Identification of low water discharge for ungauged locations in Thuringia

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Wir digitalisieren, modellieren und visualisieren Wassersysteme.

01.

Introduction

Introduction

- Natural low-water situations → periods of increased physiological stress of water biocenosis
- additionally anthropogenic influences → the ecological functionality can be severely impaired
- in order not to increase low water situations, it is necessary to know the natural low water flows in rivers
- this information is strictly only known for observed gauges,
- With several methods transfer these low flow values to other areas

Introduction

- The term "regionalization" summarizes a few methods, which transfer point information (e.g. gauge information) to other not observed locations.
- The DHI WASY GmbH was commissioned by the Thuringian State Institute for the Environment and Geology (TLUG) to regionalize mean low flow discharges for Thuringia.
- Methode:
  - multiple linear regression between discharge and different catchment area parameters
  - regional analysis and compensation of the residuals of multiple linear regression with top kriging

Introduction

- Major milestones in the processing are the
  - identification of catchment area parameters,
  - determination of quasi-homogeneous runoff regions,
  - the application of the regionalization procedures and
  - the plausibility check of the results.

- Result,
  - average low water discharges for the year (MNq_{Year}), the summer period (MNq_{Summer}) and winter period (MNq_{Winter}) are available for defined river profiles, for selected weir sites and hydraulic structures on largely uninfluenced waters.

02.

