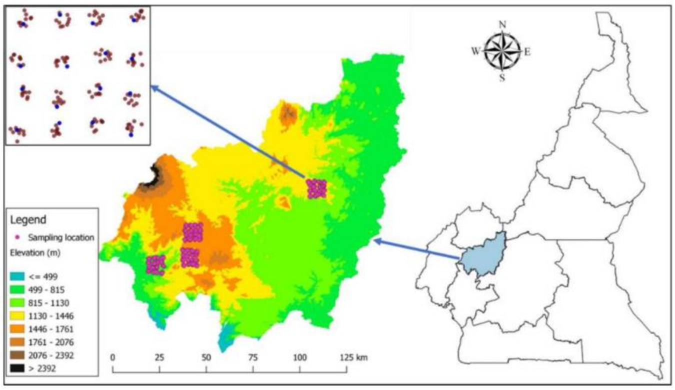
UNCERTAINTY AND SPATIAL SUPPORT



As explained in the lecture, a change of the spatial support has an impact on the uncertainty about model outputs. Aggregating the outputs to larger spatial units implies that within-unit variability will partly cancel out. The extent of this cancelling out depends on the spatial correlation of the model inputs.

In this practical, we assess the effect of spatial aggregation on predicted nutrient-limited maize yields at the original plot support, at aggregated administrative unit (division) support and at a further aggregated regional support. The predictions are obtained by running the QUEFTS model (Janssen et al., 1990) on simulated soil nutrient levels that are conditioned on sample data collected over the study area. QUEFTS is a rule-based model that takes into account individual nutrient levels as well as interactions between soil nutrients to constrain water-limited yields to levels under suboptimal nutrient supply. Uncertainty about the (spatially correlated) soil nutrient levels inputs thus propagates to the yield predictions. In today's practical, soil organic carbon is taken as a proxy for soil nitrogen.

The simulated soil data set has already been prepared for you; if you are interested in how this was done you can study the contents of the file `Preparation_soil_property_realisations.zip`. There is no need to run the contents of that file, though.

Script & input data

The R script and input data are provided in the zip file `SupportFriday.zip` on MS Teams. The data originate from a paper by Takoutsing et al. (2025). The study area is located in the Western Highlands of Cameroon. The zip file contains the following files:

`Friday_support2024.R`	The main R script
`QUEFTS_functions.R`	An implementation of the QUEFTS model, which is called by the main script.
`df_realisations_soil_prop.Rda`	100 simulated realizations of soil P, K, pH and SOC, conditioned on sample data.
`crop_parameters.csv`	Crop parameters used by the QUEFTS model
`The folder divisions`	Contains shape files with the geometry of the administrative units within the study area.
`Preparation_soil_property_realisations.zip`	Script and data for geostatistical simulation to prepare the soil data used in this practical. This file is supplied should you want to study how the data were prepared. You don't have to run the script.

Download (and extract) the files and the folder to a folder with a convenient name on your local drive.

Setting up running QUEFTS on the original plot data

Point to the correct folder on line 28 and study and run the first 175 lines of the script `Friday_support2024.R`. There should be no error messages and you should be able to plot the maize yield simulated with the first realization of the soil data.

Next, run the script up to line 234. Try to get a basic understanding of the logic. Running QUEFTS on the 100 realizations of soil properties will take a couple of minutes.

Spatial aggregation

Step by step run the remainder of the script to compute spatial means and uncertainty metrics at different levels of spatial aggregation.

Q1 *Would it also be possible to first average the model inputs over all realizations and then run QUEFTS on the spatial means of the inputs? In other words, would the results be different when calculating first and averaging later compared to averaging first and calculating later? Why?*

Q2 *What is the likely cause of spatial patterns in the standard deviations of maize yield at plot level? Where is the yield uncertainty greatest?*

Q3 *How can the pattern of the standard deviations of maize yield at the level of administrative divisions be explained?*

Q4 *Are the yield uncertainties everywhere reduced upon aggregation? Why?*

References

Janssen, B.H., Guiking, F.C.T. , van der Eijk, D., Smaling, E.M.A., Wolf J., van Reuler. H., 1990. A system for quantitative evaluation of the fertility of tropical soils (QUEFTS). Geoderma 46: 299-318. https://doi.org/10.1016/0016-7061(90)90021-Z

Takoutsing, B., Heuvelink, G.B.M., Aynekulu, E., Shepherd, K.D., 2025. Modelling and mapping maize yields and making fertilizer recommendations with uncertain soil information. Precision Agriculture 26, 5. https://doi.org/10.1007/s11119-024-10200-6