Mapping Risk to drought on a pan-European scale

HYDROLOGY

UNI FREIBURG

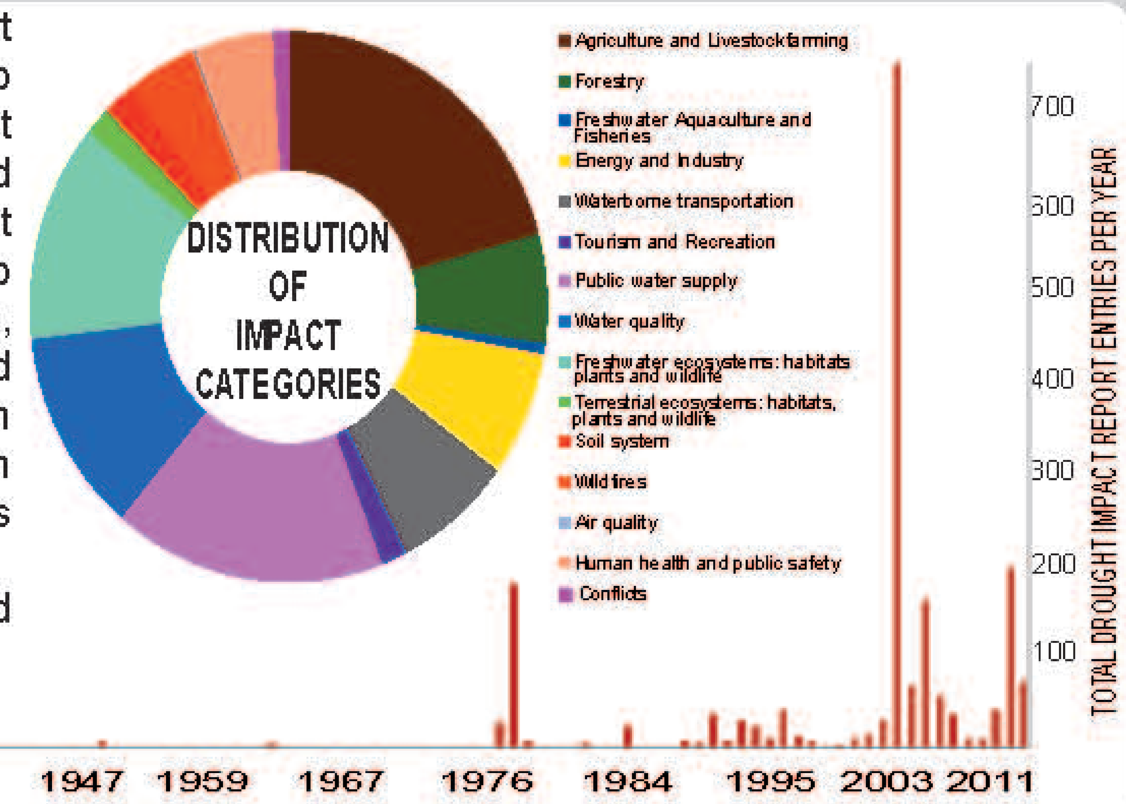
Veit Blauhut [1], Lukas Gudmundsson [2], Kerstin Stahl [1], Sonia Seneviratne [2]

