Landslides distribution in the changing landscapes of the NW provinces of Rwanda

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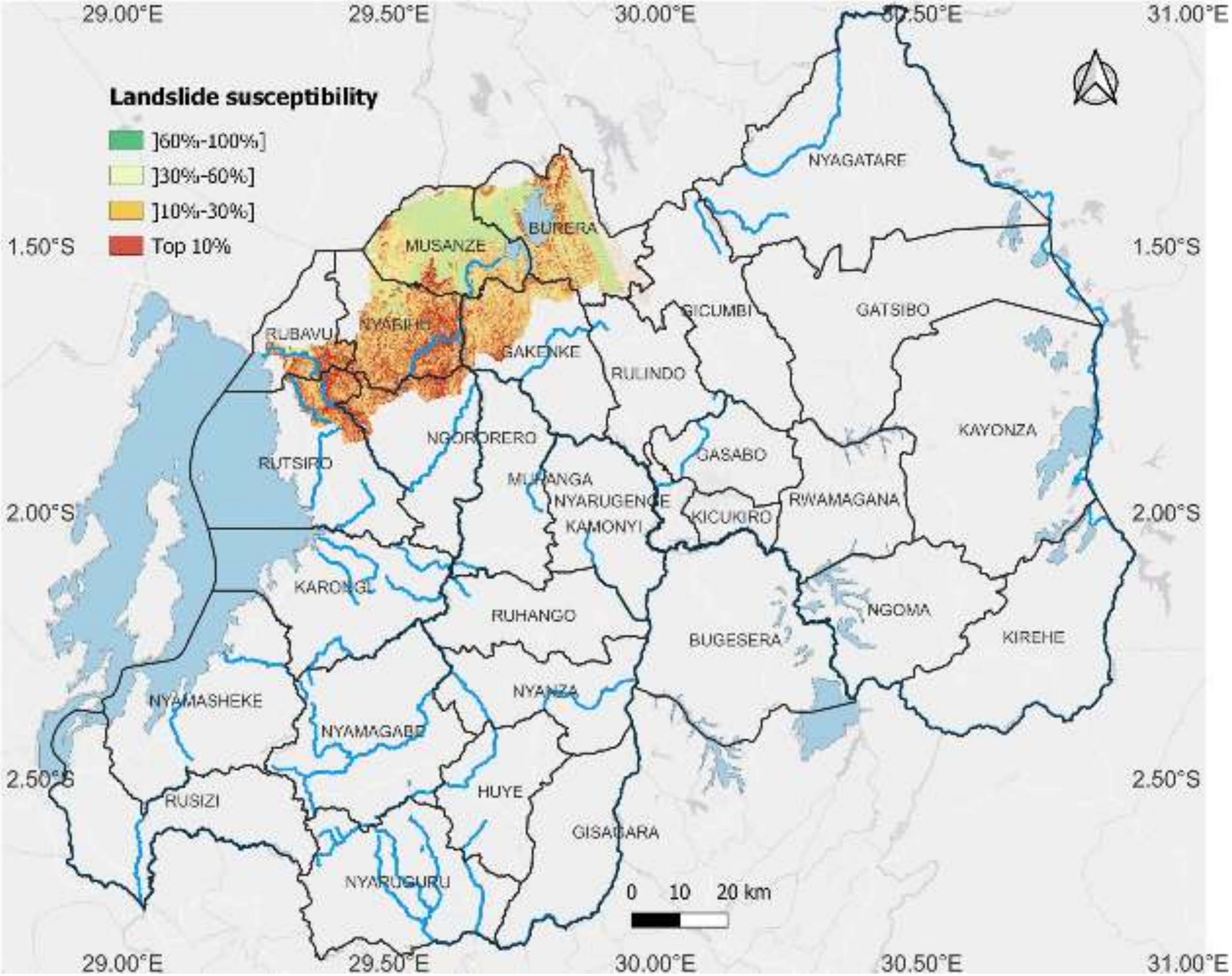
Rwanda context: steep tropical environment



Research goal

Spatio-temporal occurrence of rainfall-triggered LS with regard to LULC changes and land management practices

Overall research objective

Key research questions:

1-Effect of terraces ?