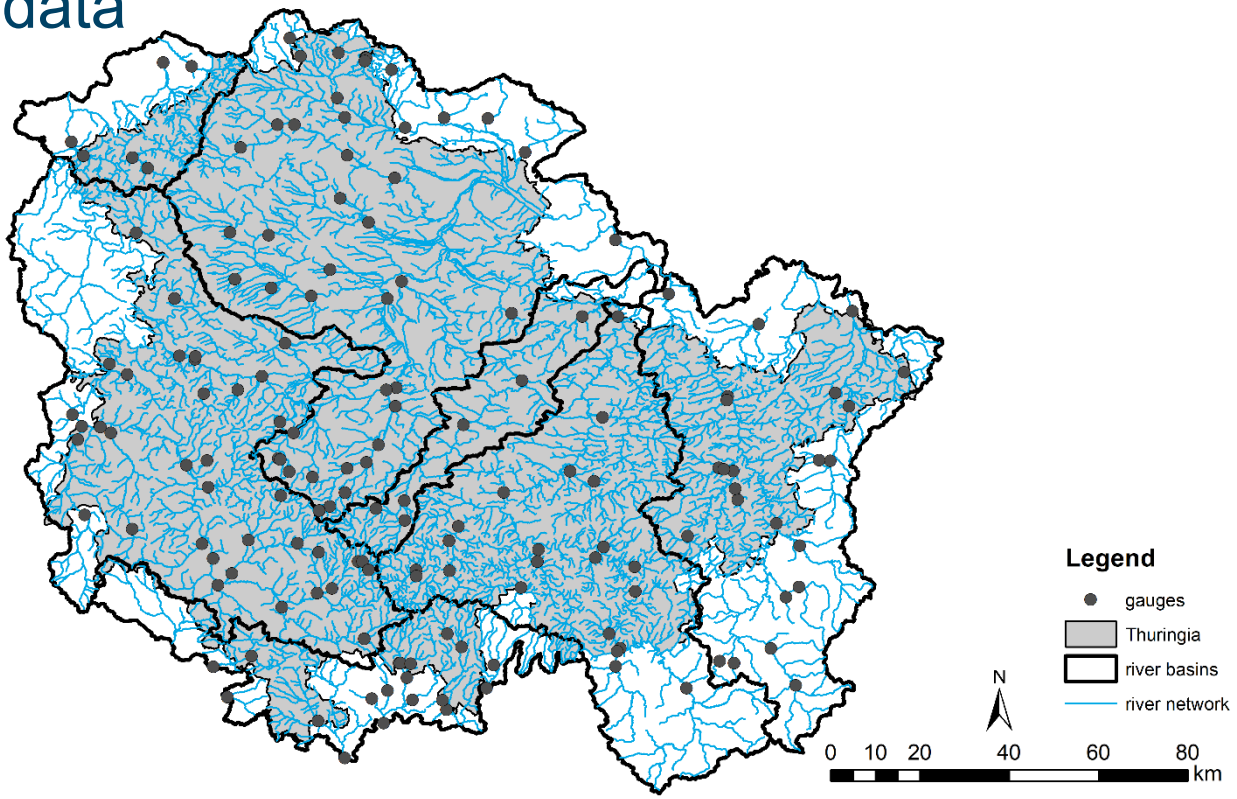
Data base

Data base

- regionalization method: multiple linear regression
  - gauge data
  - area parameters

Data base – gauge data

- Gauge data are required
- 160 gauges with average low flow discharge
- 121 gauges from Thuringia
- 39 gauges from neighboring states



Data base – Geodata → area parameters

- Catchment area size [km²]
- Form factor [km^{-1}]
- Ground level [m NHN]
- Average ground slope [°]
- Proportion of forest [%]
- Proportion of field and grassland [%]
- Usable field capacity [mm]
- Hydraulic conductivity [m/s]
- Groundwater recharge [mm]
- Avg. Precipitation (full year, summer half-year, winter half-year) [mm]
- Avg. Temperature (full year, summer half-year, winter half-year) [°C]
- Avg. Evaporation deficit (full year, summer half-year, winter half-year) [mm]

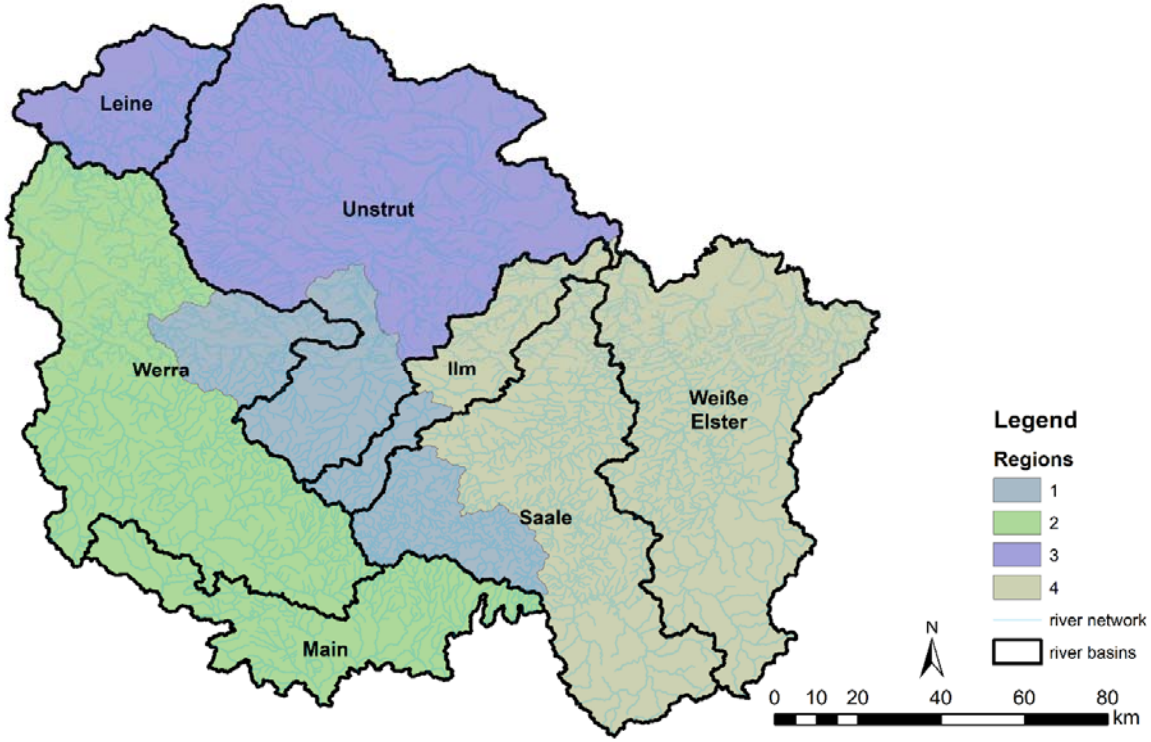
03.

