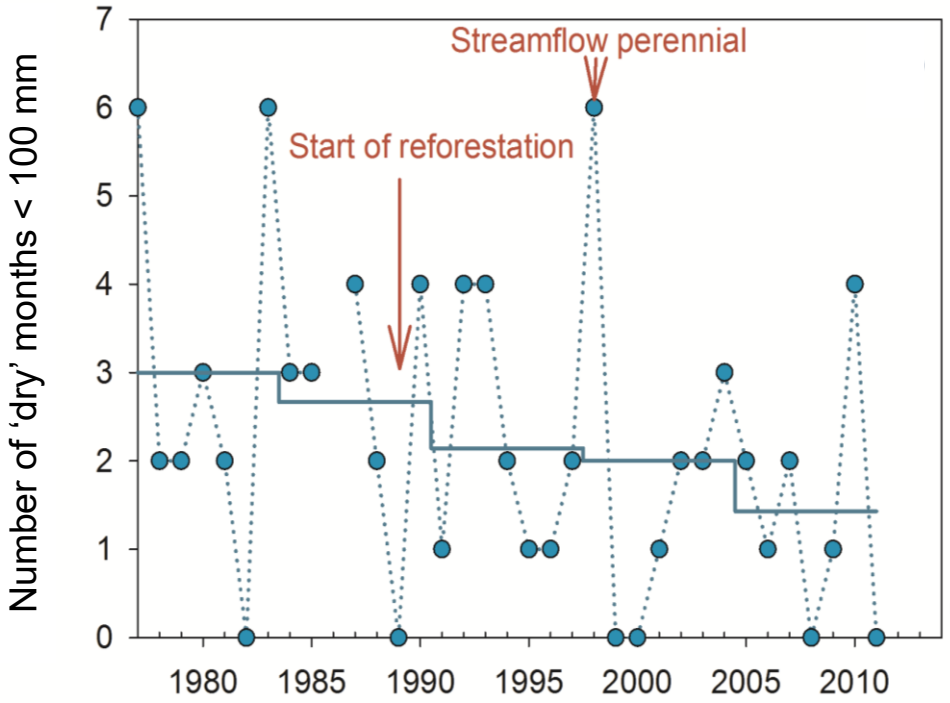
FIRE-CLIMAX GRASSLANDS AFTER REPEATED SLASH-AND-BURN: WIDESPREAD IN SOUTH-EAST ASIA

- Total area of Asian *Imperata* grassland estimated recently at 57 million ha and increasing?
- Associated with enhanced surface erosion, landslides, and flooding when grazed.
- Reforestation failures frequent due to fire, adverse soils, and social issues.
- Net impact of reforesting *Imperata* grassland on streamflow regime unclear…

Sarangani, Philippines (C. Salanio)

ANECDOTAL EVIDENCE: REFORESTATION IMPROVED LOW FLOWS IN LEYTE ISLAND, THE PHILIPPINES

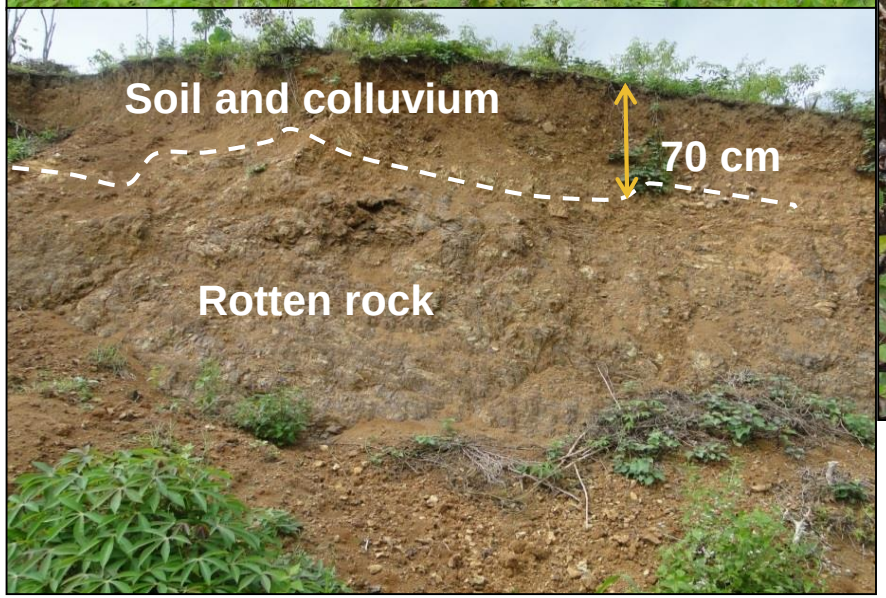


BASPER GRASSLAND CATCHMENT

- Catchment area 3.2 ha
- No burning after 2003
- Many landslip surfaces (1080 m^2)