3-Soil moisture, LULC and land management practices in simulation and prediction of rainfall triggered landslides in tropical and intensively cultivated environments?

4- How do LULC and land management practices affect the occurrence and characteristics of landsliding?

2-Rainfall-soil moisture response variation in relation to the soil type, LULC type, and land management practices?

Chapter 1: Effect of terraces on landslide occurrence in respect with landslide susceptibility in NW of Rwanda

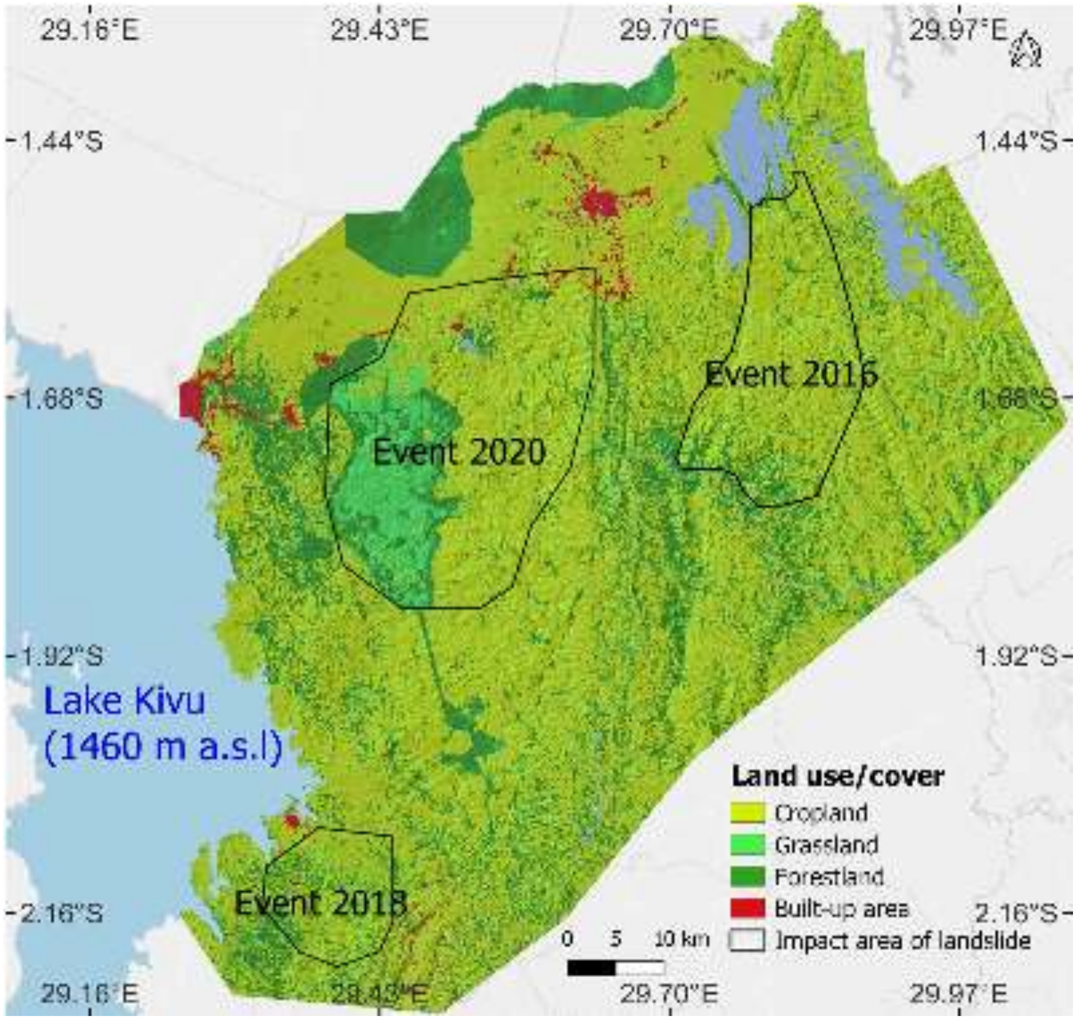
-Do more landslides occur on terraces?