Application of regionalization procedures

Application of regionalization procedures

Homogeneous regions of low water discharge

- Seasonality statistics
- Residual Pattern Method



Application of regionalization procedures

Multiple linear regression for each region

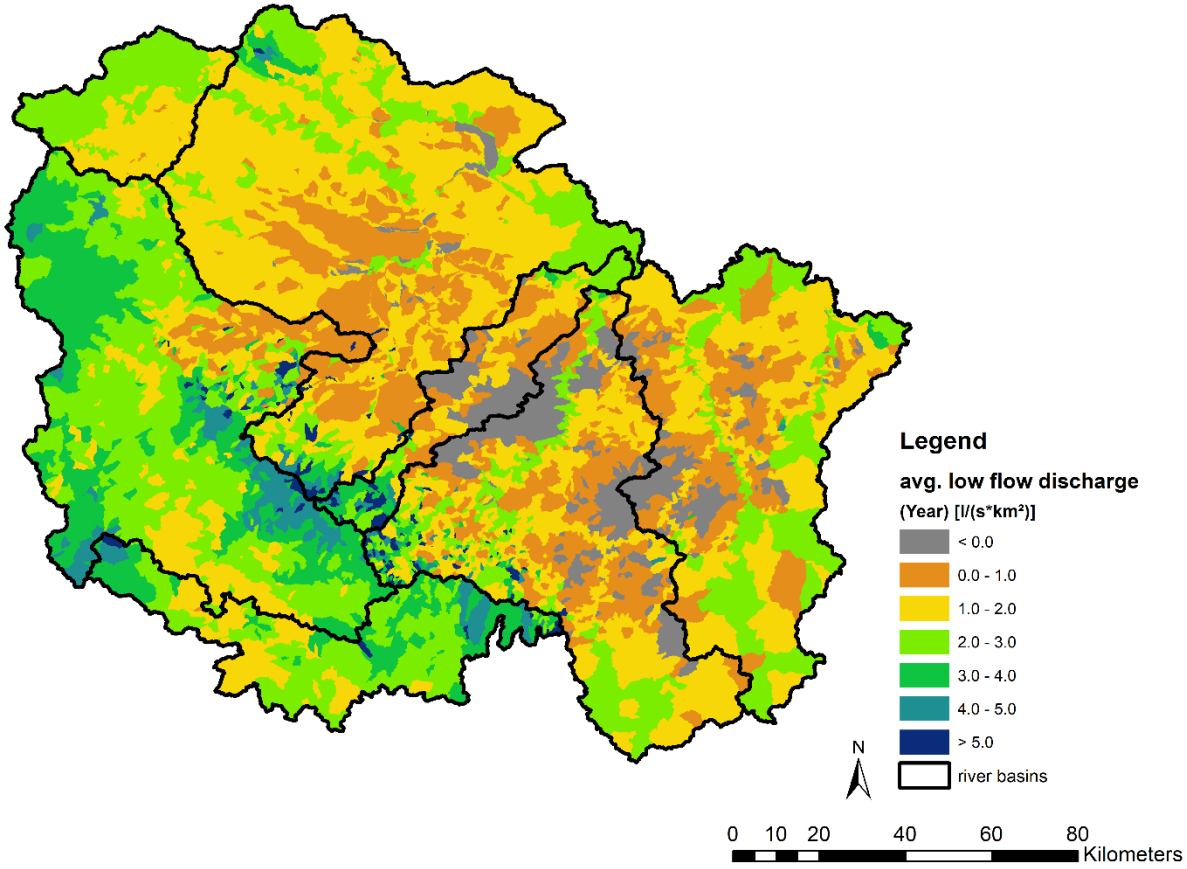
- The multiple linear regression establishes a relationship between a considered target variable (e.g. discharge) and a number of area parameters.
- Assumption: With the regression models you can also be determined the discharge for not observed locations whose area parameters are known.

