Learning from drought impacts to improve drought monitoring & early warning

Drought Impacts: Vulnerability thresholds in monitoring and Early-warning Research (DrIVER)

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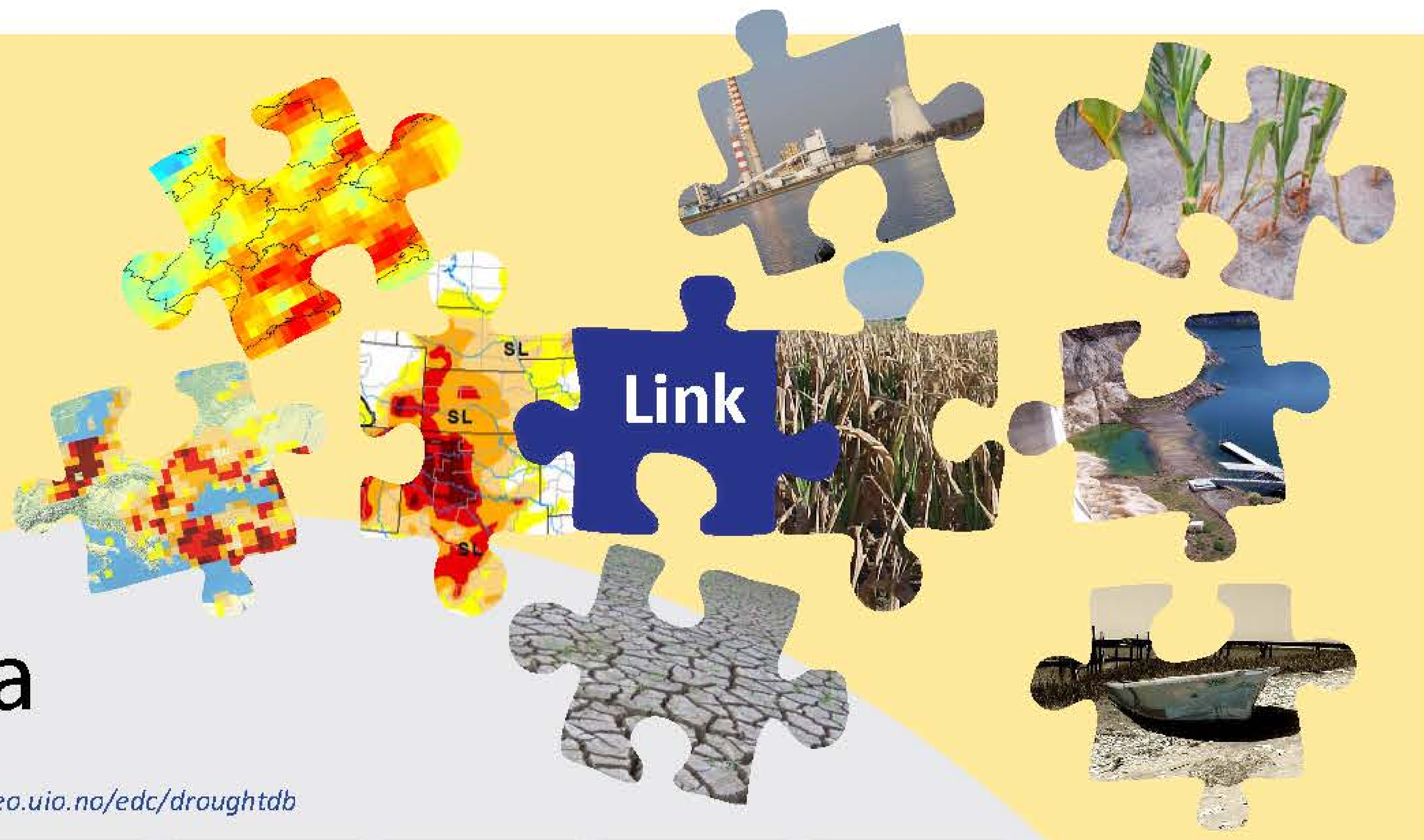
Motivation and objective

Drought is a complex natural hazard with severe environmental and socio-economic impacts. To improve drought monitoring and early warning systems we need to better understand the link between hydro-climatic drought indicators and impacts on the environment, the society, and the economy. The objective of this study is to learn about the meaning of different drought indicators for impact occurrence on the ground through exploring the European Drought Impact report Inventory (EDII). For two countries well covered in the EDII – Gemany and the UK – the following research questions shall be answered:

- Which indicator(s) best explain(s) drought impact occurrence?
- Can we identify indicator thresholds that are critical for impact occurrence?