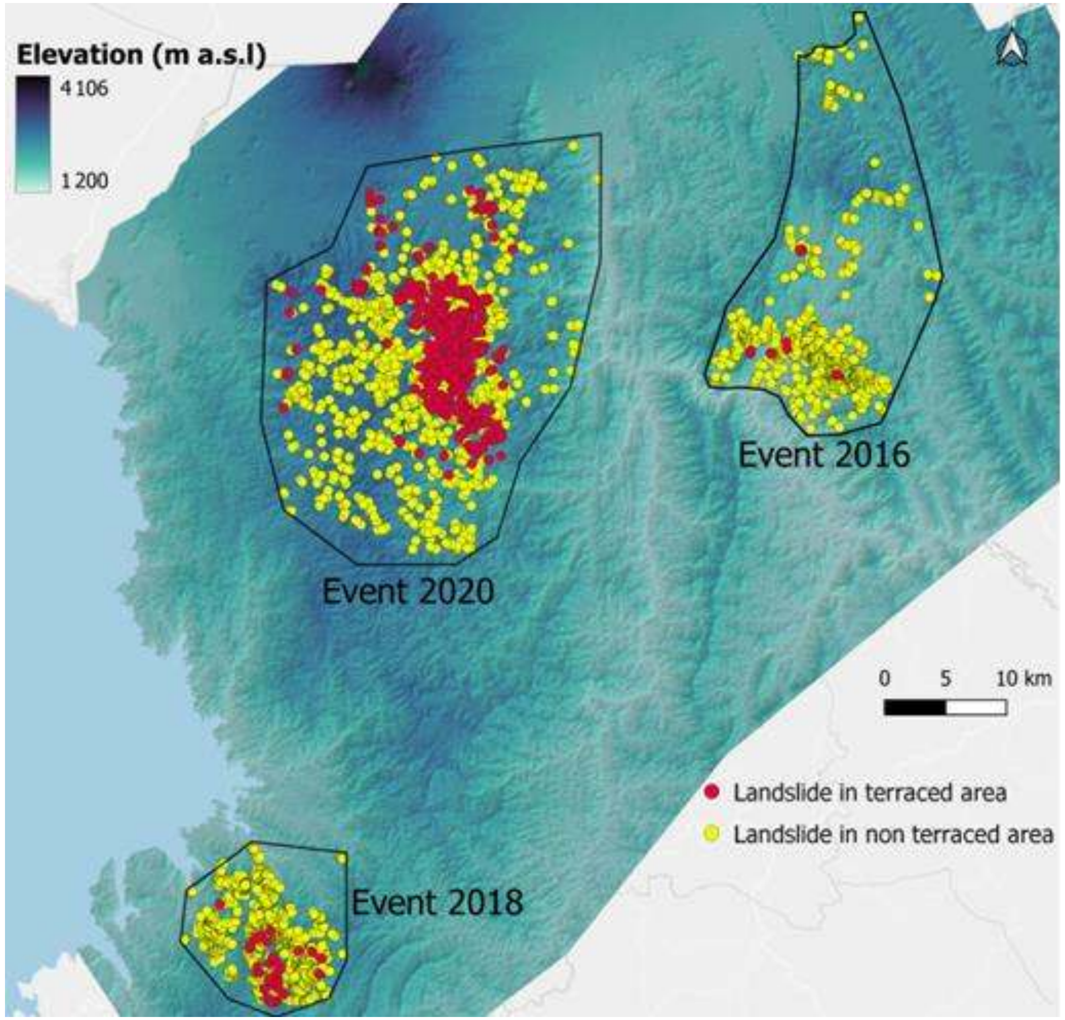
-Are the landslides on terraces larger or smaller?

-Do terraces lead to the same type of landslide?

-Which factors potentially control the effect of terraces on landslides?

