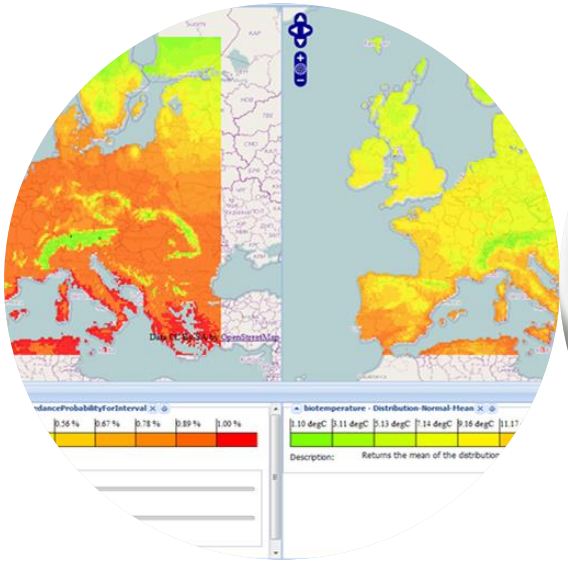
‘spup’ – an R package for uncertainty propagation in spatial environmental modelling

Kasia Sawicka and Gerard B.M. Heuvelink



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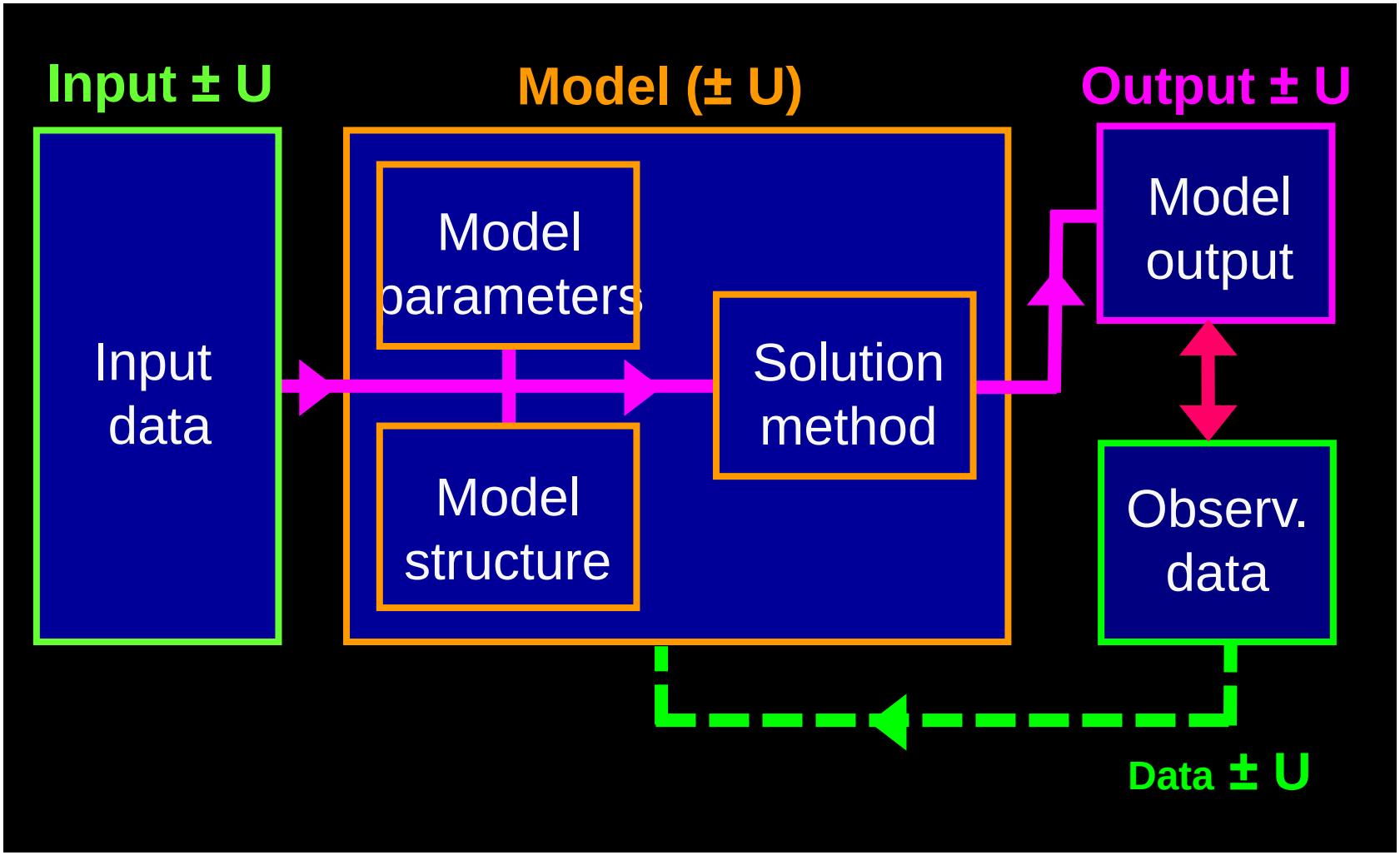
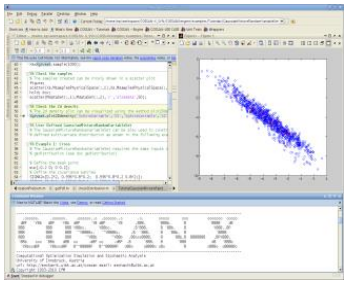
Uncertainty propagation overview



