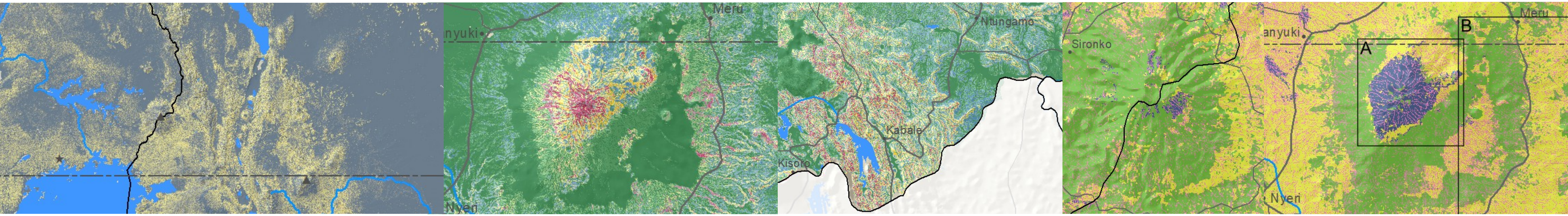
A systematic assessment of uncertainties in large scale soil loss estimation from different representations of USLE input factors

A case study for Kenya und Uganda



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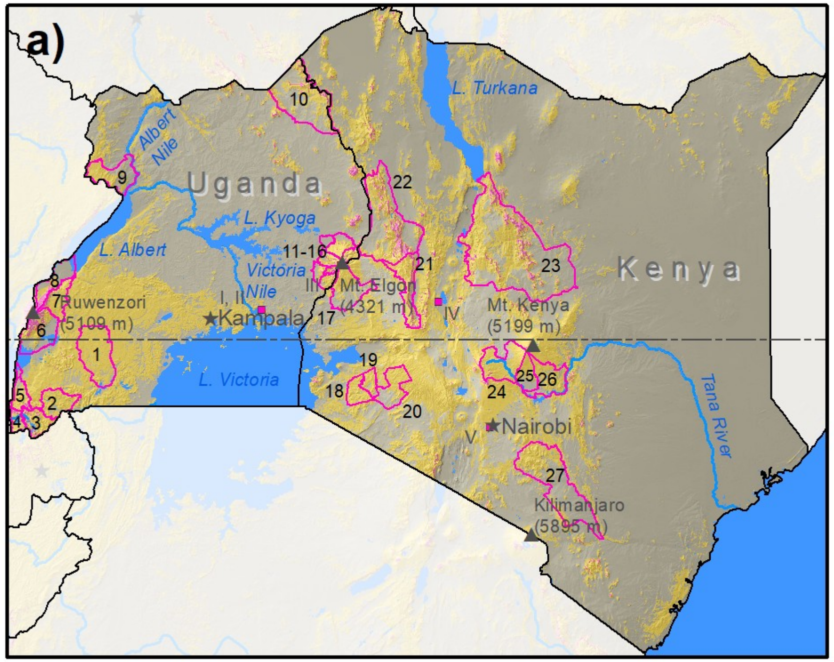
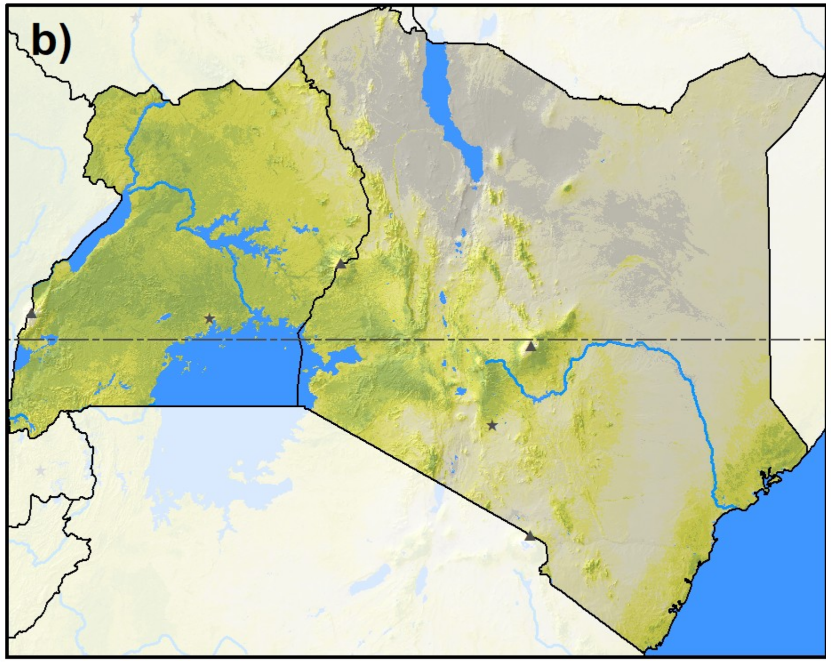
[3] Leibniz Institute of Freshwater Ecology and Inland Fisheries (IGB), Berlin, DE
[4] Institute of Natural Resource Conservation, Christian-Albrechts-Universität zu Kiel, DE