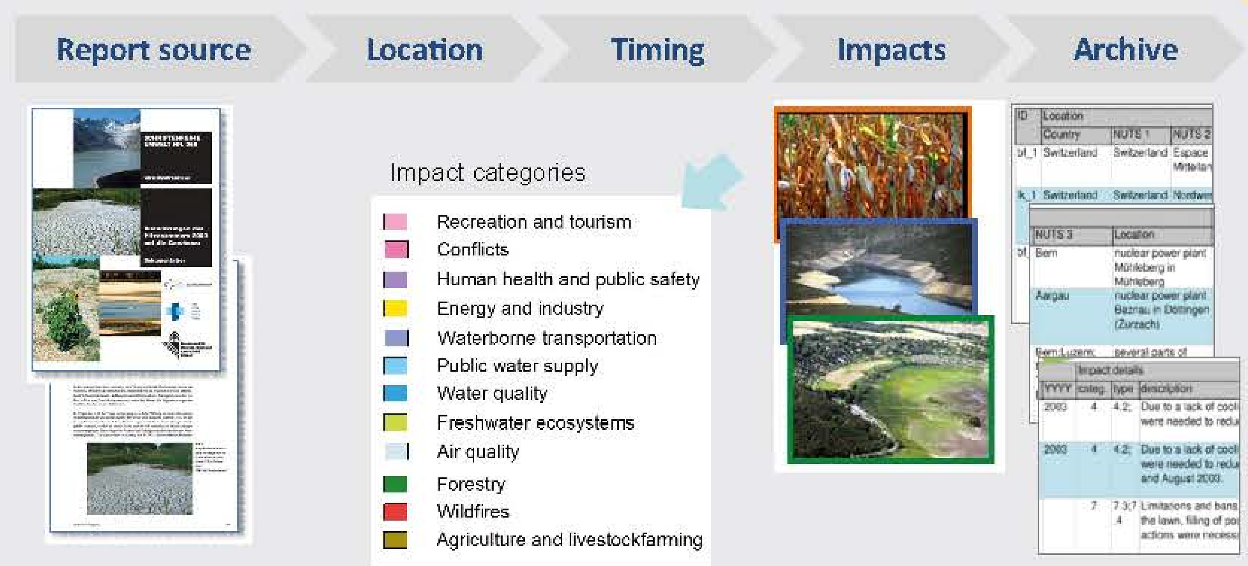


Data

www.geo.uio.no/edc/droughtdb

Drought impacts

Impact information from the European Drought Impact report Inventory (EDII): textual evidence of drought impacts



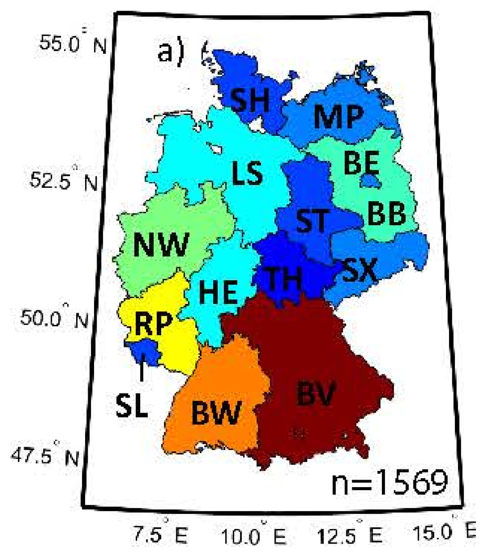
Drought indicators

- Standardized Precipitation Index (SPI)
- Standardized Precipitation Evaporation Index (SPEI)
- Streamflow percentiles (Q)
- Groundwater level percentiles (G)