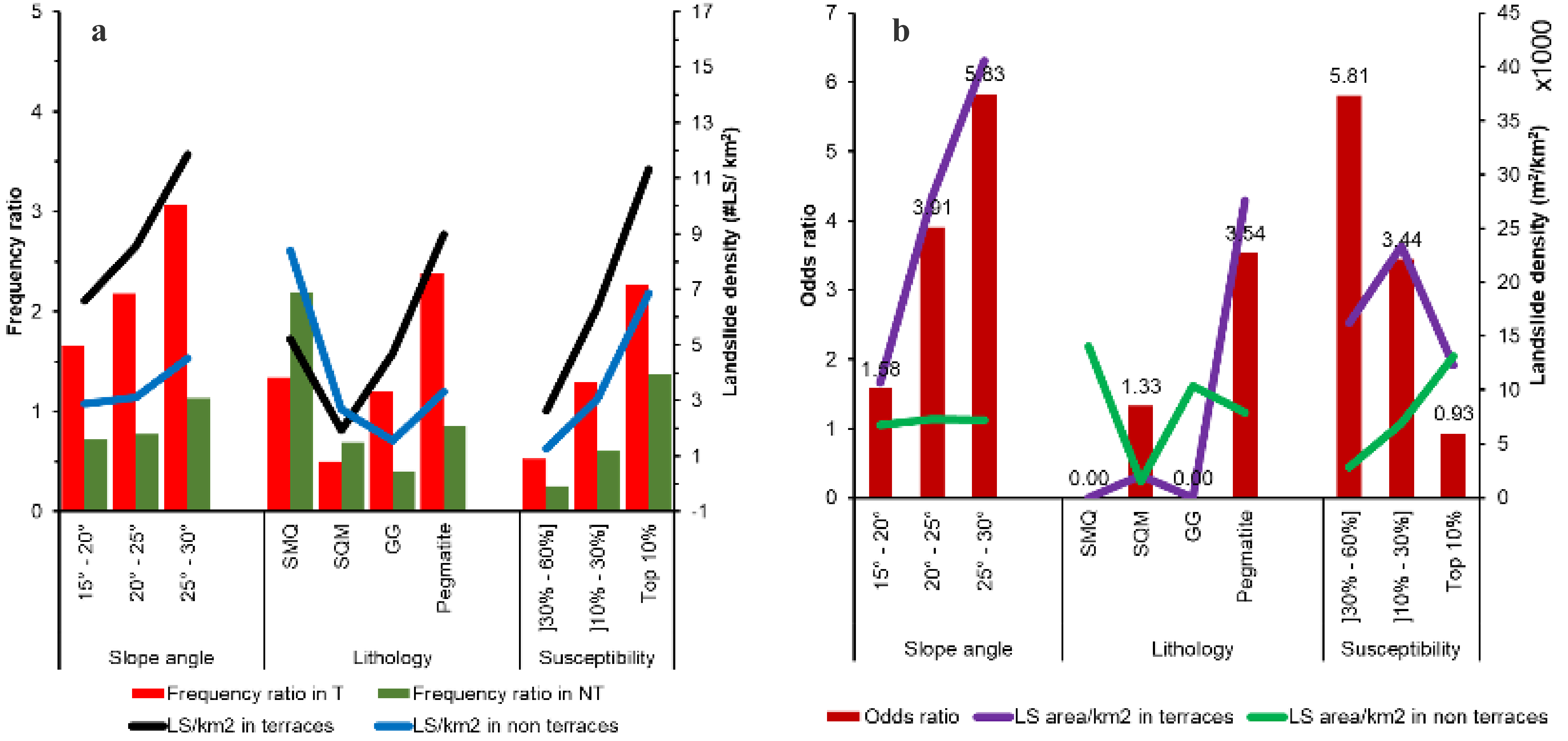
Impacted area & landslide inventory





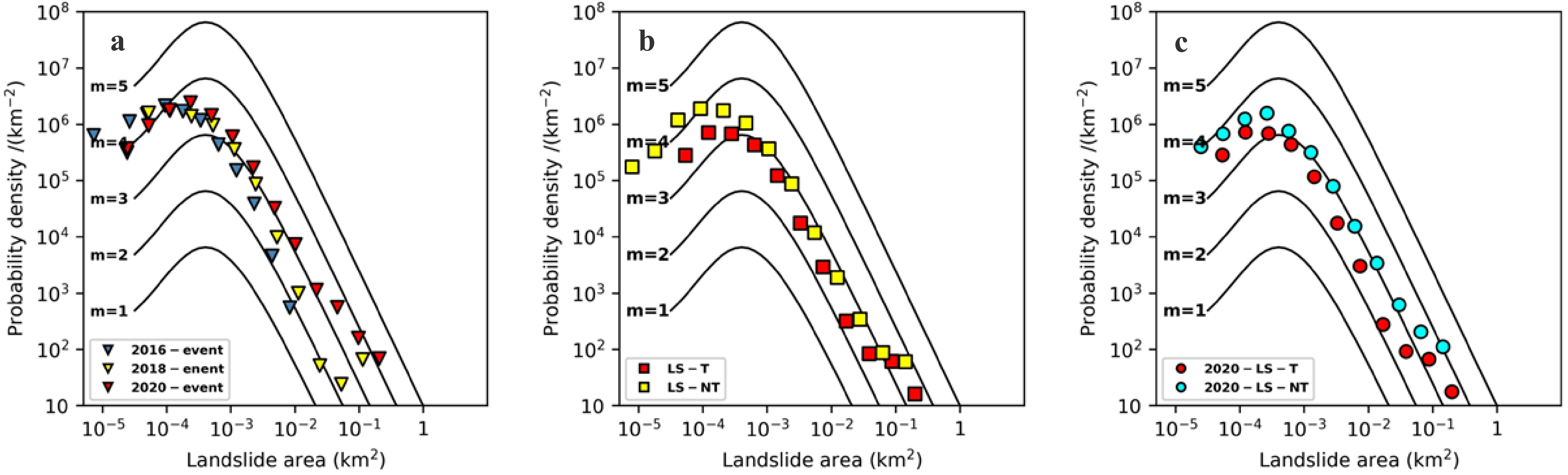
4687 LS (all these LS occurred in May) mostly debris and avalanches types

Role of terraces on landslide occurrence



Frequency ratio of 3 landslide events (a), and odds ratio between the cumulative areas of landslides that occurred in terraced hillslopes and in non-terraced hillslopes (b). Landslide frequency is higher in terraces than in the non terraces. The cumulative landslide areas are higher in terraces than in non-terraced hillslopes.

Role of terraces on landslide occurrence



Probability area distribution a) for the set of three landslide events; b) landslides occurred in terraces and non-terraces for the set of three landslide events; c) the 2020 landslide event subdivided into terraced and non-terraced areas

Overall, the landslides in terraced hillslopes are smaller.