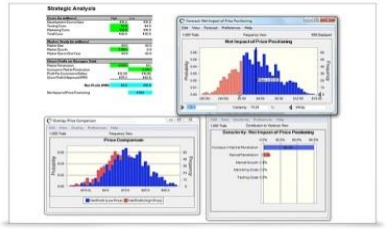
Motivation

@RISK

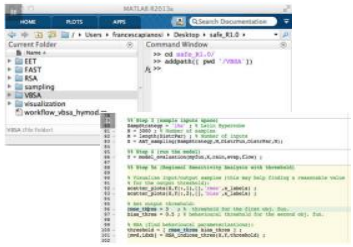
COSSAN



Crystall Ball



SAFE



UQLab

UNCSIM

UNCSAM

UCODE

TIME

OpenTURNS

OSTRICH

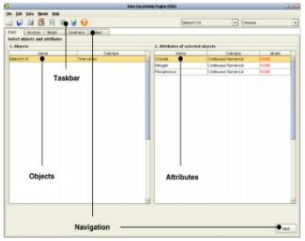
PEST

PSUADE

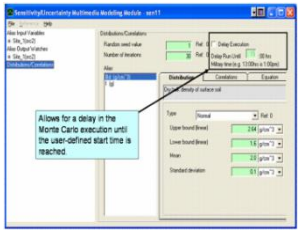
SimLAB

DAKOTA

DUE



FRAMES

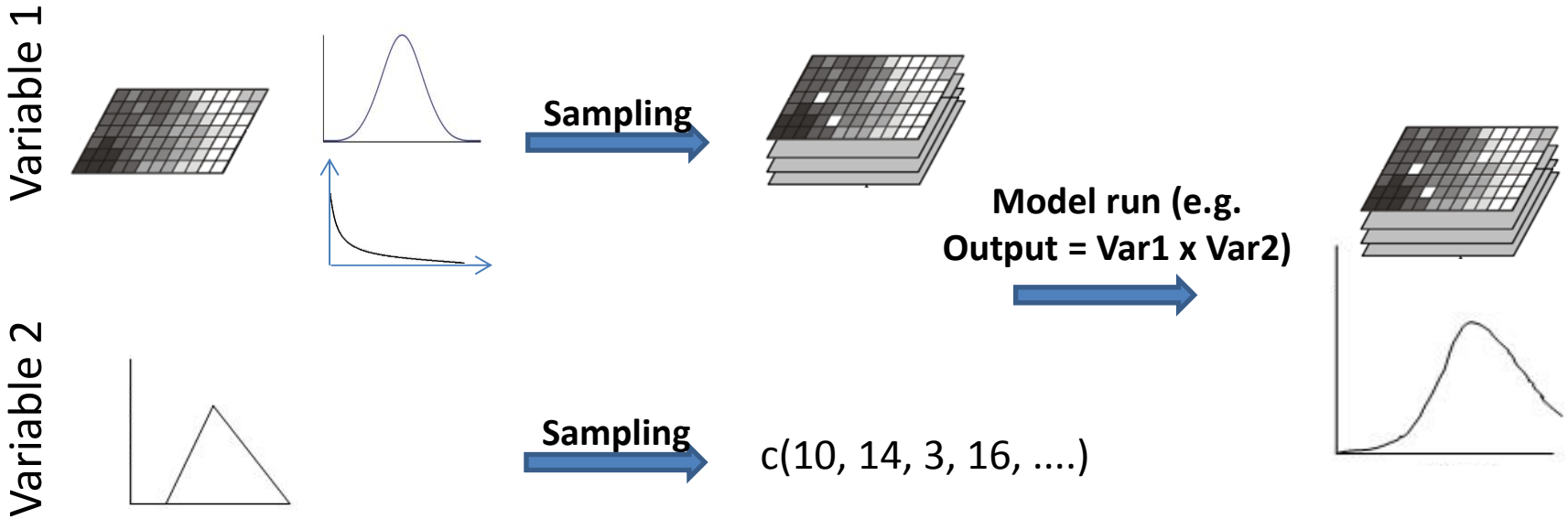


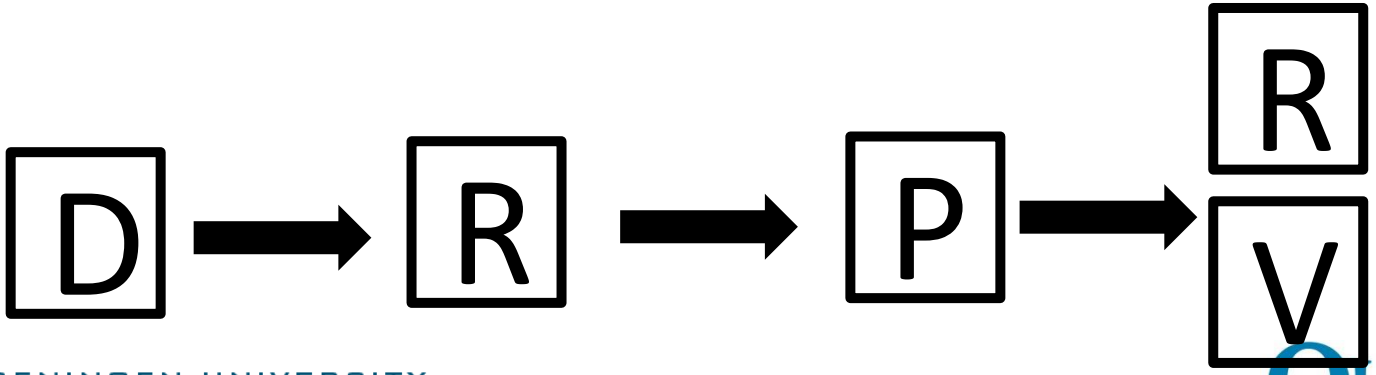
R packages:

- propagate
- FME
- mcmcse
- ArArRedux
- betaper
- UncerIn2
- usdm
- sensitivity
- and others...