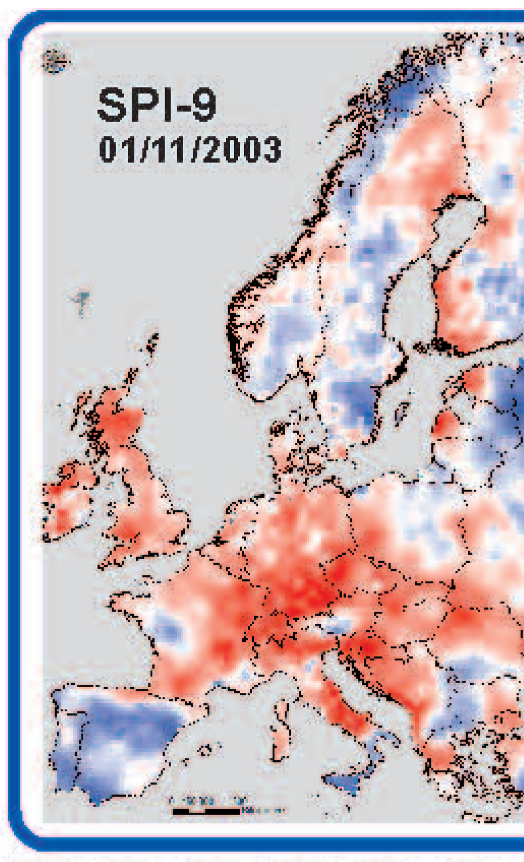
INTRO

Drought develops slowly and on large scales, causing a variety of direct and indirect environmental and socio-economic impacts. It is a recurrent, transboundary phenomenon and can affect vast areas and millions of people. For the last 30 years, droughts in Europe caused over 30 billion Euros of losses from impacts in various sectors; including agriculture, water quality and energy production. For characterizing and monitoring of the natural hazard a number of drought indices are commonly used. While many small scale studies have documented the effect of drought on environmental and socio-economic systems, the focus of large scale investigations has to date been mostly on easy-to-access, strongly generalized data, that have not been linked to observed impacts. Moreover, observed pan-European drought impacts have not yet been quantitatively related to the most important climatological drivers. Here we propose an approach for linking climatological drought indices with observed drought impacts. Data from the European Drought Impact Inventory (EDII) compiled by the EU FP7 Drought R&SPI (Fostering European Drought Research and Science-Policy Interfacing) project are used as a proxy for sector-specific (impact categories) vulnerabilities following the idea that an reported impact reflects a regions vulnerability to the hazard.

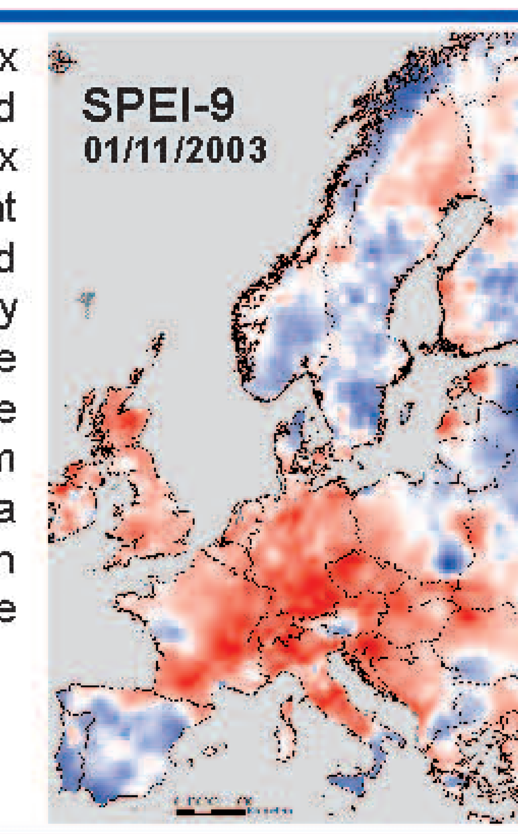
DATA

The European Drought Impact report Inventory (EDII) developed aims to collect and build a database of past drought impacts in Europe reported by various sources. Impact information is: (a) classified into pre-defined impact categories (right), (b) referenced temporally and spatially, and (c) complemented with additional reported impact information including drought response measures where applicable .
Further information can be gained from the EDII poster.





The Standardised Precipitation Index (SPI) and the Standardised Precipitation- Evapotranspiration Index (SPEI) can both estimate drought severity according to its intensity and duration. The SPI is defined only by precipitation. Its relevance is therefore limited to precipitation effects. The SPEI partly accounts for effects from evaporanspiration, albeit with a simplified potential evaporation formulation. SPEI calculations are based on E-OBS data.[3]



METHOD

Logistic Regression

Likelihood of drought impact = f(drought indicator)