Kenia and Uganda - an overview

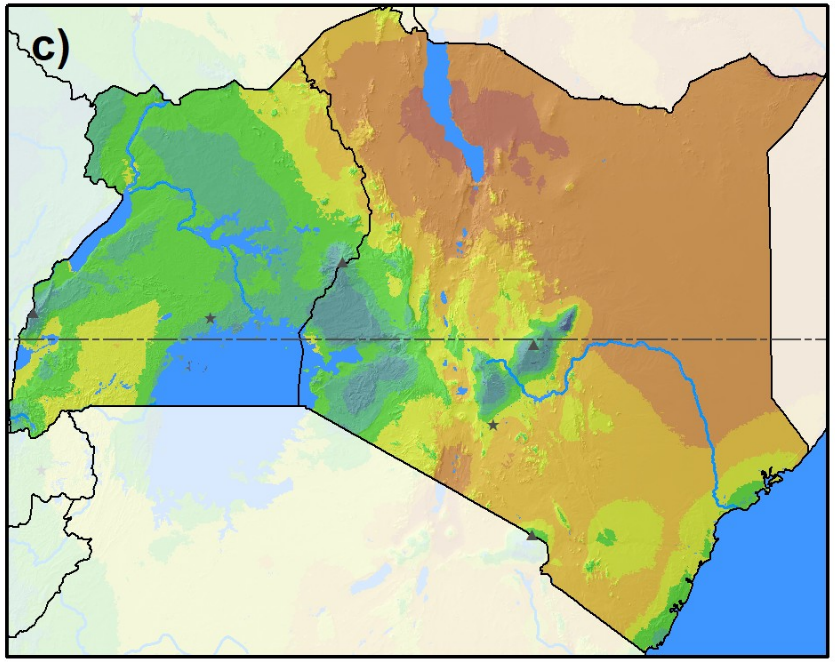
Erosion potential from topography



NDVI as a proxy for vegetation density



Mean annual rainfall



a) Erosion Risk from Topography

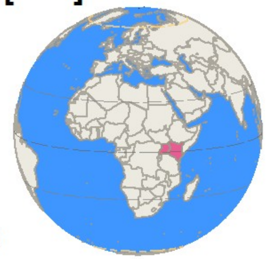
- Very gentle inclinations (< 3°) - first domain of sheet erosion
- Moderate to steep slopes (3° to 20°) - domains of active gully erosion & growth
- Very steep slopes (> 20°) - prone to mass movement, severe rain splash and sheet erosion

b) Mean Annual NDVI (2001-2018) [-]

0 - 0.2, 0.2 - 0.3, 0.3 - 0.4, 0.4 - 0.5, 0.5 - 0.6, 0.6 - 0.7, 0.7 - 0.9

c) Mean Annual Rainfall 1970-2000 [mm]

below 250	1 000.1 - 1 250
250.1 - 500	1 250.1 - 1 500
500.1 - 750	1 500.1 - 2 000
750.1 - 1 000	over 2 000.1