Steep landslip surfaces delivering ‘direct’ runoff and sediment to creek

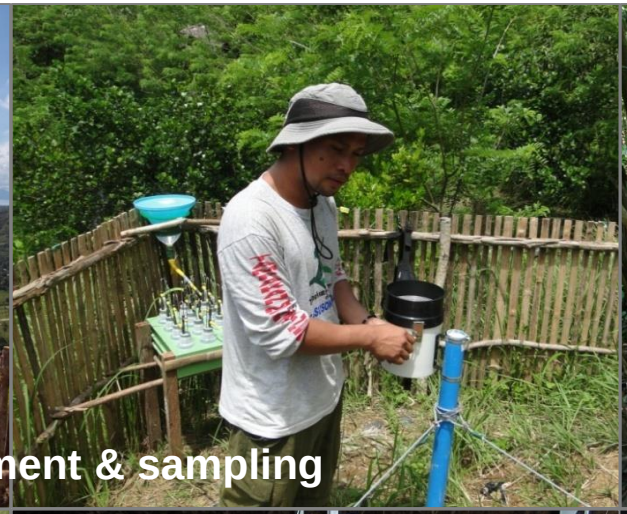
MANOBO 23-YR ‘REFOREST’ CATCHMENT



8.7 ha, > 50 different tree species

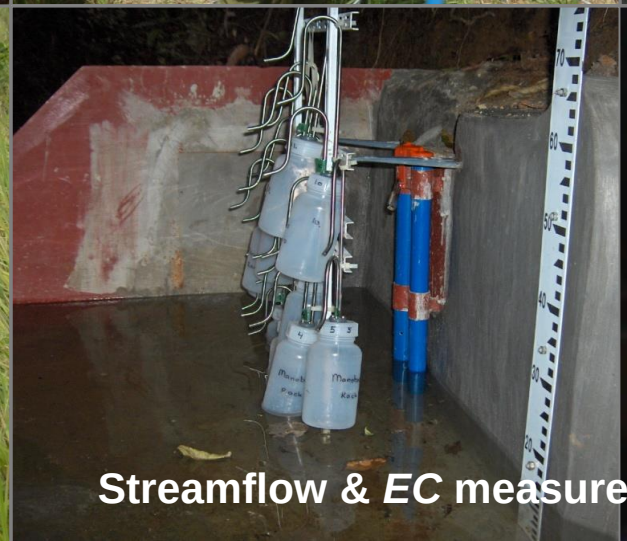
ONE YEAR OF FIELD MONITORING (2013/6 – 2014/6)

