The challenges of empirical impact prediction with monitored drought indices



Kerstin Stahl, Sophie Bachmair, Veit Blauhut, Irene Kohn, Erik Tijdeman

Motivation

Drought monitoring and early warning still relies primarily on drought indicators selected or combined from hydrometeorological variables, such as precipitation, modeled soil moisture, observed or modeled streamflow, and in some cases remotely sensed vegetation health.

👸 || No/limited data available about local drought conditions |

Lack of expertise in evaluation

Sophie Bachmair, ¹⁴ Kerstin Stahl, ¹ Kevin Collins, ² Jamie Hannaford, ³ Mike Acreman, Mark Svoboda, ⁴ Cody Knutson, ⁴ Kelly Helm Smith, ⁴ Nicole Wall, ⁴ Brian Fuchs, ⁴ Neville D. Crossman and Ian C. Overton No/limited data available about drought impacts Drought indicators are proliferating, but with little consideration of which are more meaningful for describing drought impacts. A number or meant reviews compare different drought indicators, but more assess which indicators are actually used in the many operational chrought momentum and early warning afters. Index evaluation does not seem necessary why they were adected, or whether they have been "ground-truthed," i.e., commend with information representing local drought conditions and/or impacts that local compensations are compensationally as a compensation of the state of conditioning drought process. To their fill this gap, we combine a review of drought indevienes an impacts with a servey of 35 providers of operational drought monitoring and only worning systems from global to regional scales. Herpite considerable works in the indicators used operationally, certain patterns energy. But the factors are undeclared to each out the content of the factors and the successional truth of monitoring does each but in Haven't thought about it

To guide the selection and give drought indices more meaning for drought management decisions, a number of studies have investigated empirically the linkage between these indices and records of drought impact occurrence. This can be done in a

Drought

Impacts

number of ways:

Hazard Variable/Drought Index

Index (e.g. SPI)

Model performance: metrics based on cross-validation

Methods

Statistical Modelling of Impacts as a Function of Drought Indices

The damage function approach employed in risk assessments of other natural hazards can be adapted to empirically relate impacts to drought indices.



For binary data,

form similarly wel

Model 3 is superior to

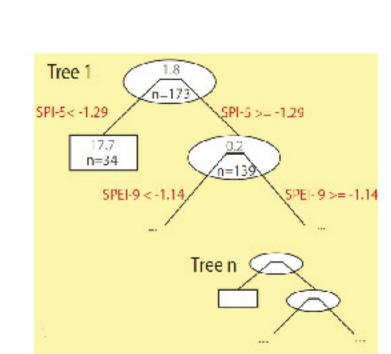
For water supply im pacts Model 3 perfo

False positive

with a hit rate of

Model 2 relates impact ocurrence and counts to drought indices by zero-altered negative binomial regression; this parametric model for count data is also known as a "hurdle" model.

Model 3 relates number of impacts to drought indices by ensemble regressiontrees, i.e. a random forest model.



All models identify

core drought peri-

onset and recovery

Temporal dynamics

(N) are better repro-

duced by Model 3

of number of impacts

ods, but vary in

Prediction: Observed and modeled time series

Co-Visualisation of Indicators & Impacts

Example from North Carolina

indicators and drought impacts. Overall, we find that much progress has been made both in research and graditie in drought indicators, but monitoring and early warning systems are not yet strongly linked with the ascessment selector impacts on the environment and society. To understand drought impacts fully requires a better framing of drought as a coupled dynamic between the environment and society. A made it, A made it.