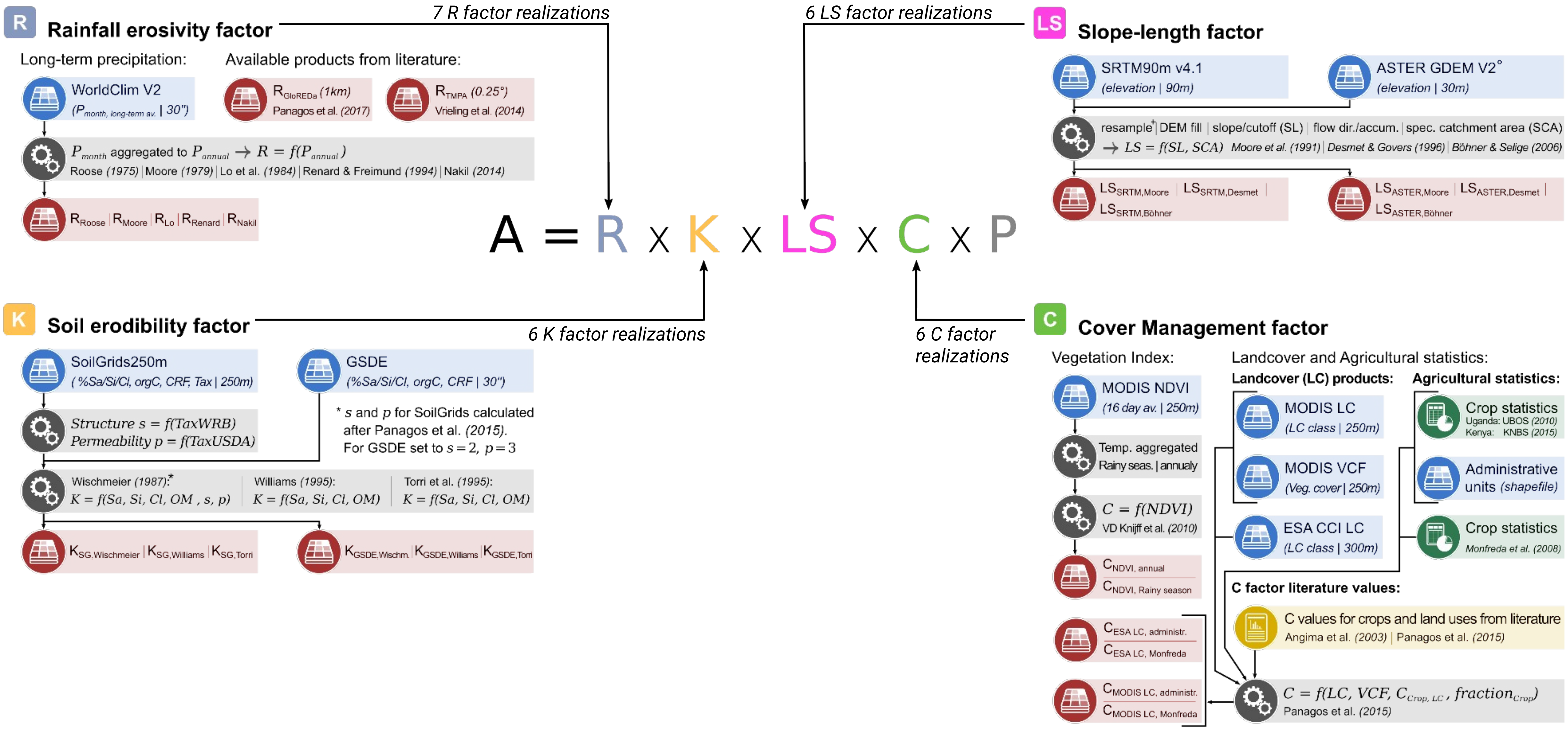


Data sources; SRTM 90m, MODIS MOD13Q1, MODIS Water Mask, WordClim Version 2, Natural Earth dataset

Study goals

- Quantification of uncertainties in soil loss estimation that result from the implementation of different realizations for USLE model inputs.
- Identification of the USLE model inputs that contribute the most to the uncertainties in the soil loss estimates.
- Comparability of soil loss estimates to in-field soil loss data.