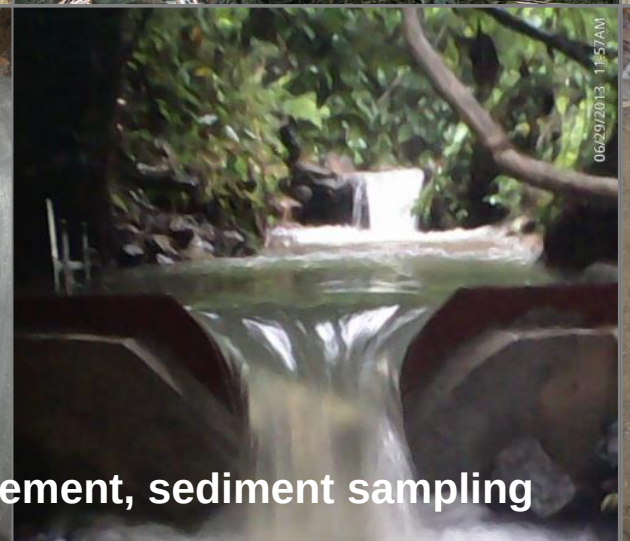

Rainfall measurement & sampling




Throughfall, stemflow & LAI measurement

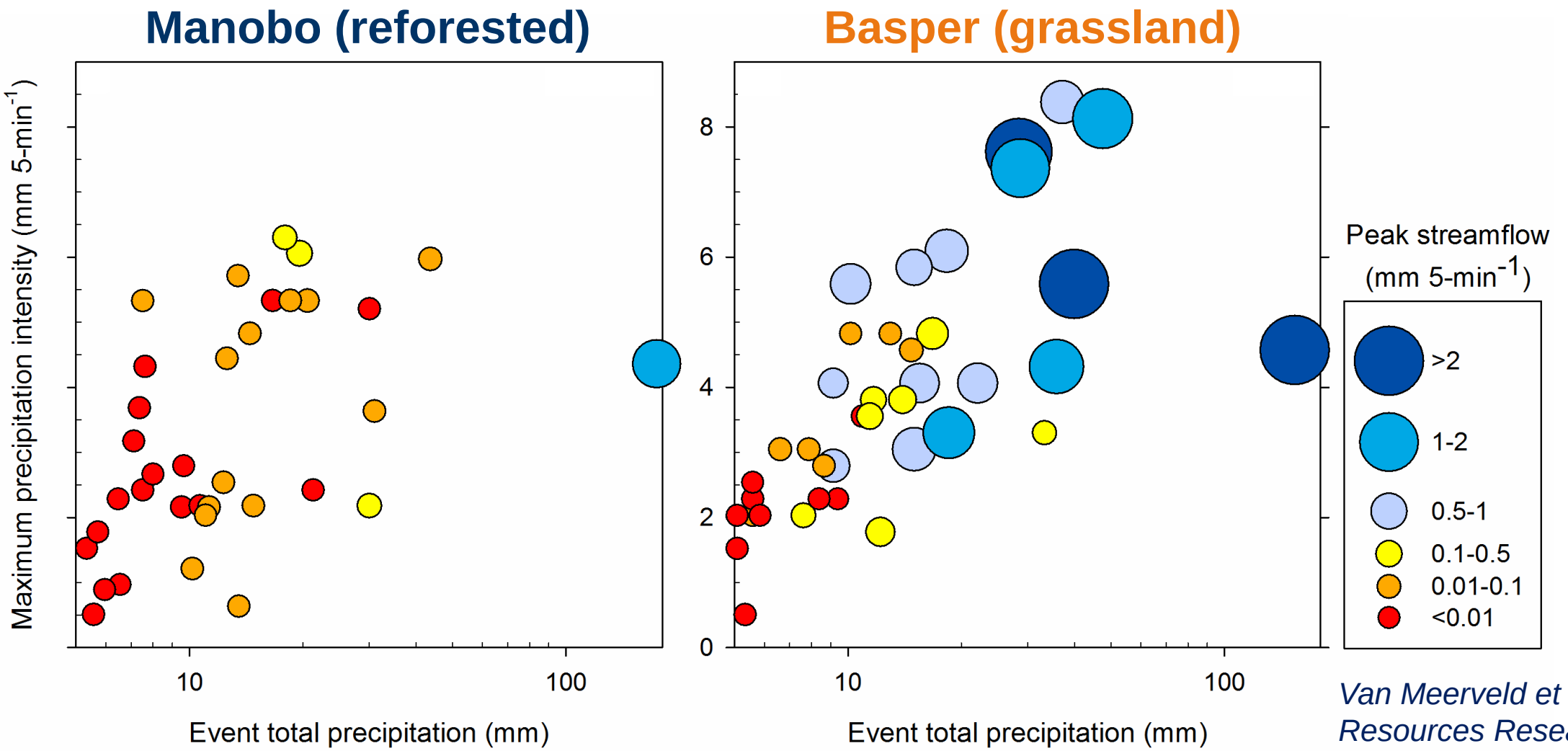

Soil physical characterization


Streamflow & *EC* measurement, sediment sampling



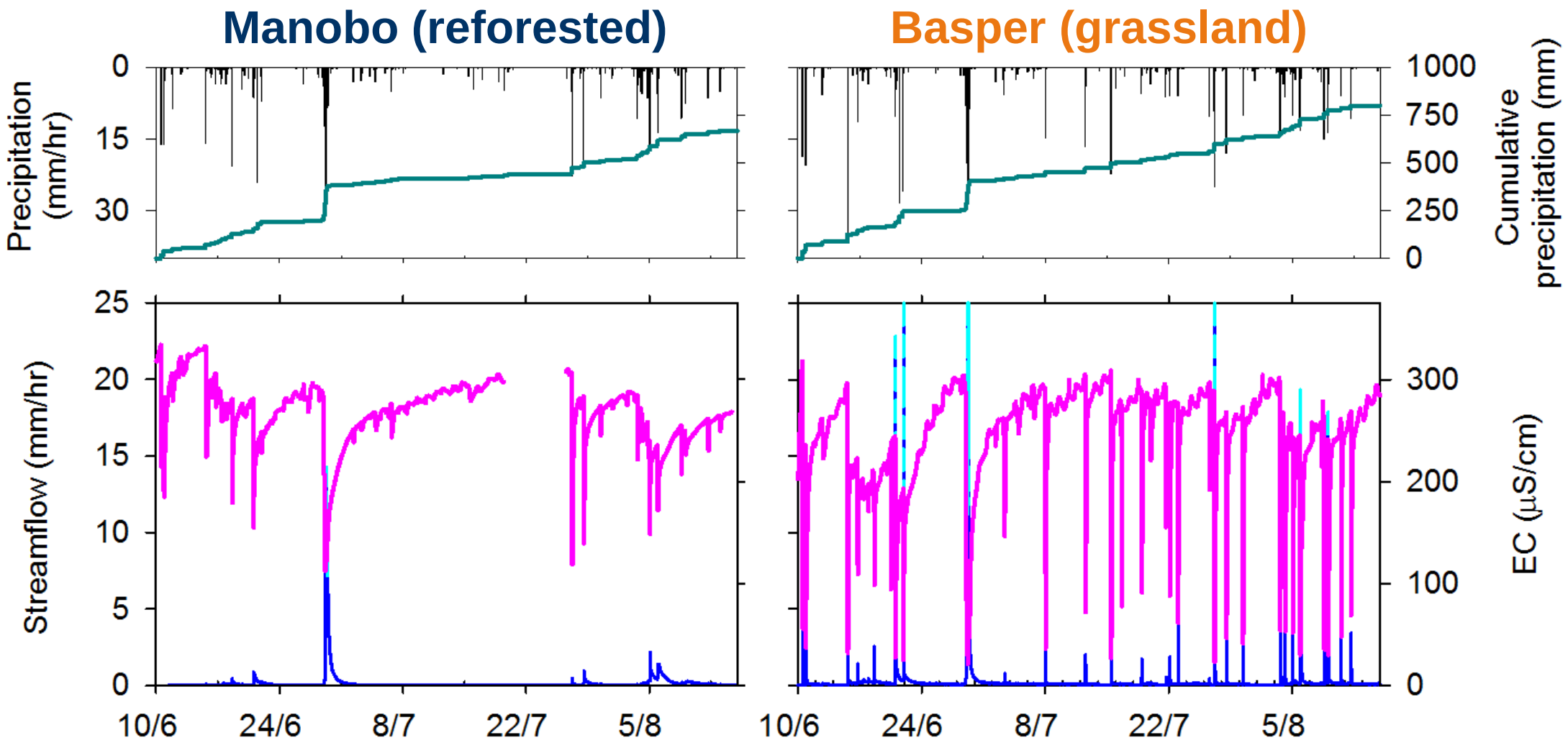