Underlying methodology

Monte Carlo approach principle





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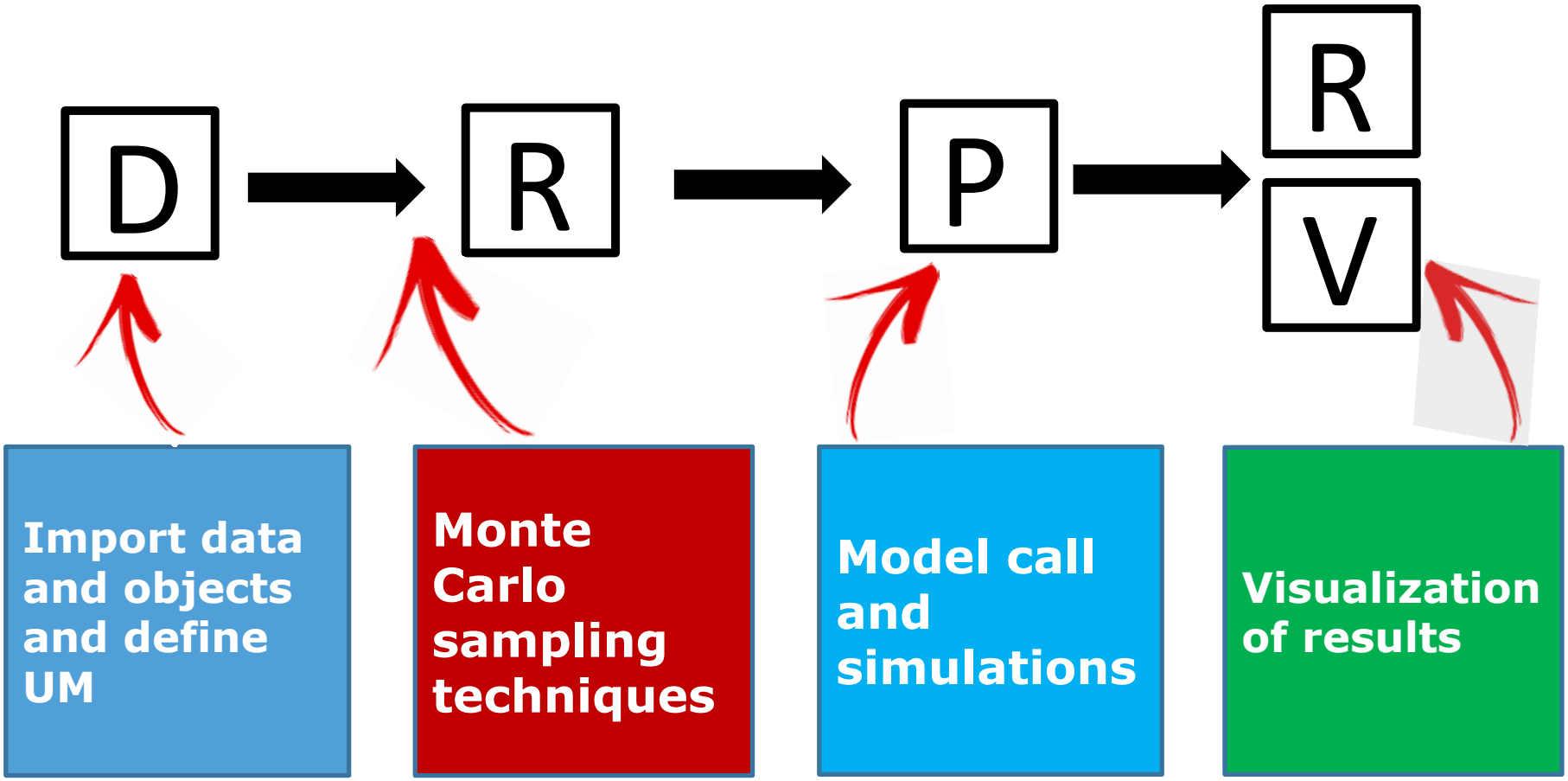
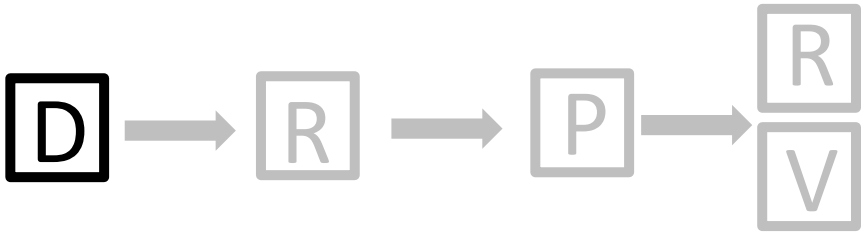
‘spup’ – spatial uncertainty propagation analysis