Workflow I – Development of USLE input realizations

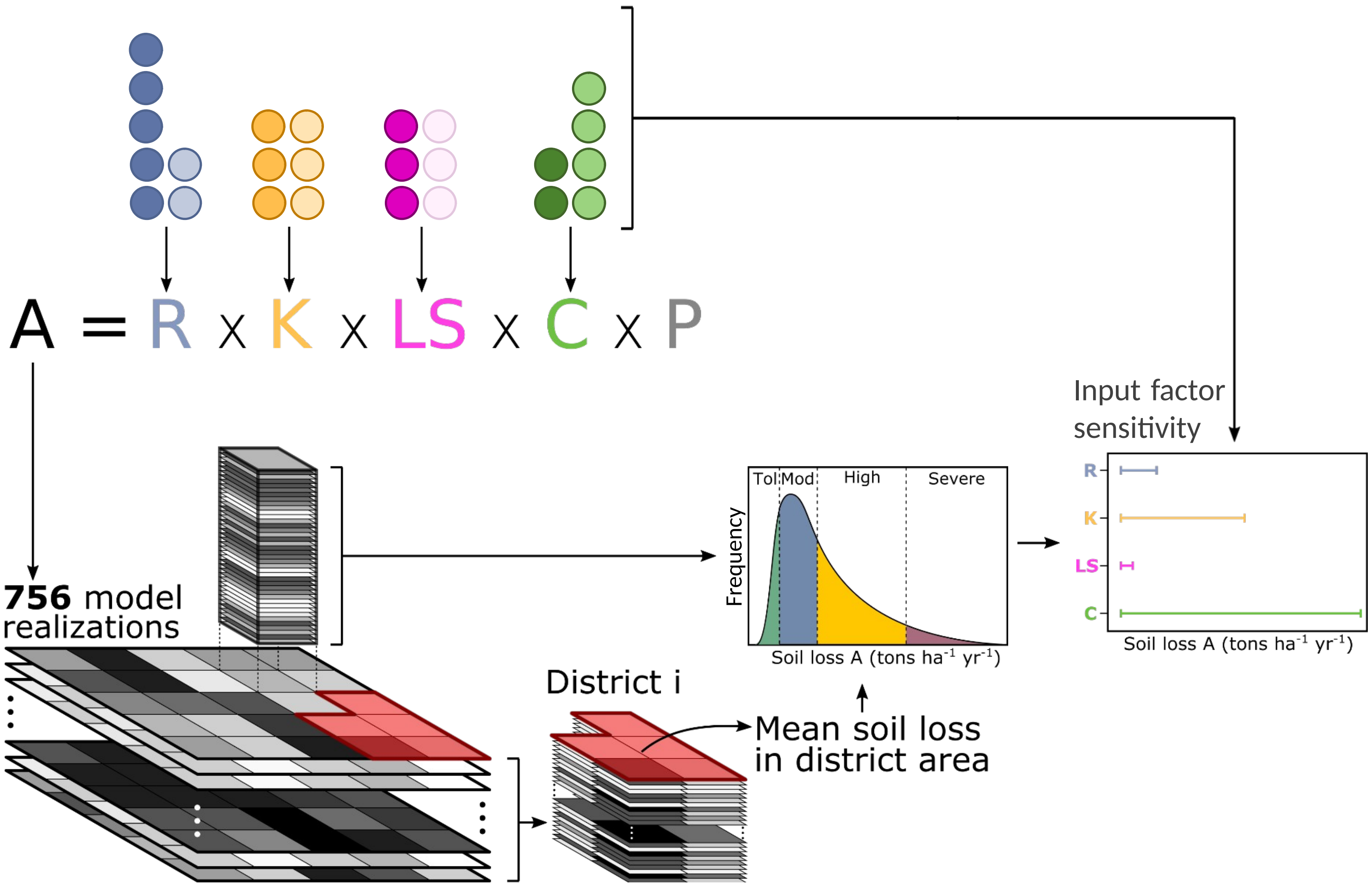


Workflow II – Soil loss estimation and analyses

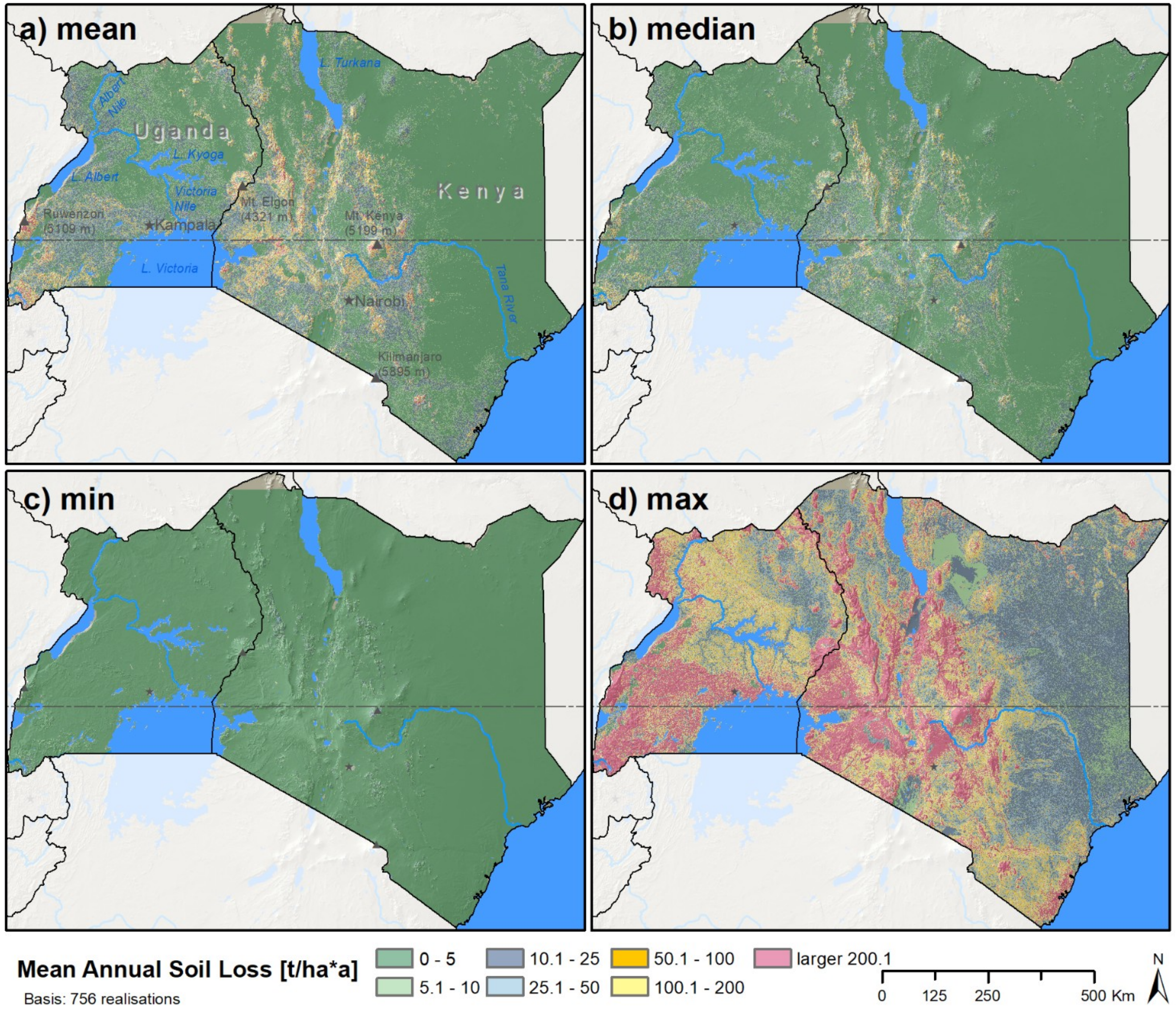
1. Schematic illustration of the USLE input factor realizations. Each dot represents one realization. The color groups them based on the used methods.

2. All input realizations are combined to USLE models and the soil loss is estimated for Uganda and Kenya spatially distributed on a 90m grid.