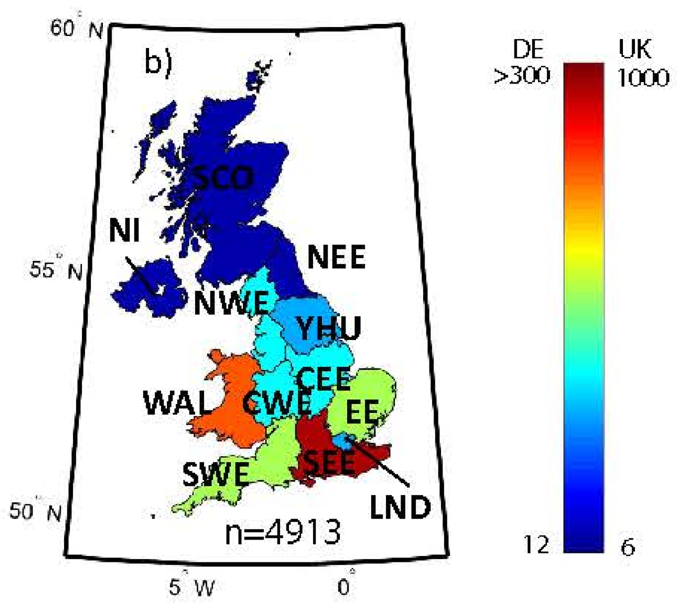
- Study area: Germany and the United Kingdom
- Temporal scale: monthly timeseries
- Spatial aggregation: NUTS1* regions (~federal states in Germany)
  - Mean of indicator per NUTS1
  - Number of impact occurrences per NUTS1

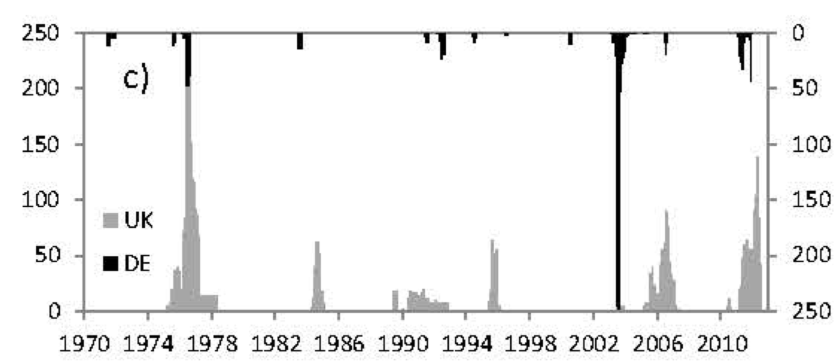
*NUTS: EU nomenclature of territorial units for statistics

Past drought impacts



Number of impact occurrences 1970-2012
a) per NUTS1 region in Germany (DE)
b) per NUTS1 region in the UK
c) for Germany and the UK over time.

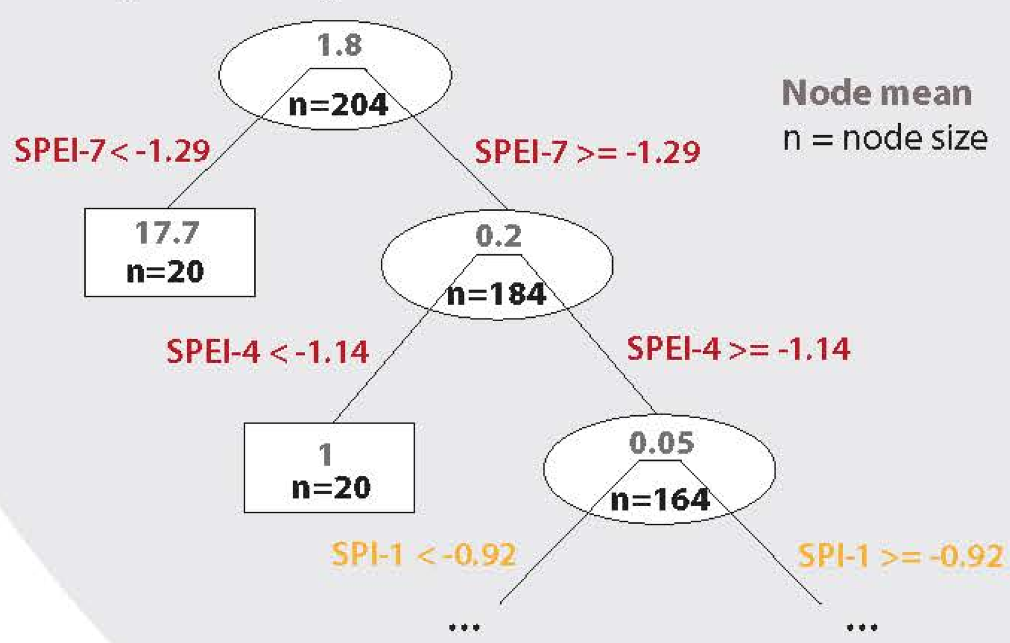




Variable importance and splitting values of important predictors are used to address the research questions.