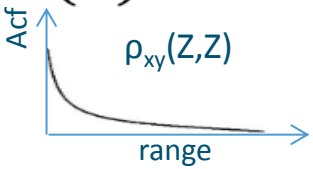


Defining uncertainty model (UM)



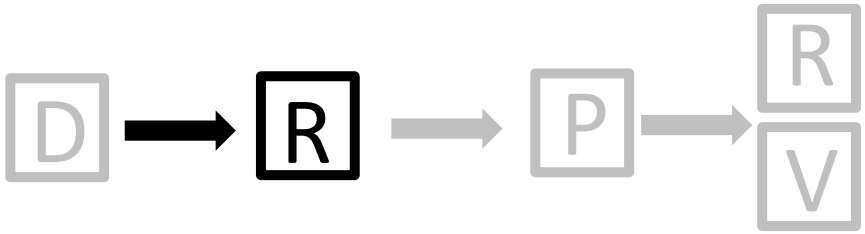
Import data and objects and define UM

$$Z(x) = \mu(x) + \sigma(x) \cdot \varepsilon(x)$$




```
> my_uncert_inp <- defineUM(uncertain = TRUE,
                            mean = raster_of_mean,
                            sd = raster_of_sd,
                            crm = my_crm)
```

Monte Carlo sampling

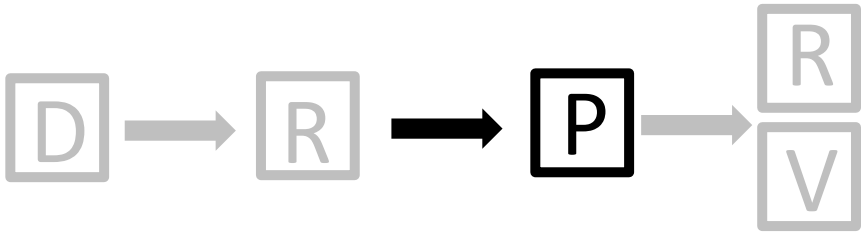


Monte Carlo sampling techniques

- Simple random sampling ("srs")
- Stratified sampling ("strats")
- Latin hypercube sampling ("lhs")

```
> my_sample <- genSample(uncert.object = my_uncert_inp,
                         n = 10000,
                         samplemethod = "srs")
```

Propagation through the model



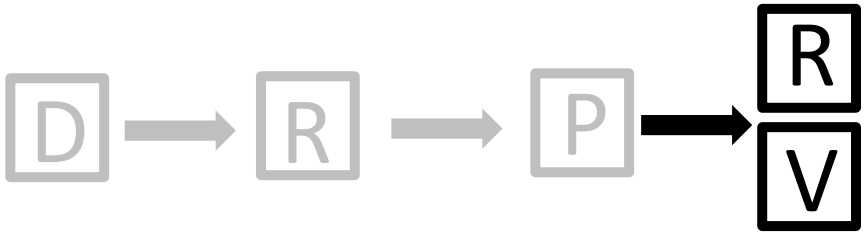
Model call and simulations

Model must be written as a function in R

```
> my_model <- function(input, ...) {
                    . . .
                  }

> my_uncert_output <- propagate(input = my_sample,
                                model = my_model,
                                n = 10000,
                                parallel = TRUE)
```

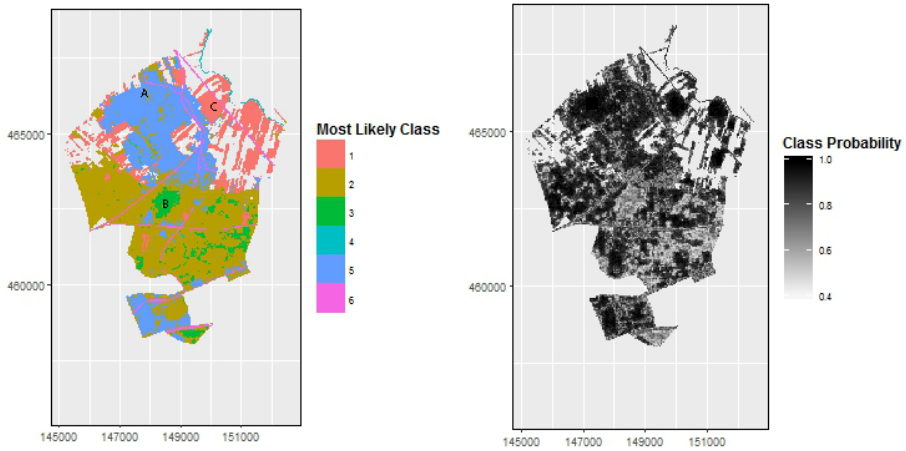
Visualization of the results (1)