3. All 756 USLE combinations are analyzed in each grid cell and aggregated on administrative level.



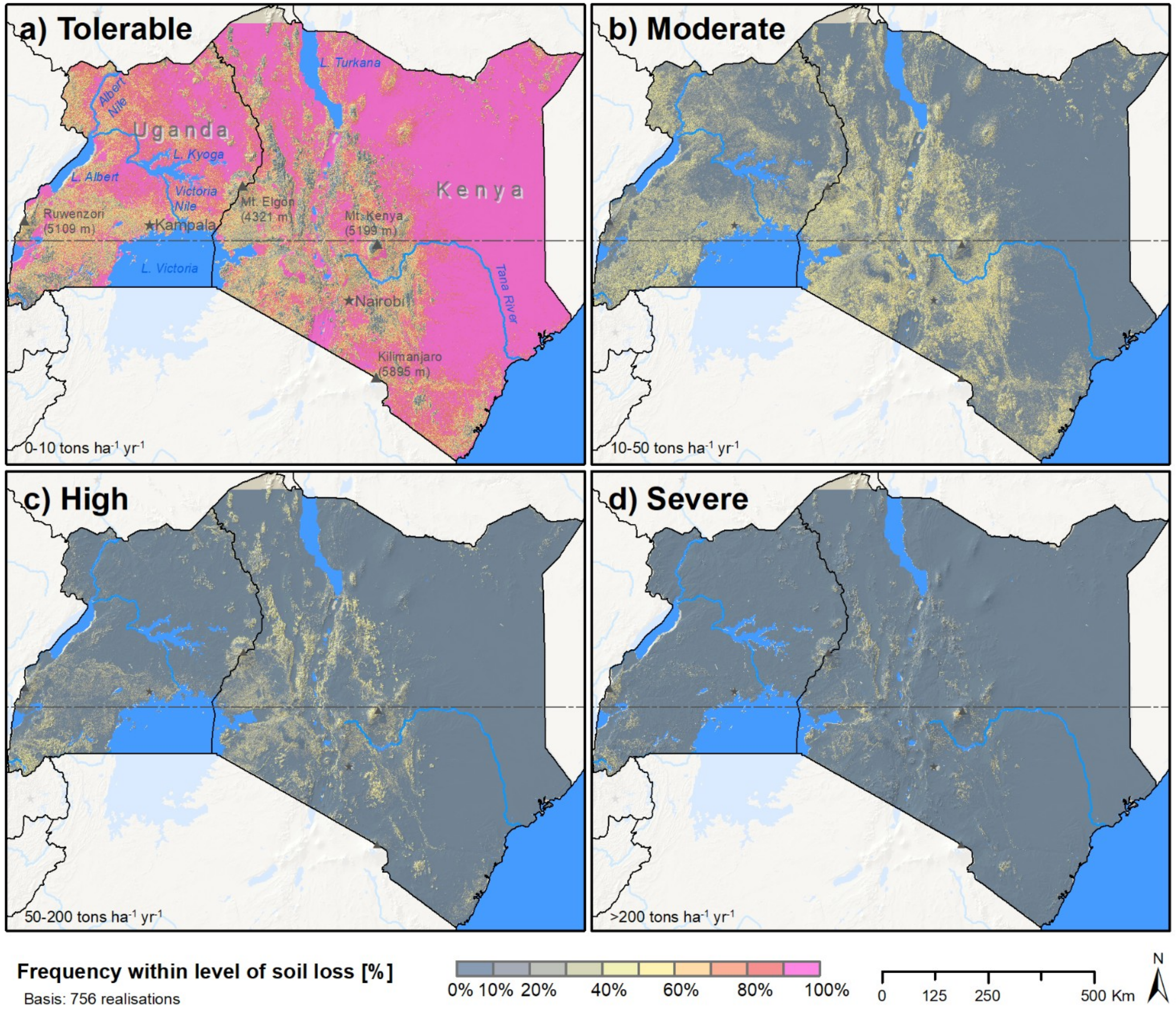
Statistical analysis of spatially distributed soil losses



> Model mean “plausible“

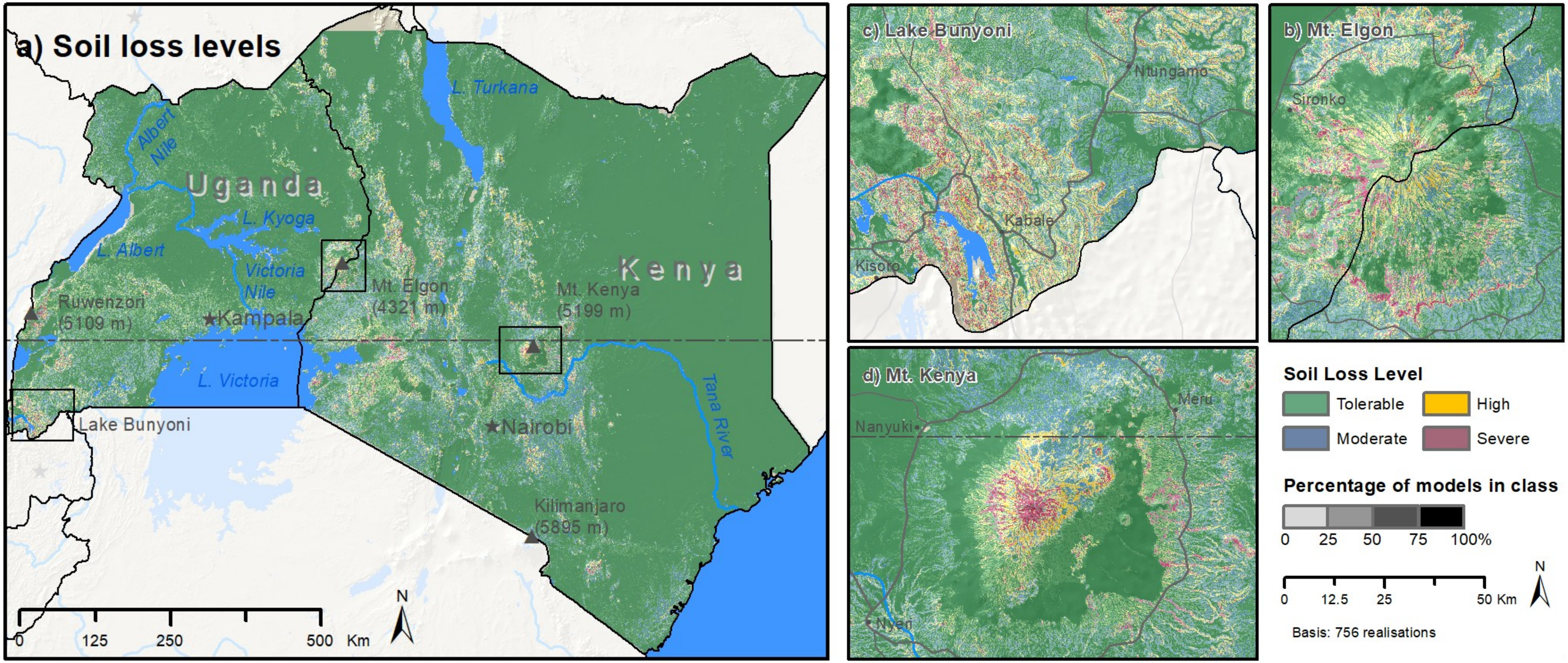
> Ranges in soil loss (uncertainty) exceed the model mean by up to one order of magnitude.