Conceptual approach

Example of one regression tree for Bavaria



Node mean
n = node size

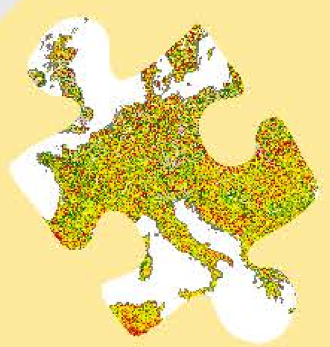
Random Forests

A regression tree explains the variation of a response variable by recursively splitting the data into more homogeneous groups (nodes) based on combinations of explanatory variables. A „random forest" (Breiman, 2001) represents a machine learning algorithm, where a large number of classification or regression trees are grown on a bootstrapped subsample of the data (~2/3). The remaining data ("out-of-bag") are used to estimate the prediction error and the variable importance of each predictor.

One model per NUTS1 region 1970-2012

Response variable:
Number of impact occurrences per month

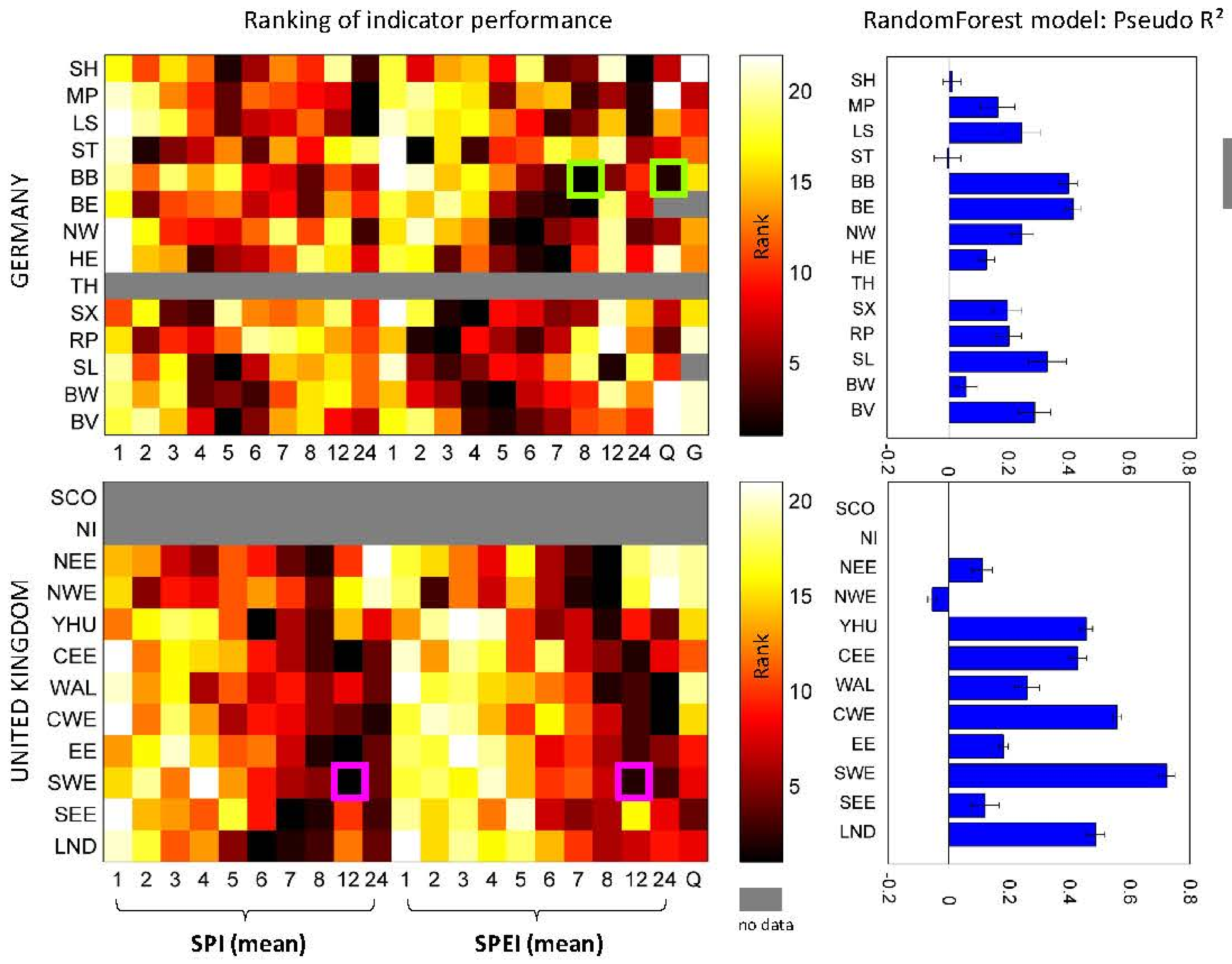
Predictors:
SPI and SPEI for 1-8,12, and 24 months, streamflow and groundwater level percentiles