One predictor > Testing different predictors > Multiple predictors > Best model

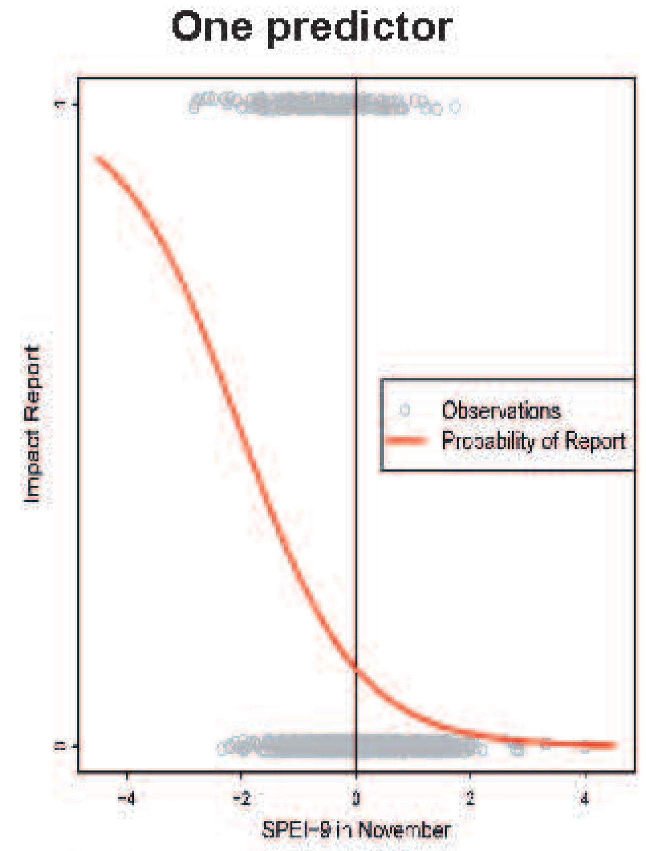


Fig.1, Impact vs. NO Impact

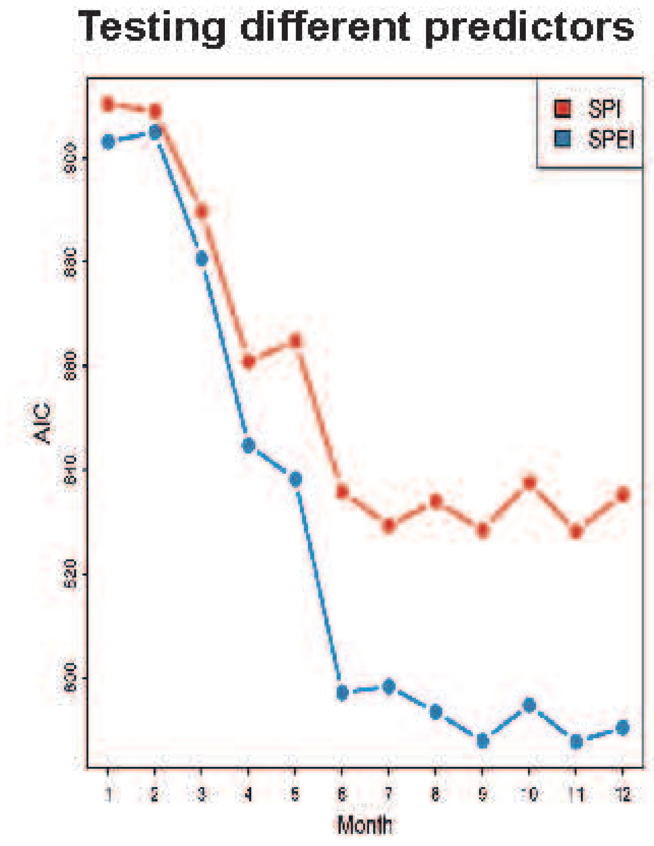