Conclusion

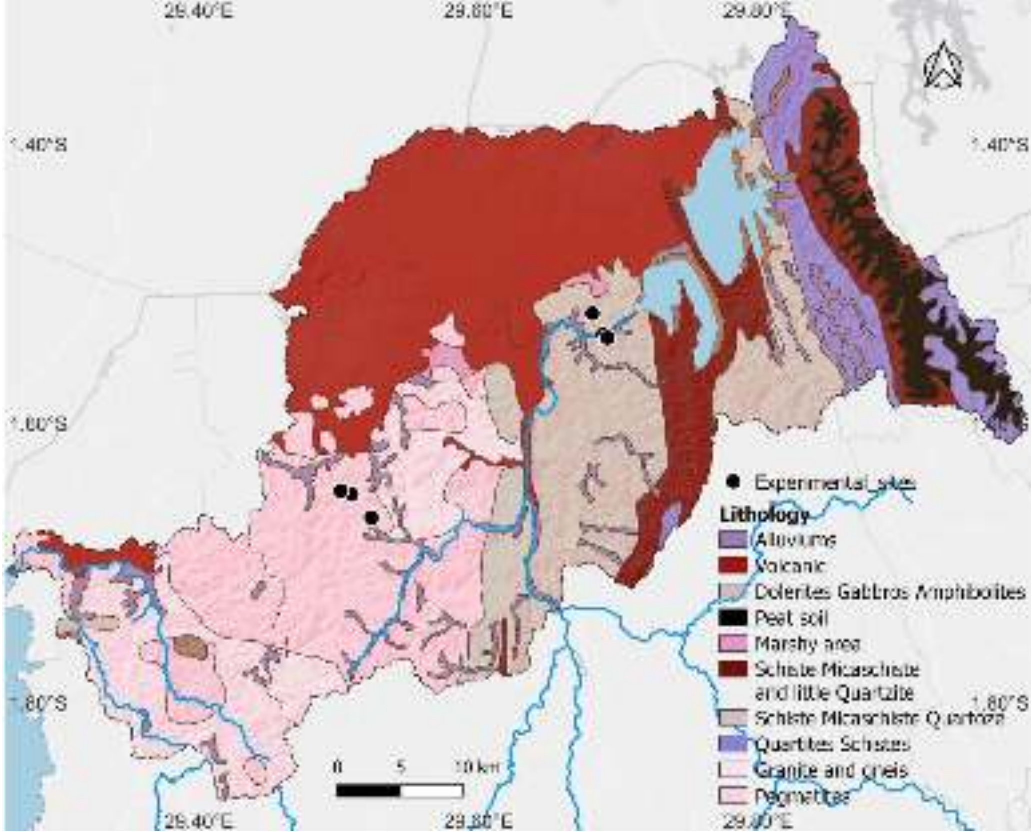
Overall, terraces increase the frequency of smaller landslides whose total impact in terms of cumulative areas is larger than the landslides in non terraces. Differences between landslide processes (slide, avalanche) as well as differences between terrace types could not be found.

Chapter 2: Variation of soil moisture content with regard to the land use(LU)/land cover(LC) type, and land management

- How does soil moisture content vary over time and in relation to antecedent rainfall events?

- Do changes in soil moisture in response to temporal variations in weather conditions also vary as a function of soil characteristics?

- Do changes in soil moisture in response to temporal variations in weather conditions also vary as a function of LULC types and land management practices?



Methodological approach

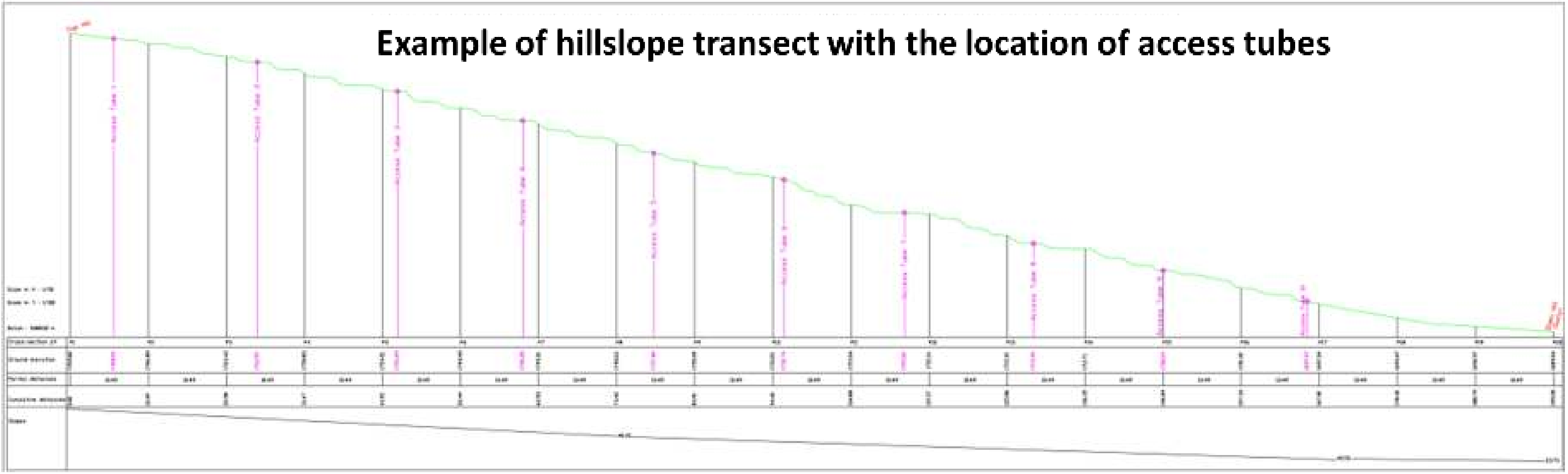
Location of the experimental sites and illustration of the hillslope transect