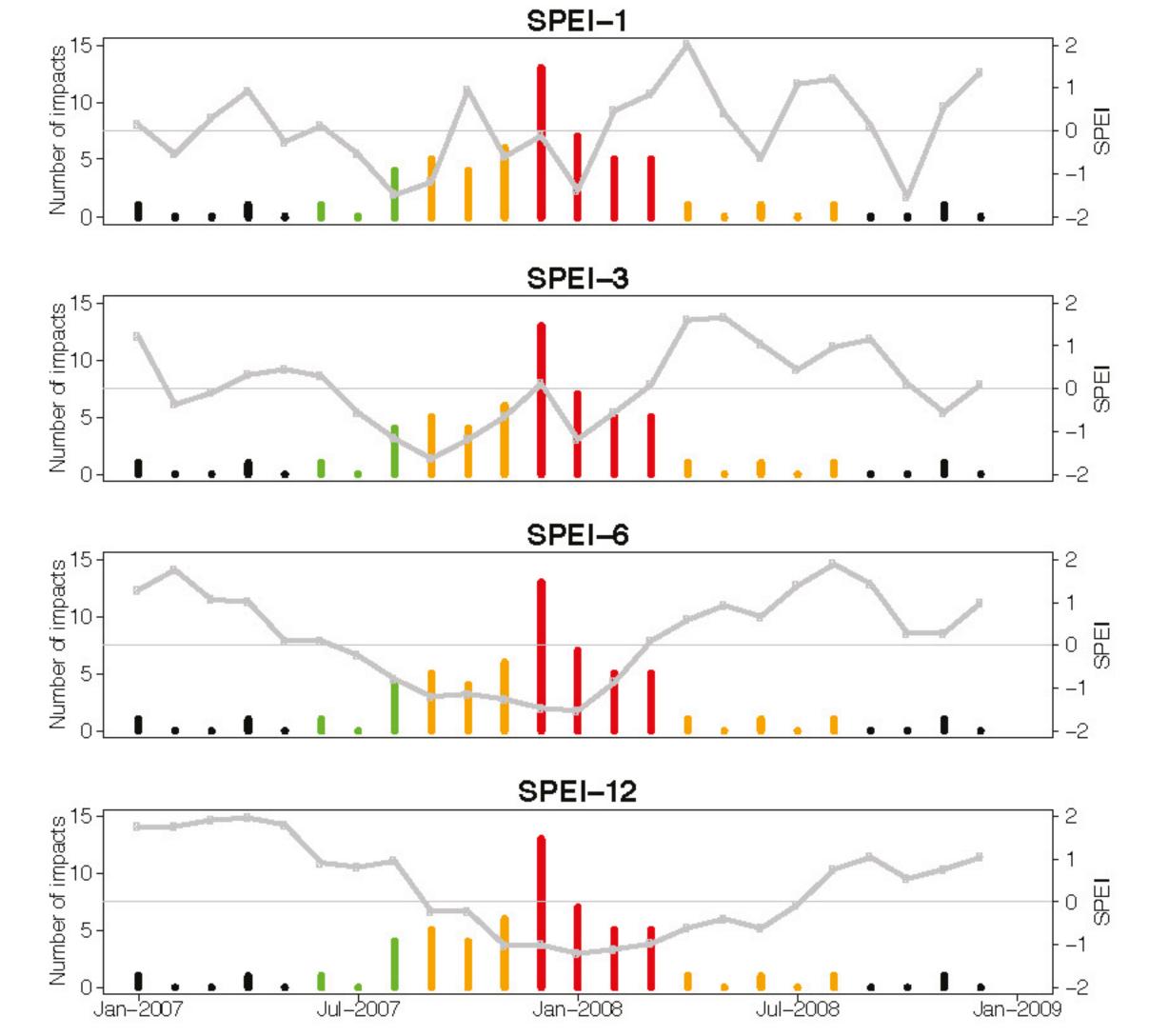
| Note to declarate the made | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 | 1986 |

SPEI-1 fluctuates strongly during the drought of 2007

SPEI-3 is negative during onset, neutral during peak of impacts and positive during recovery

SPEI-6 is negative at the peak of impact counts, but positive during onset and re-

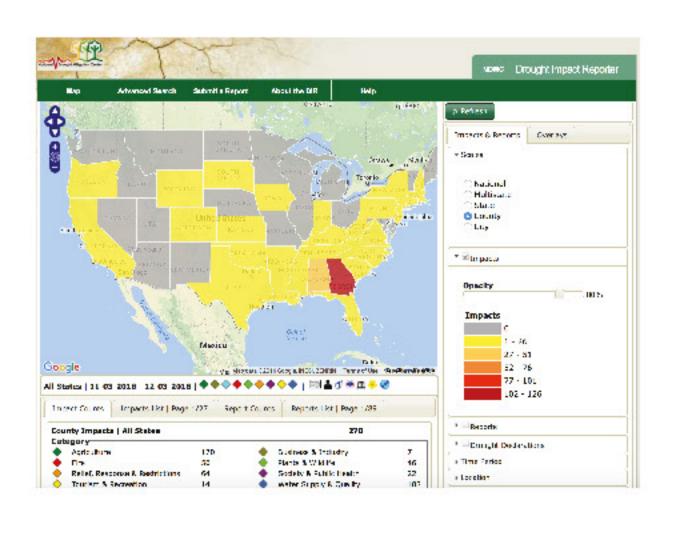
SPEI-12 is low at the peak of impacts and



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US Drought Impact Reporter

droughtreporter.unl.edu



The DIR collects near

real-time News Media reports

The EDII is a research

reports from a range of

sources. It uses a more

categorisation to consider

international differences in

detailed sub-type

drought impacts.