Soil moisture measurement

CONTRASTING PEAK STREAMFLOW RESPONSES TO RAINFALL

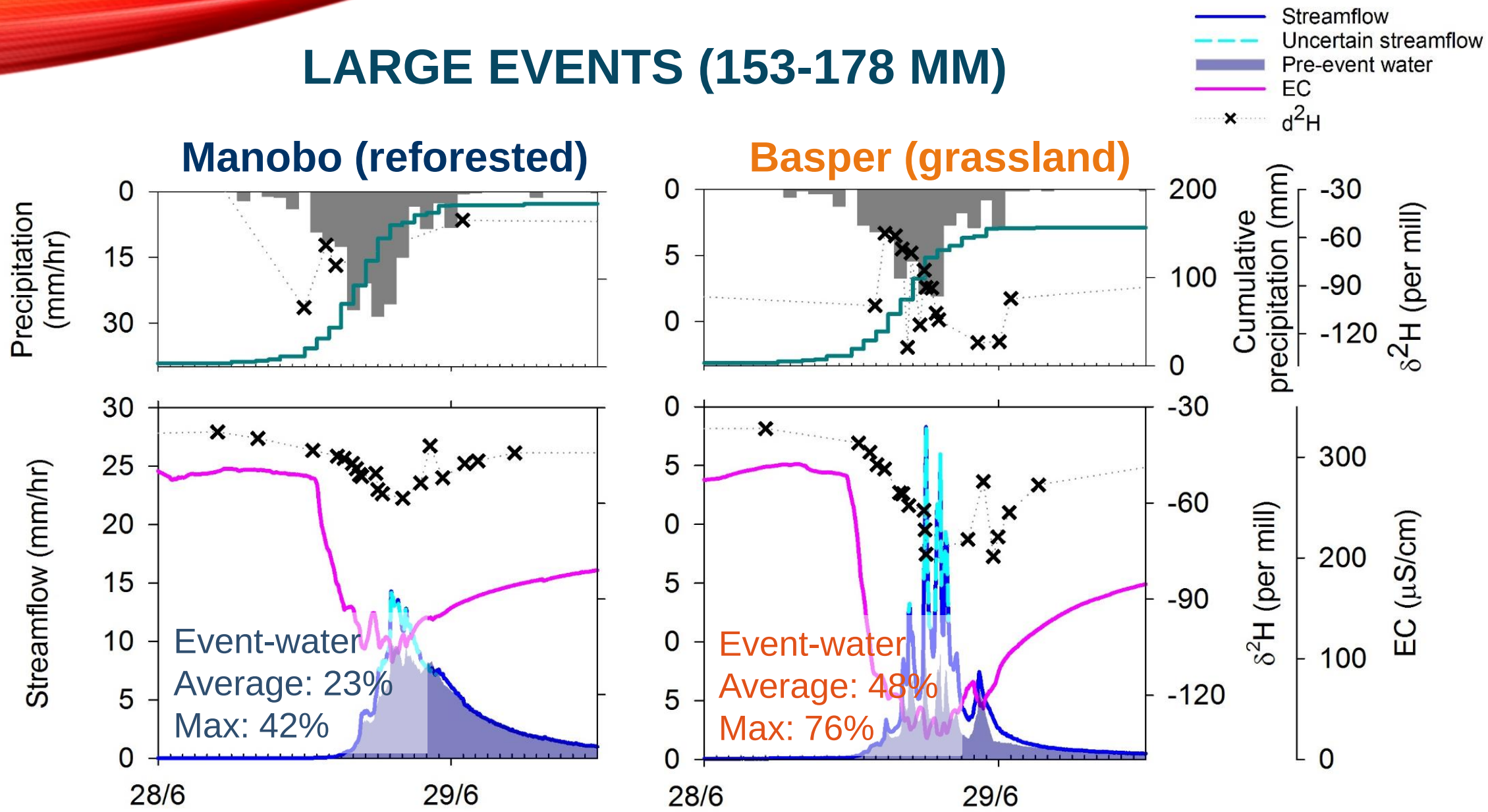


Van Meerveld et al. (Water Resources Research, 2019)

CONTRASTING STREAMFLOW AND CONDUCTIVITY RESPONSES TO RAINFALL

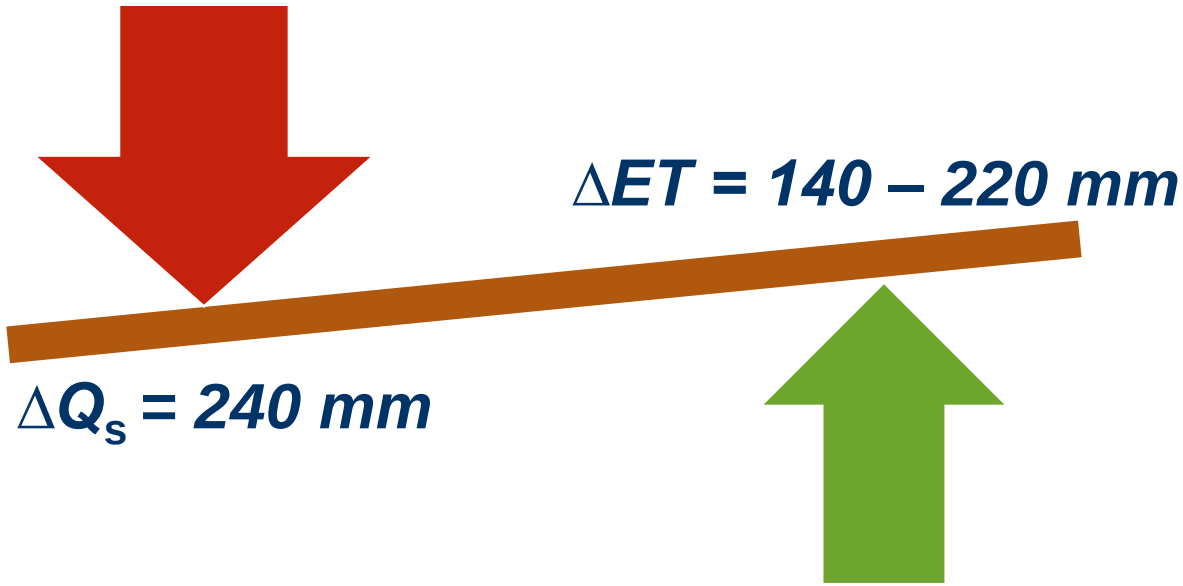


LARGE EVENTS (153-178 MM)