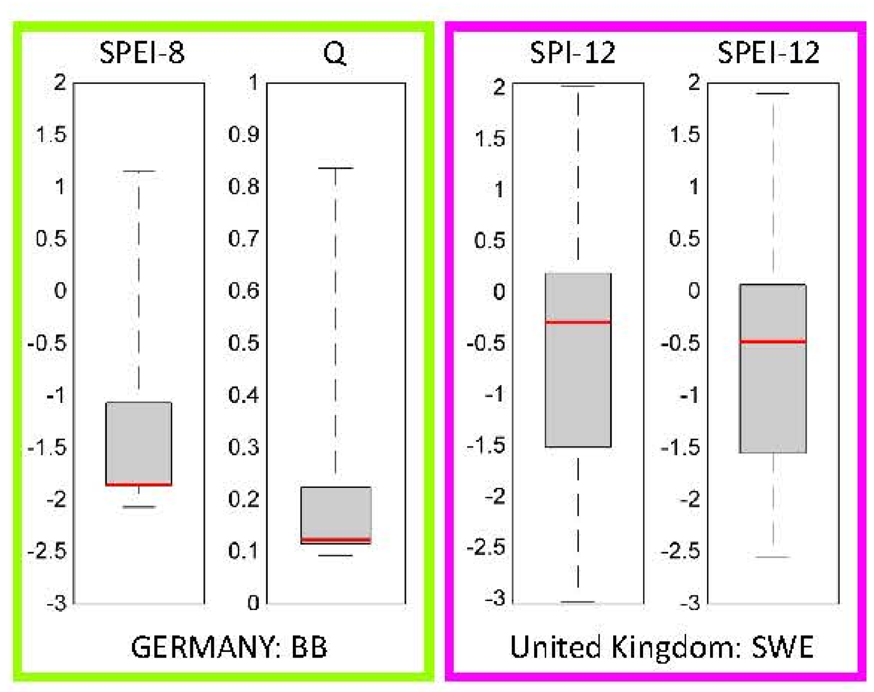
Preliminary results

Performance of drought indicators

There are distinct patterns regarding „best" indicators for drought impact occurrence: In Germany intermediate accumulation periods (3-6 months) of SPI and SPEI generally perform best; SPEI often outperforms SPI. In the UK, longer accumulation periods (8-24 months) of SPI and SPEI show top ranks. Streamflow (Q) is a high-scoring predictor for some NUTS1 regions in Germany, yet not in the UK.



Q: Streamflow percentiles G: Groundwater level percentiles



Indicator thresholds

The graph on the left displays the distribution of splitting values of the best ranking drought indicators selected during the randomForest construction for two example NUTS1 regions: Brandenburg (BB) and Southwest England (SWE). A single threshold value cannot be identified; however, the median of the splitting value distribution could serve as reference value triggering drought management actions.

Conclusion

The preliminary results demonstrate the value of text-based information on drought impacts for learning about the meaning of different hydro-climatic drought indicators. Different „best" predictors for drought impact occurrence were identified through the „RandomForest" analysis for Germany and the UK at the NUTS1 region level. The tree model approach also allows identifying splitting values that may represent critical thresholds for impact occurrence. Overall, knowledge on the indicator-impact relationship can help to „ground-truth" drought indicators and thus improve drought monitoring and early warning systems.

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