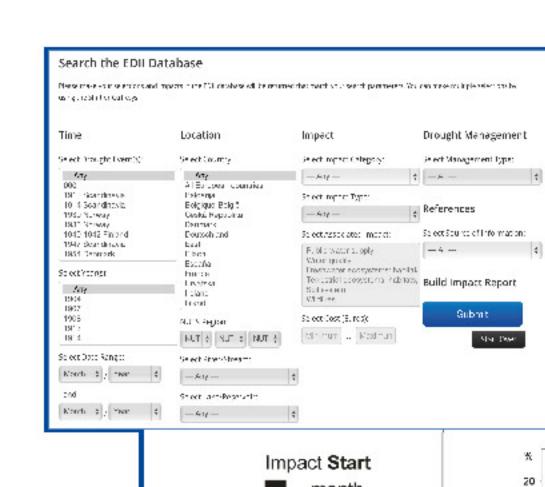
database, collecting impact

and observations of impacts.

European Drought Impact report Inventory (EDII)

www.geo.uio.no/edc/droughtdb

Data



Agriculture and livestock farming

Visualisation of reported impacts:

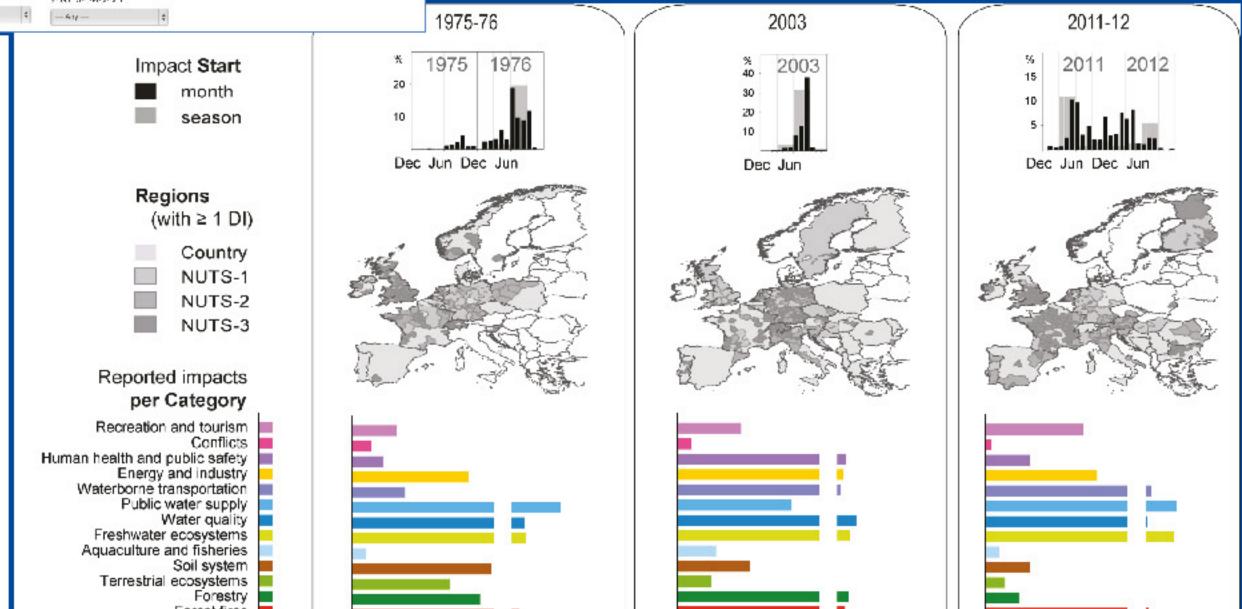
DROUGHT

 provides narratives of past droughts, anecdotal evidence of drought impacts, and

Example Study of SE

-8 -6 -4 -2 0 2

 may be used as historical analogues to construct scenarios for planning purposes.



Towards impact-prediction

Coded impact reports, such as the EDII and the US DIR can be used to fit empirical impact models. The challenges include:

- a rapid decrease of data when subsetting for specific impact sectors or smaller spatial areas,
- the choice of the link model,
- a variety of potential dynamic changes to the underlying conditions between and even during drought events.
- → More systematic impact monitoring, reporting and archiving is needed!

Lessons learned

Different drought indicators, e.g. SPEI at different time scales, link best to different phases of the drought (onset, peak, recovery)

Impact counts reflect reported responses to drought, including water use restrictions.

These can mitigate or exacerbate water shortage impacts.