Soil loss classification: class frequencies in model ensemble



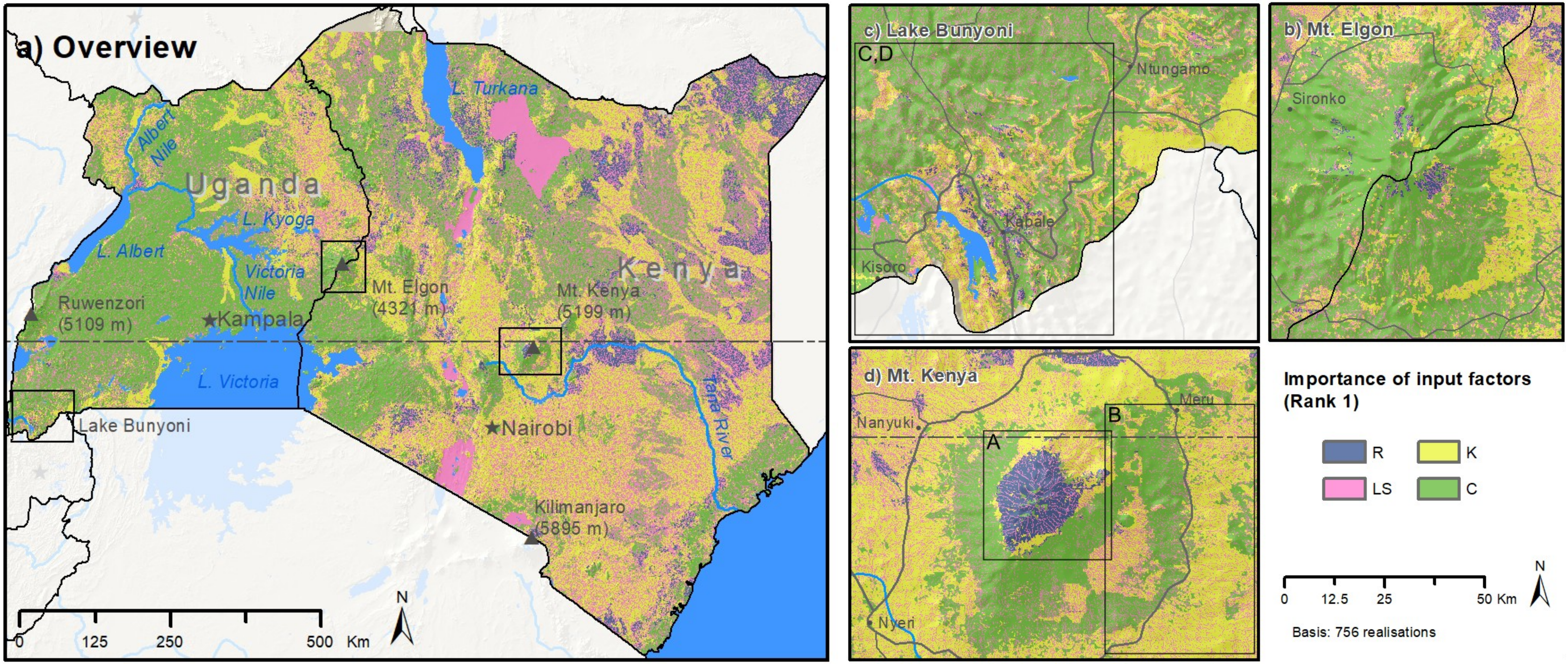
- Almost the entire model ensemble predicts a tolerable soil loss for a large part of study area.
- Steep and complex topographies show strong disagreement between the USLE model realizations.
- Very locally larger numbers of model realizations predict severe soil loss.

Spatial analysis of dominant soil loss classes



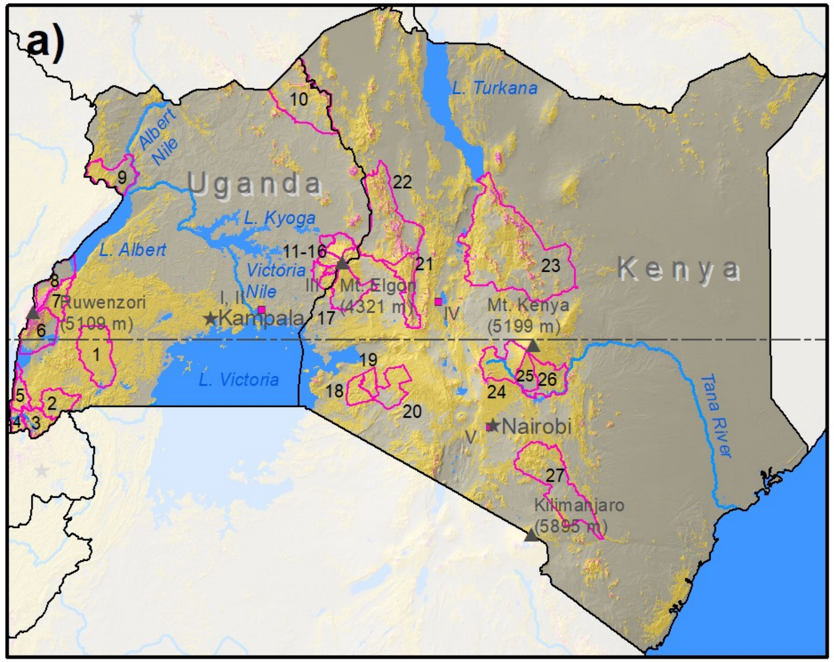
> Patterns of dominant soil loss classes follow the patterns of topography and vegetation.