- Two contrasting soil types: sand & clay
- Three transects per each soil type
- Transect: terraced, cultivated, and forest hillslope

Installed equipment







Example of hillslope transect with the location of access tubes

Data collection

-Rainfall: raw (each 15 minutes), hourly, daily, weekly, monthly

-Spatial soil moisture content; measured by PR 2/6 SDI-12, (Since November 09, 2021, **dataset of 504,846 measurements**).

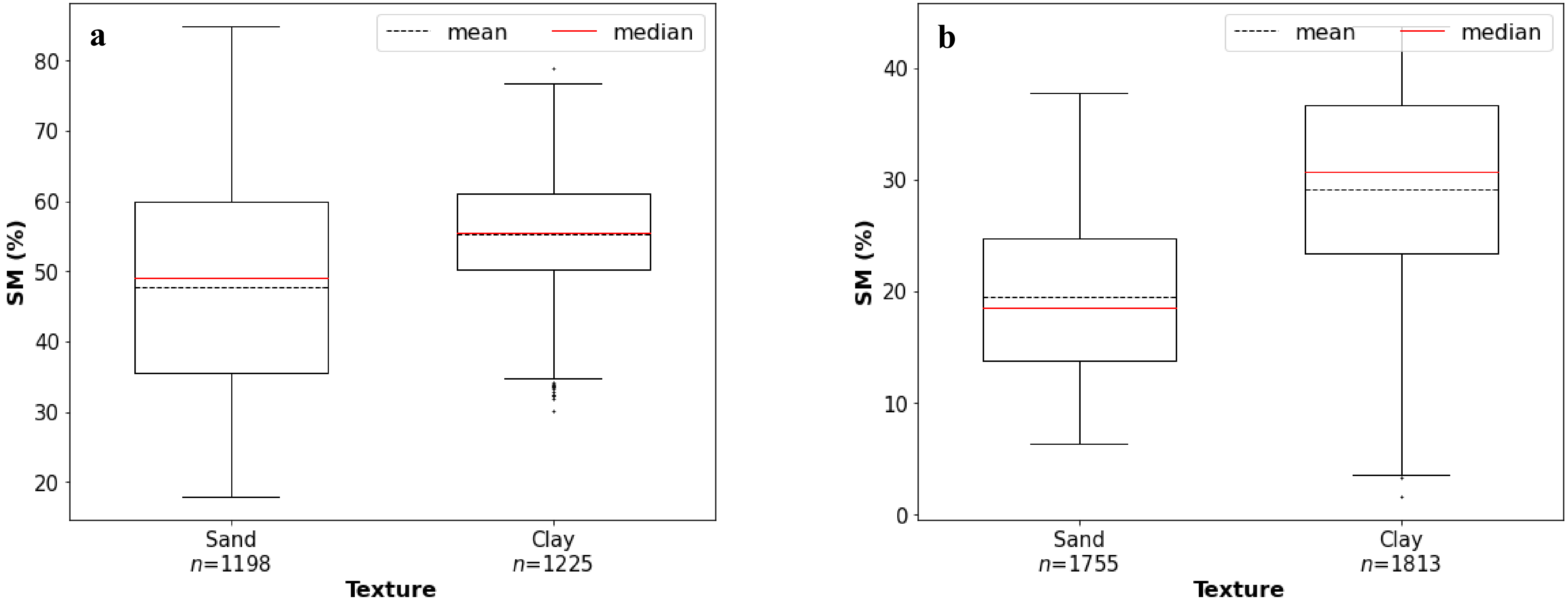
-Temporal soil moisture content; measured by Ech20 10SH sensors (25,920 measurements per day)