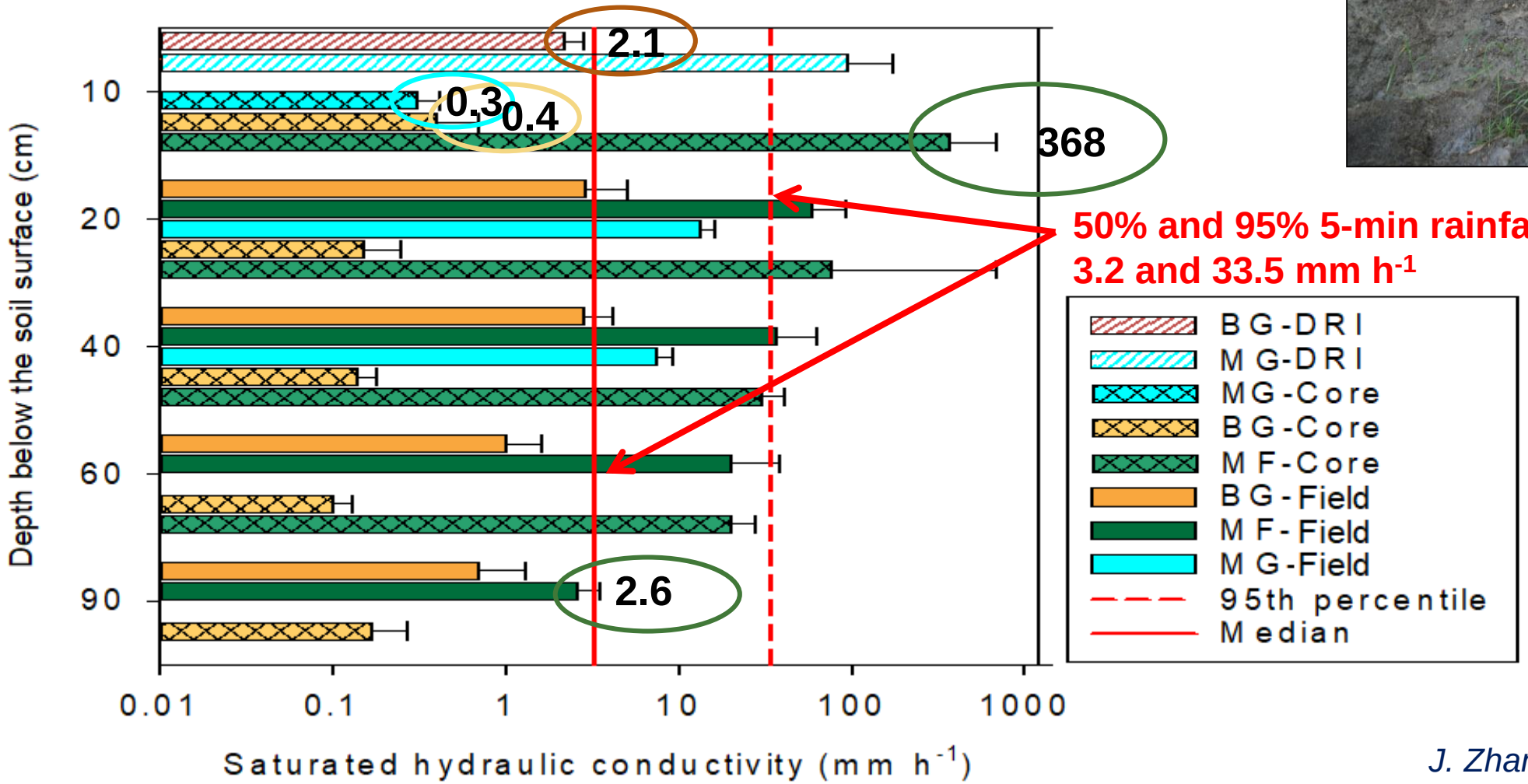
TENTATIVELY POSITIVE INFILTRATION TRADE-OFF 23 YEARS AFTER REFORESTATION

- Annual reduction in storm runoff after reforestation: *ca.* 240 mm/yr.
- But: extra water use by the reforest 140–220 mm/yr.
- Inferred *net gain of 20–100 mm/yr*, tentatively confirming local claim of improved baseflow after reforestation.
- What caused the large reduction in storm runoff after reforestation?