$$Y = a_o + a_1 * X_1 + a_2 * X_2 + ... + a_n * X_n$$

Y	independent variable (e.g. avg. Low flow discharge)
$X_1 \ldots X_n$	independent explanatory variables (area characteristics)
$a_1 \ldots a_n$	regression coefficient
a_o	regression constant

Application of regionalization procedures

Multiple linear regression



Application of regionalization procedures

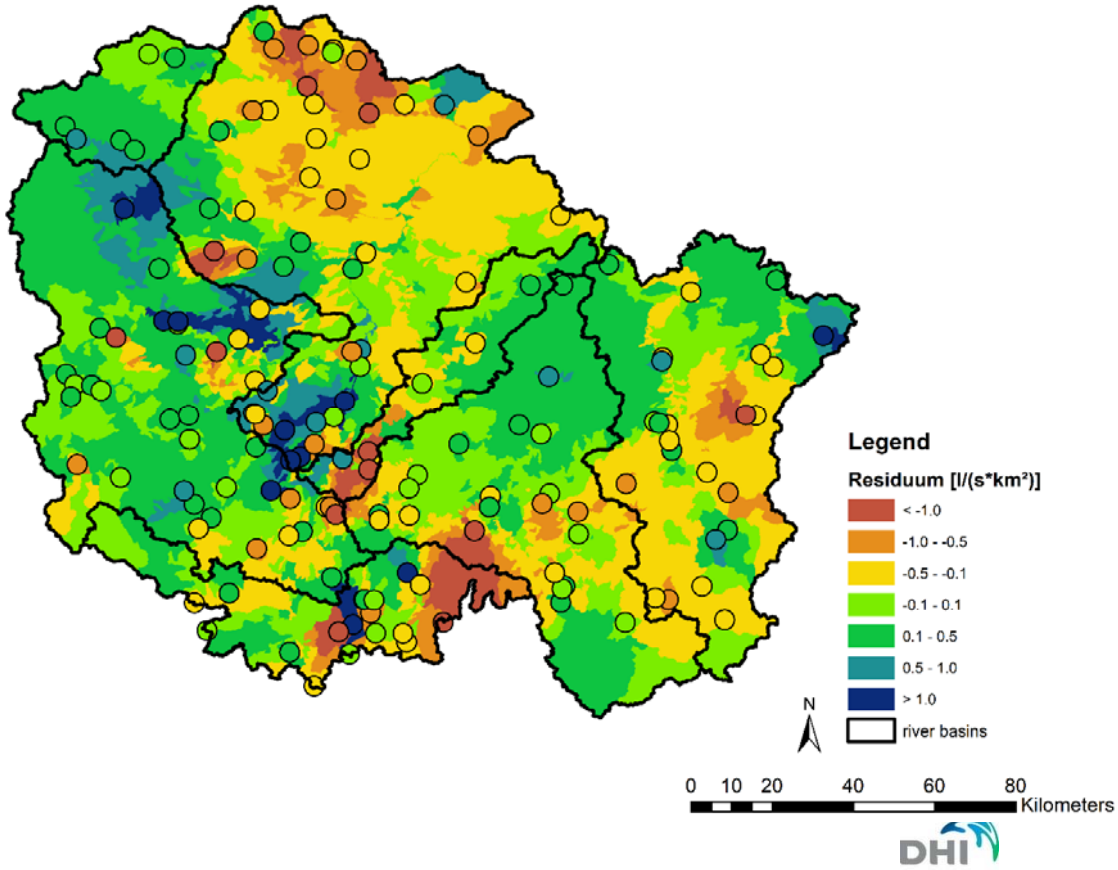
Top Kriging

- Top Kriging belongs to the group of geostatistical methods
- neighboring areas show a similar flow behavior,
- Geostatistical methods are used for the spatial interpolation of many hydrological variables (e. g. groundwater levels, soil moisture, precipitation)
- current investigations: transferring the residuals to unobserved areas
- residuals are the difference between the calculated and observed avg. low flow discharge