Spatial analysis of the most influential USLE inputs



> Vegetation in humid and vegetated regions, and soils in dry regions show large patterns of greater importance.

Soil loss on the administrative level



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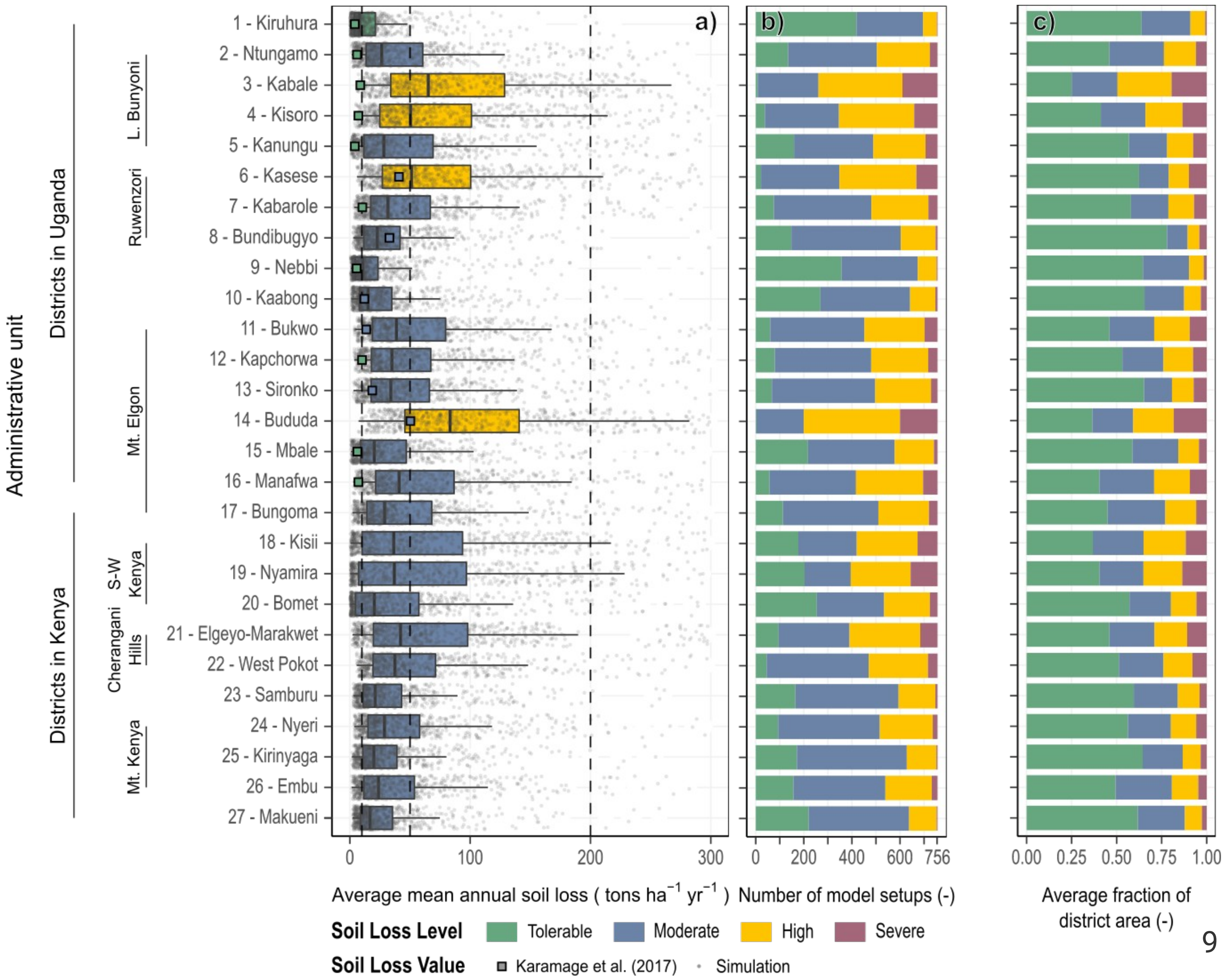
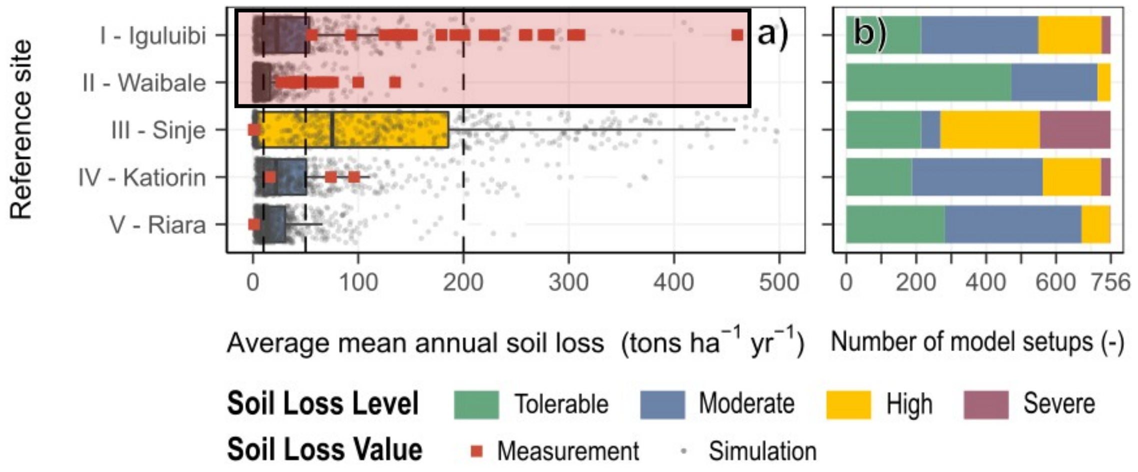