J. Zhang et al. (Ecohydrology, 2018)

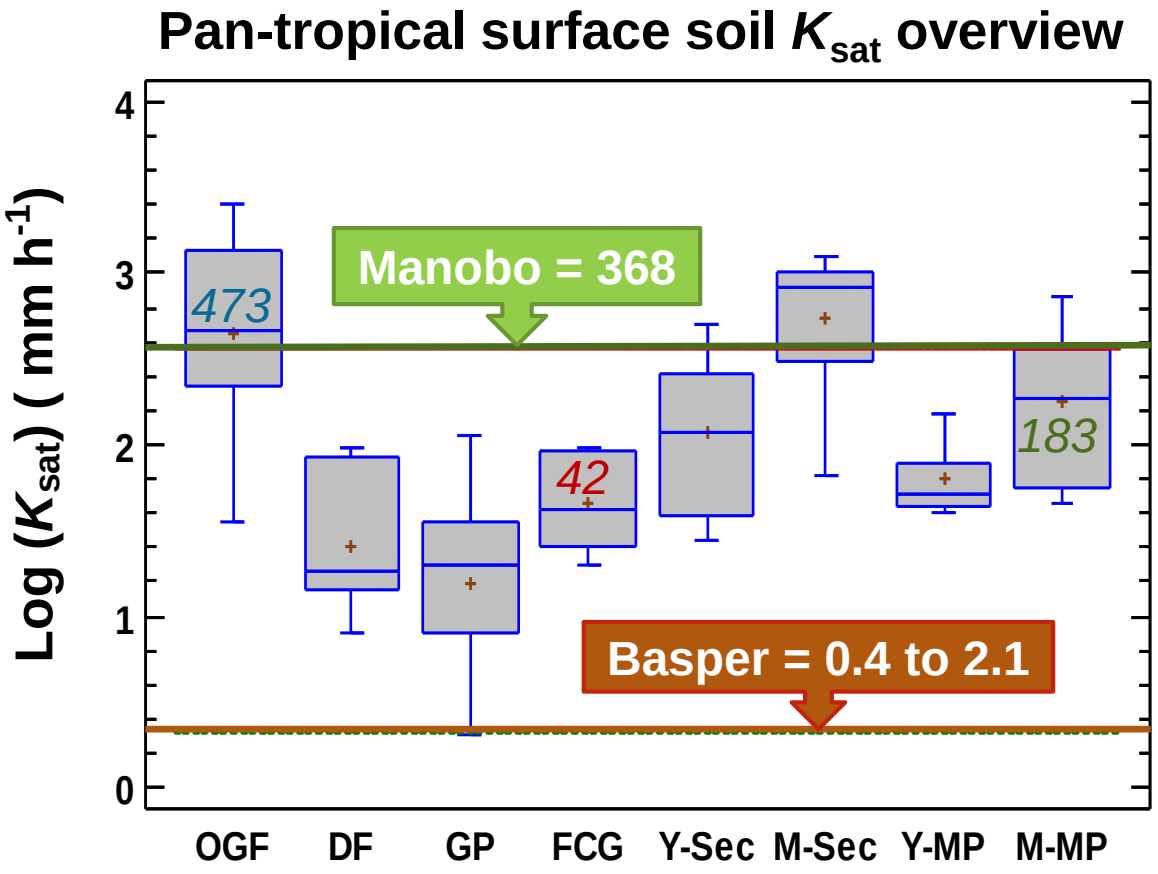
REFORESTED SOIL: HIGHER INFILTRATION



J. Zhang et al. (Geoderma, 2019)

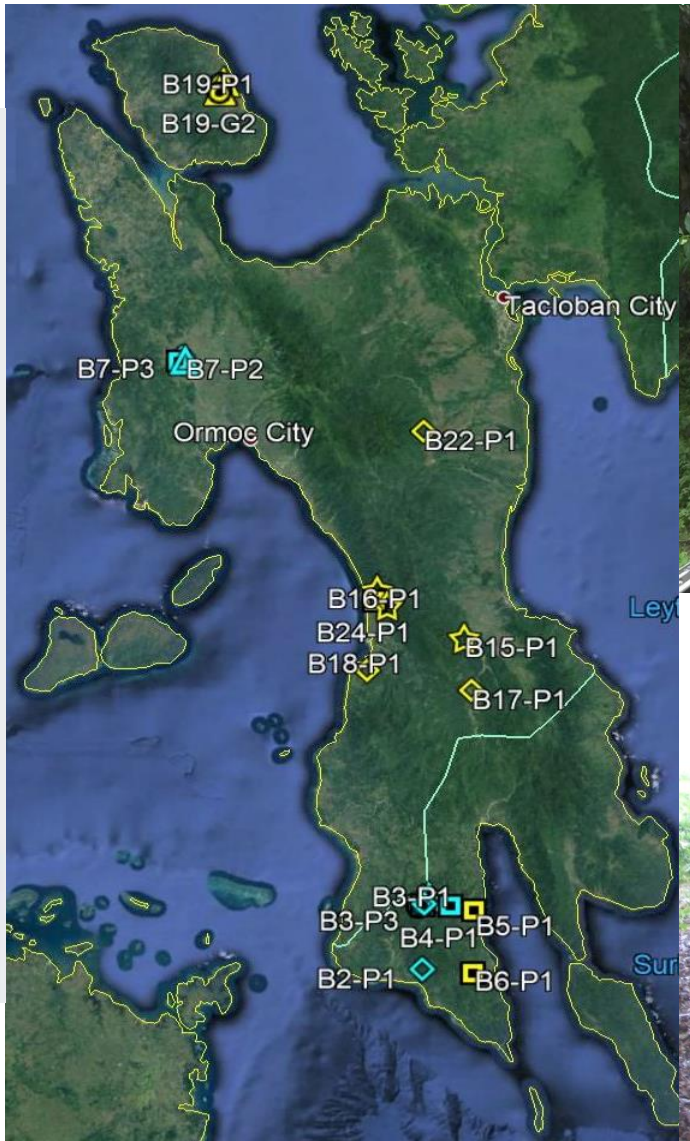
SURFACE INFILTRATION AND LAND COVER ACROSS THE TROPICS

- Compared to other tropical studies, the Manobo result confirms other work, but the Basper result is excessively low.
- How do these results compare with other fire-climax grasslands, secondary forests and tree plantations across Leyte Island?



SOIL IMPROVEMENT ACROSS LEYTE: PLANTATIONS *VS.* SECONDARY FORESTS

- V-Grassland
- L-Grassland
- V-Gmelina
- L-Gmelina
- V-Mahogany
- L-Mahogany
- V-Acacia
- L-Acacia
- V-Sec.forest
- L-Sec.forest