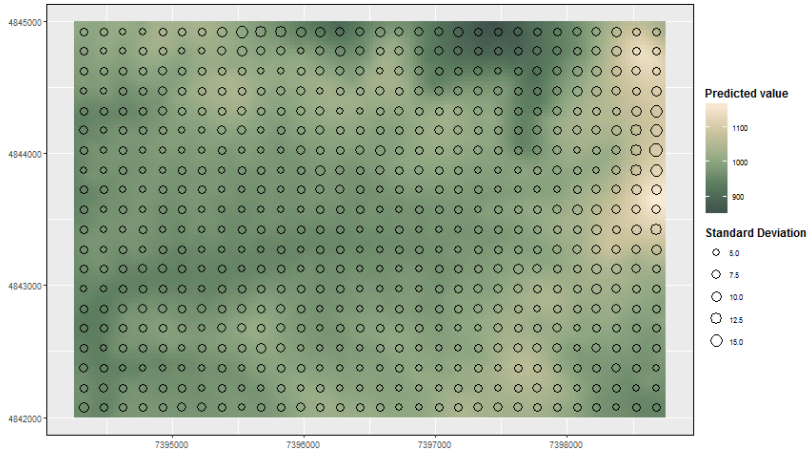
Visualiz. of results

Static methods:

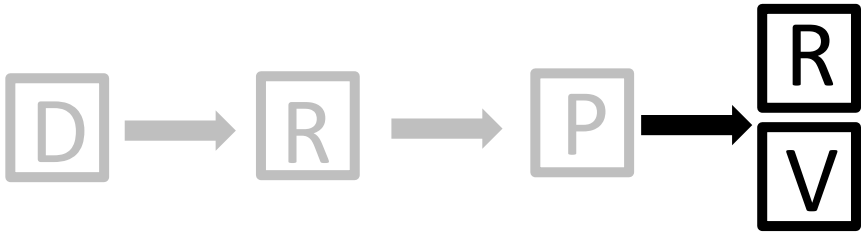
Adjacent maps



Glyphs

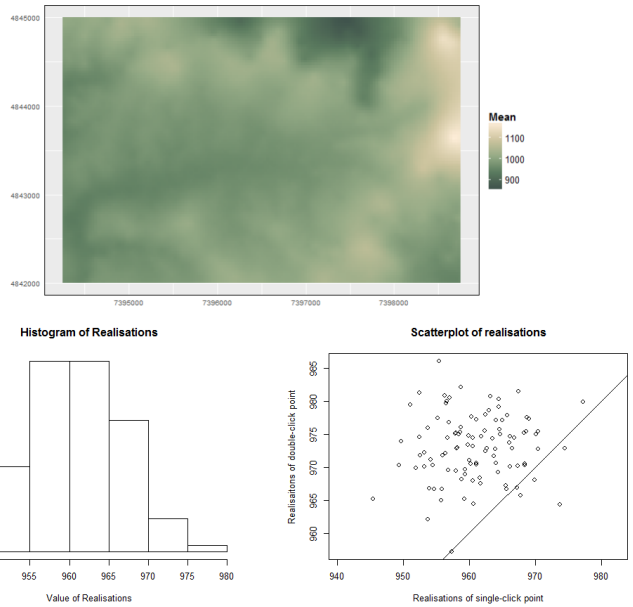


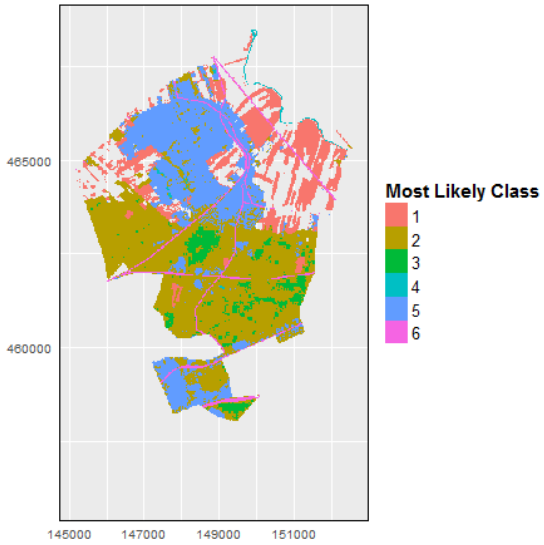
Visualization of the results (2)

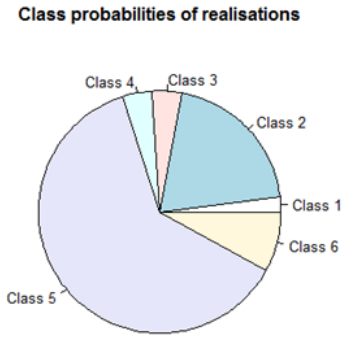


Visualiz. of results

Interactive methods:

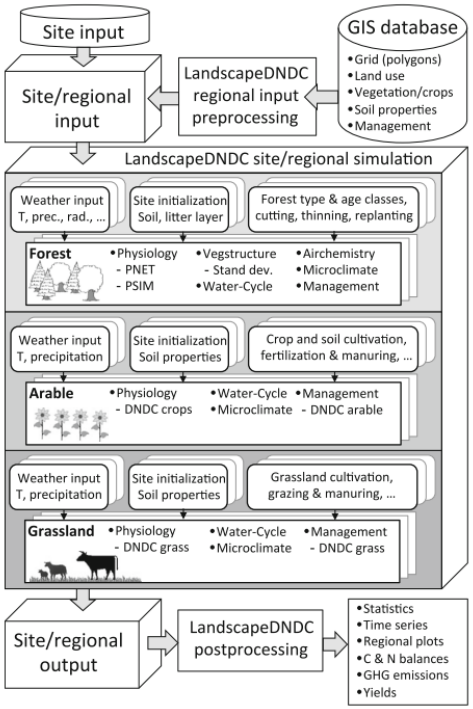