Application of regionalization procedures

Top Kriging - Residuen

- residuals summed up to the low flow discharge
- The result: the gauge basins areas reflect the observed low flow discharge values
- Possible over- or under-estimates of low flow discharge can be compensated



Application of regionalization procedures

Plausibility of low flow discharge

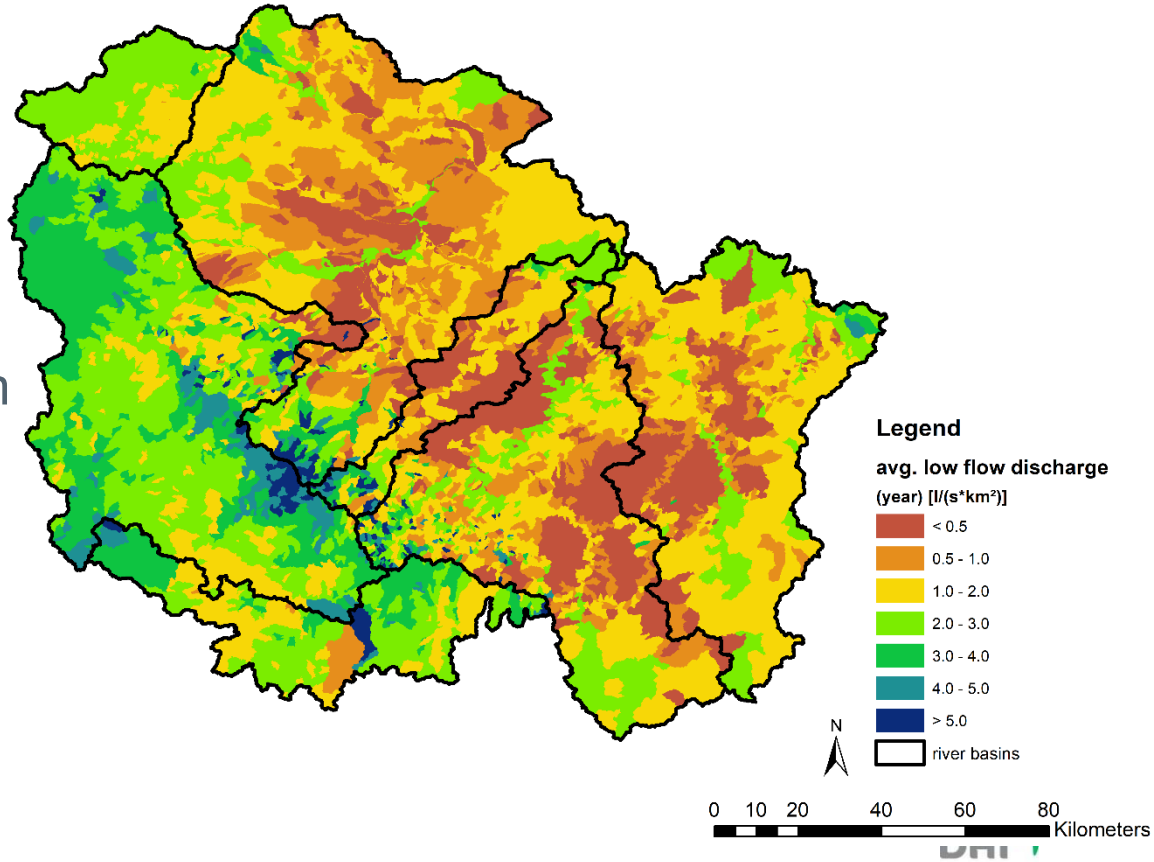
- Implausible small low flow discharges have been identified
- the local consistency of the results was checked
  - ($MNq_{Year} \leq MNq_{Summer}$ and $MNq_{Year} \leq MNq_{Winter}$)
- the plausibility in longitudinal section was examined.
- The implausibilities were corrected by increasing the low flow discharge to the lowest plausible value.

Application of regionalization procedures – final results

Low flow discharge are available for all subareas in Thuringia

These values can be used to determination of the minimum water runoff in the running waters.

These values are necessary to ensure the fish passability and water ecological functioning.



Thank you for your attention

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