Maasin-Lunus
Limestone –mahogany & grassland

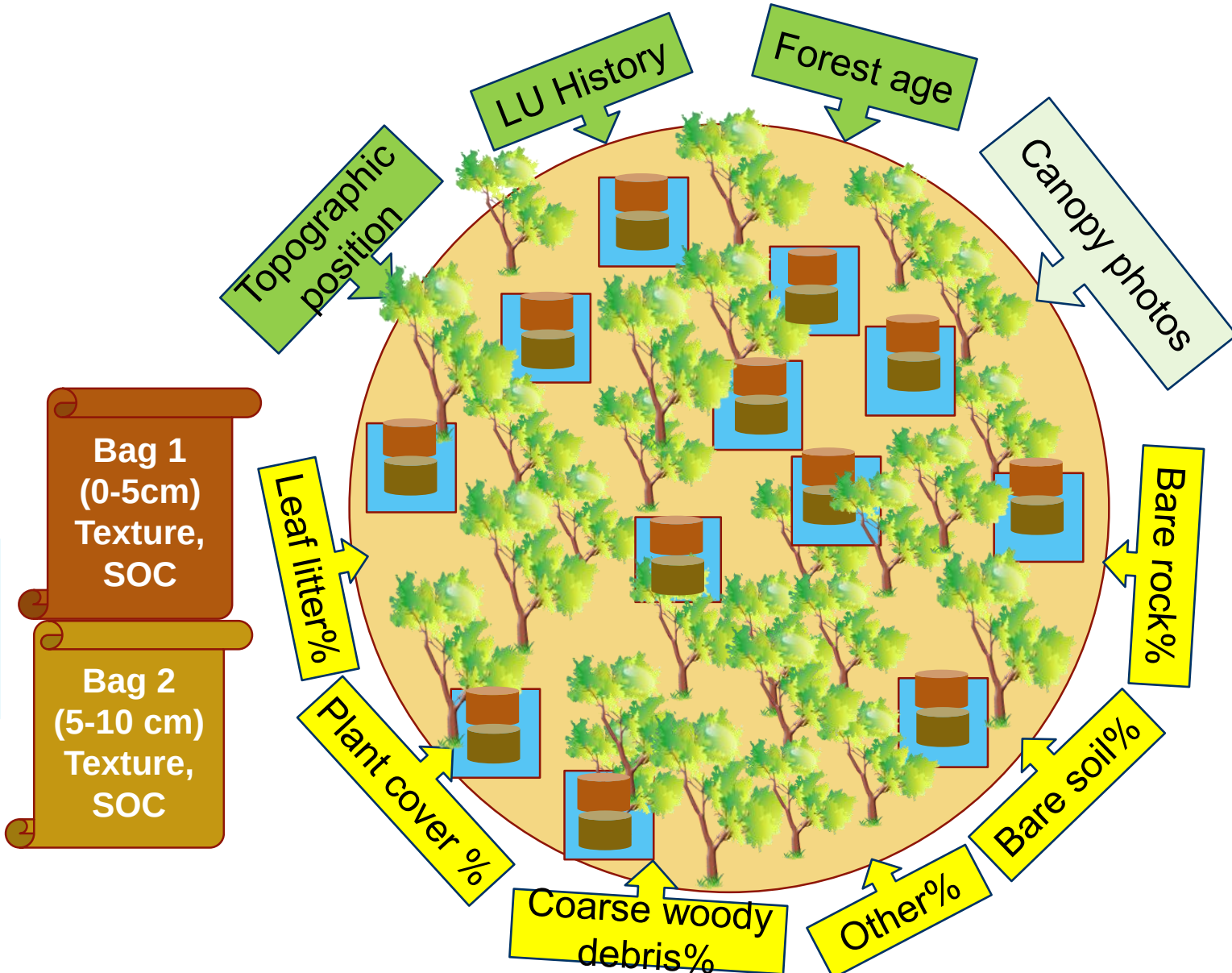
Merida San Jose
Limestone -Mahogany-1995

Biliran
Volcanic-Acacia & grassland

SOIL SAMPLING STRATEGY

15 Volcanic sites include:
5 LU: Grassland (GR), Sec. forest (SF), Gmelina (GP), Mahogany (MP) and Acacia plantations (AP)
(3 replicates each)