Comparison to in-field data – Farm compounds



- Small scale but long-term soil losses estimated by De Meyer et al. (2011) are substantially larger than model ensemble predictions.
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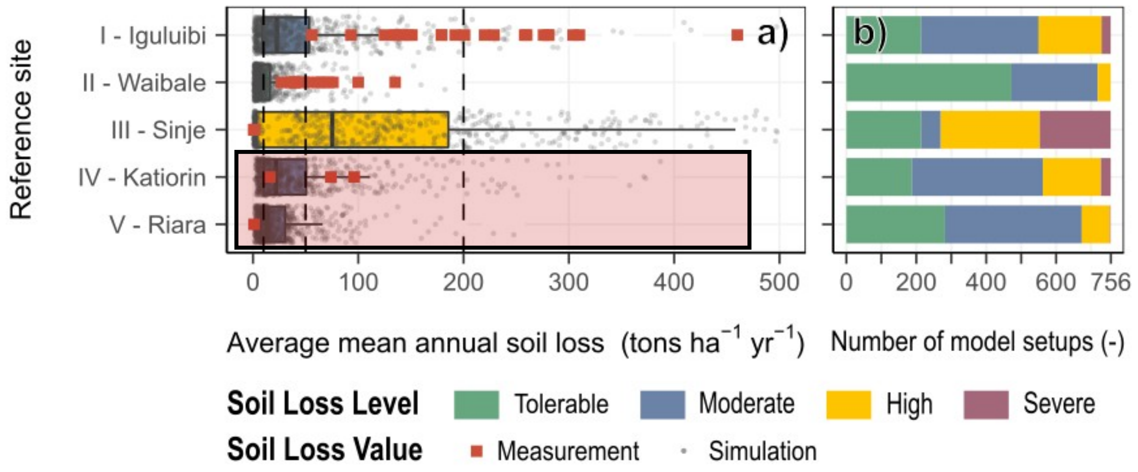
Comparison to in-field data – Sediment yields from catchments



- Small scale but long-term soil losses estimated by De Meyer et al. (2011) are substantially larger than model ensemble predictions.

- Short-term sediment yield records are lower or in a comparable range to the model ensemble.

Summary and conclusions

> The estimation of soil loss with the USLE involves large uncertainties that result from the selected methods to calculate the USLE inputs.

> Steeper and more complex topographies, sparsely vegetated areas show an increased soil loss, but also substantially larger uncertainties.

> Uncertainties in the C and K factors are relevant on larger scales. The uncertainties introduced by the LS factor shows very small scale patterns.

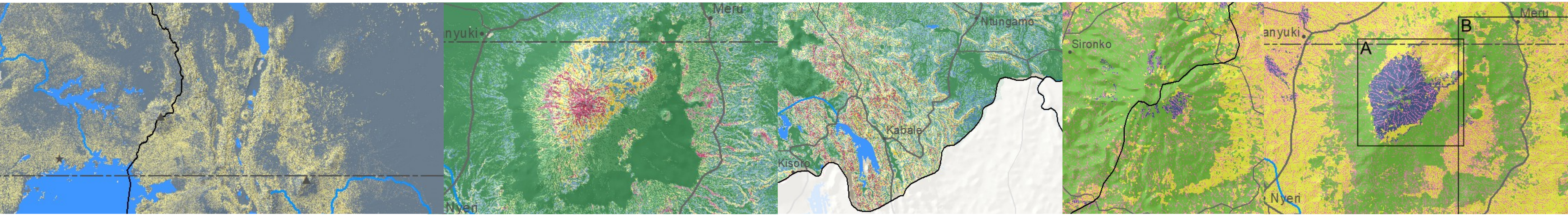
> A comparison to single model analyses illustrates the relevance of a comprehensive uncertainty analysis with a USLE ensemble.

> A comparison of soil loss estimates to in-field data is limited, due to temporal and spatial constraints, but also due to differences in the measured entities.

Further Questions?

This presentation summarizes results that are presented in the manuscript:

Schürz, C., B. Mehdi, J. Kiesel, K. Schulz, and M. Herrnegger (in review, 2019) *A systematic assessment of uncertainties in large scale soil loss estimation from different representations of USLE input factors - A case study for Kenya and Uganda*, In: Hydrol. Earth Syst. Sci. Discuss., doi: 10.5194/hess-2019-602



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