Planned applications

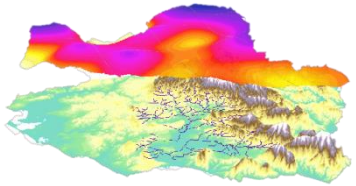
Uncertainty propagation analysis with process-based model LandscapeDNDC



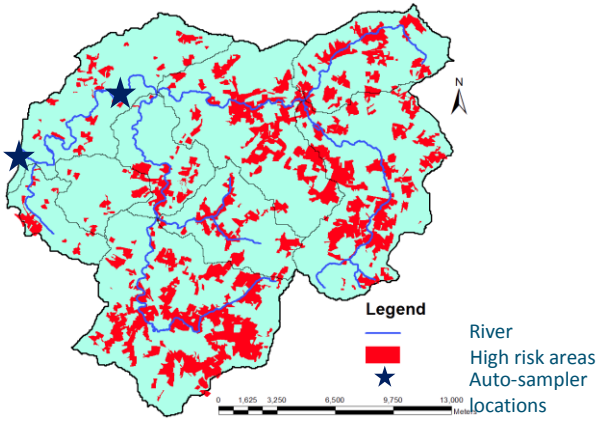
Haas et. al. (2013)

Uncertainty propagation analysis with Metaldehyde Prediction Model

Radar rainfall data



Risk map



Acknowledgments

Da

Ste

Syt

Dennis Walvoord

QU

EU

https://github.com/

ksawicka

‘spup’ repository