13 Limestone sites include:
5 LU: GR, SF, GP, MP and AP
(3 replicates each, except AP)



LABORATORY MEASUREMENTS: OVERVIEW


1. Saturation (porosity)


2. Hydraulic conductivity

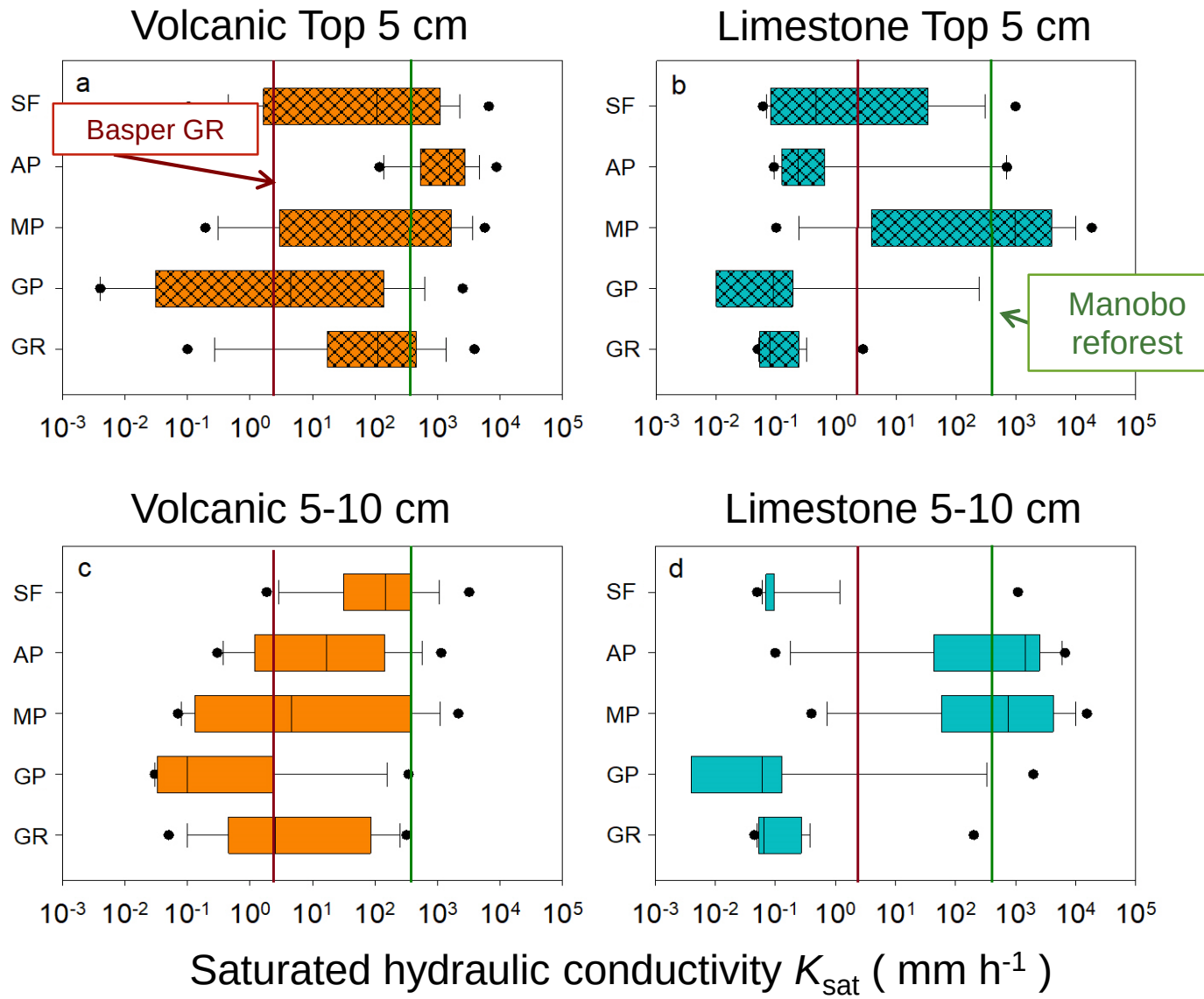

3. Gravity drainage 3 days (pF ~2.3, 'field capacity')


4. Wilting point (pF 4.2) (Amsterdam)

- Various simple techniques to demonstrate changes in soil water holding capacity and permeability.
- Soil texture, bulk density, organic carbon, etc.

SATURATED HYDRAULIC CONDUCTIVITY

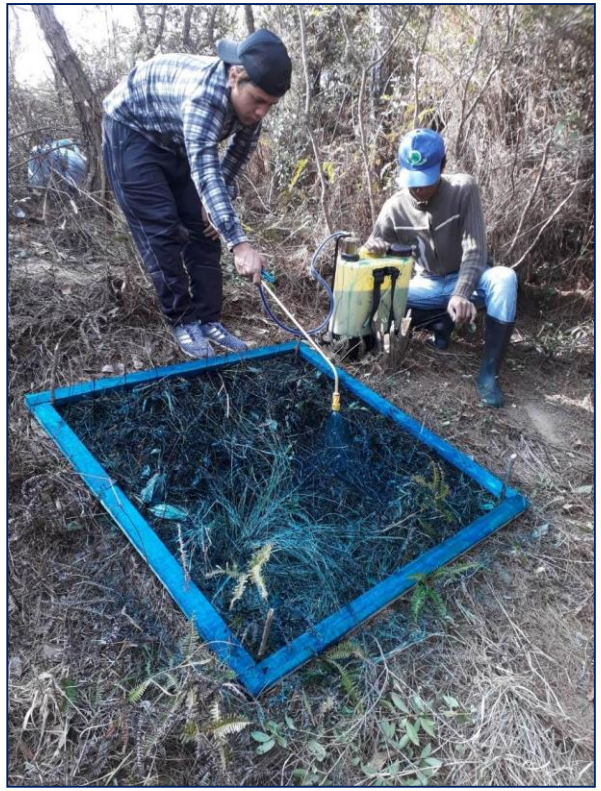
- K_{sat} of limestone soils lower, regardless of vegetation type, except for Mahogany (MP).
- *Grassland (GR)* K_{sat} improved after refo/regrowth, except for *Gmelina*.
- K_{sat} of Manobo refo higher than median value for Volcanic SF; Basper GR <75% Volcanic-GR but larger than GR on limestone.
- BUT, use of small soil cores may underestimate K_{sat} in clay soils (macropores!).

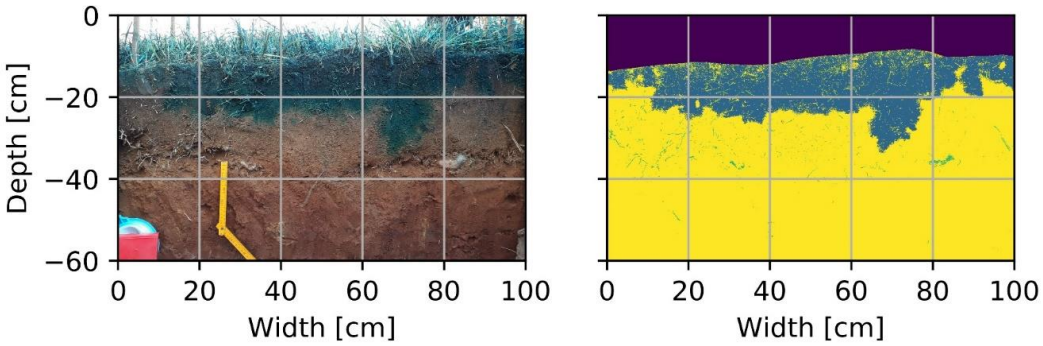


BLUE DYE INFILTRATION TO INVESTIGATE MACROPORE CONNECTIVITY

Basper soil, millipede

Blue dye testing, example from NE India





CONCLUSIONS

- Positive hydrological trade-off after reforesting *Imperata* due to greatly improved infiltration and a modest contrast in vegetation water use.
- Surface infiltration in Manobo reforest after 23 years higher than the 75th-percentile for semi-mature secondary forest across the tropics.
- Surface infiltration in Basper and Manobo *Imperata* grasslands lower than the 90th percentile for fire-climax grasslands across the tropics.
- *Imperata* grassland soils in the Philippines appear to have poor infiltration but causes incompletely understood (compaction? fire effect? low faunal activity?).
- *Soil physical characterization required prior to refo to better assess future impacts on hydrological functioning!*

THANK YOU!

SALAMAT!

XIE XIE NI!

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