-Groundwater fluctuation; recorded by T-Divers and collected via computer (144 measurements per day)

Soil sampling for gravimetric analysis

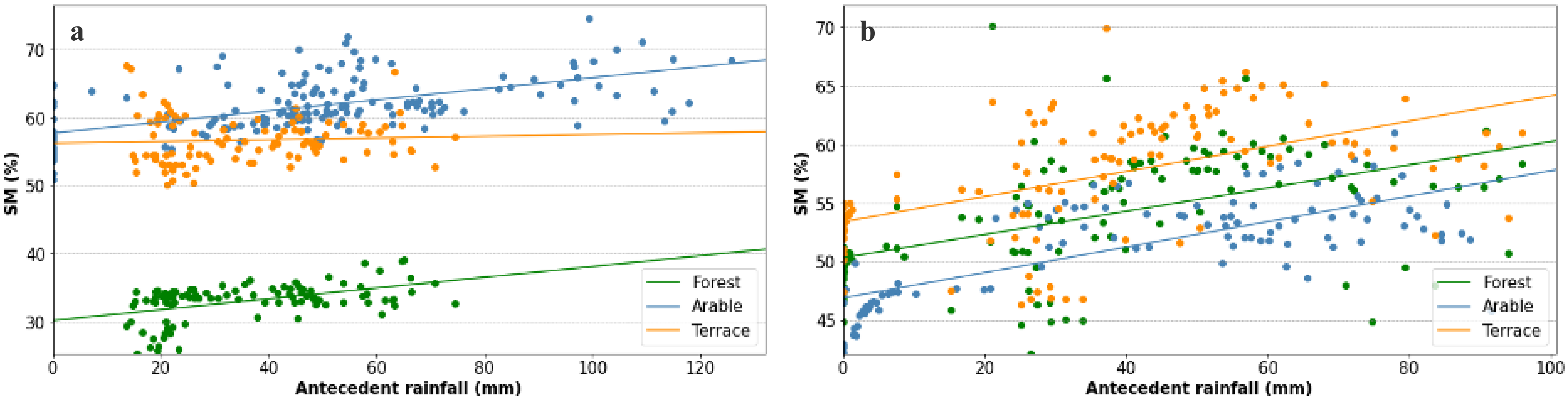
Field campaign for soil sampling for gravimetric analysis

Soil moisture vs soil texture (Pieter's results)



Boxplots of soil moisture distribution in sandy and clayey soil at different depths a) 100 cm and b) 60 cm

Soil moisture-adjusted antecedent rainfall



Relationship between soil moisture variation and antecedent rainfall in two contrasting soil types at 100 cm depth: a) sandy soil with time lag of 1 day, b) clayey soil with time lag of 4 days

NEXT

1-Recent compound event; it is foreseen to extend our analysis with satellite imagery and data from field work.

2-The outputs from chapters 1 and 2 will be used to produce a local-scale landslide susceptibility model and analyze how it can result in a better simulation and potentially better prediction of the spatio-temporal patterns of rainfall-triggered landslides.

3- To detail how the LULC and land management practices (and in particular their effect on soil water content) affect the occurrence and characteristics of landsliding.

Complementarity with other two PhD

1- With consideration of the effects of LULC and land management practices on landslide occurrence, the resilience measures could be set accordingly.

2- A landslide can cause:-sediment load: this decreases the hydraulic capacity of the drainage system;-denudation: this suddenly changes the runoff coefficient and can cause a flash flood.

3- Landslides remove the vegetation, hence change the runoff conditions that can cause flood in upstream of a certain hillslope, and this contributes to an increase of infiltration rate that results in an increase of pore water pressure predisposing the slope to failure.

Operational context

1-Data sharing is very important to valorize the relevant existing data and maximize disaster risk reduction management.

2- The model to be developed should serve as a tool in policymaking (especially for land use and land management strategies).

3-Community outreach: workshops and seminars would be organized with the aim of knowledge sharing and increasing awareness of the increase in hazards due to anthropogenic factors.

THANKS FOR YOUR ATTENTION!

ANY FEEDBACK IS WELCOME.

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