Fig.2, Akaike Information Criterion

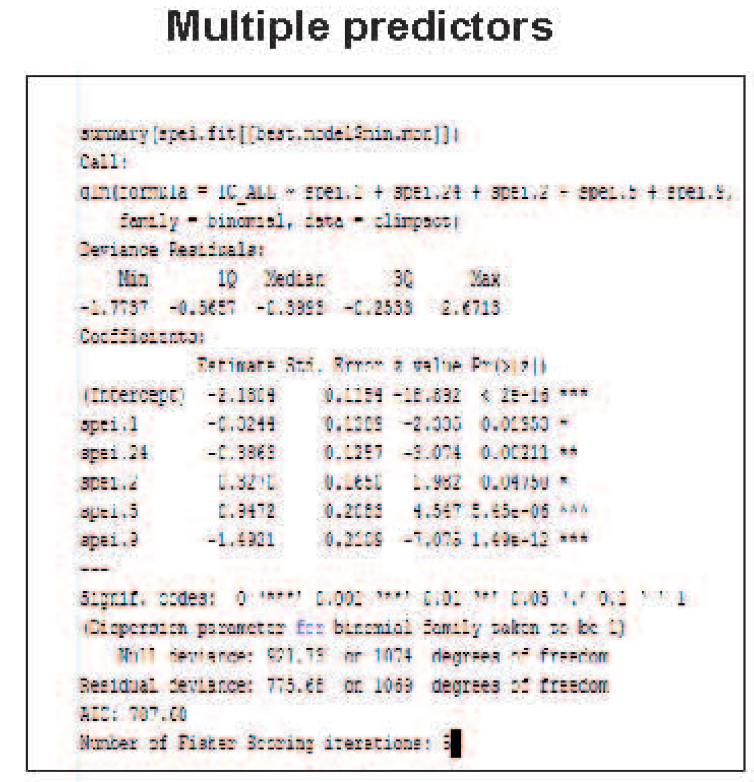


Fig.3 Best model fit

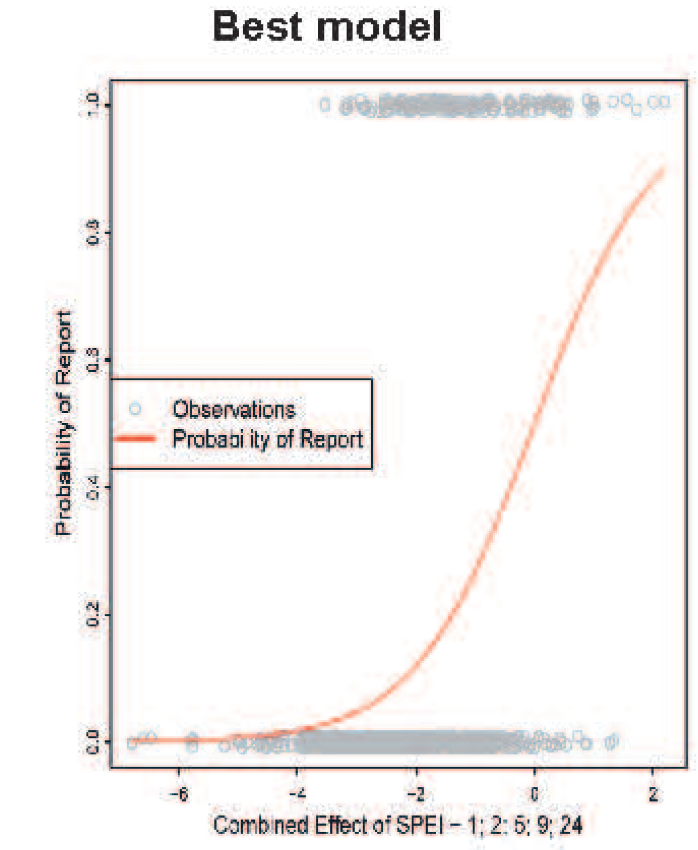
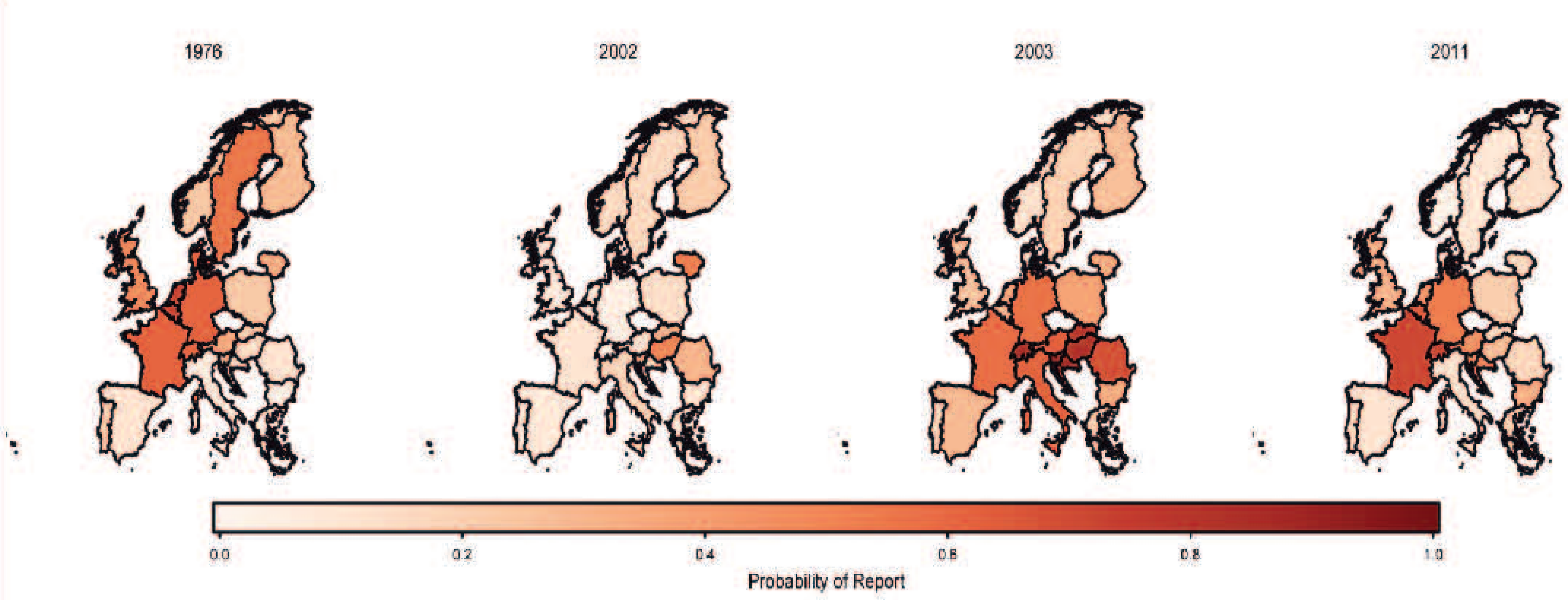


Fig.4 Likelihood of impact occurrence

Figure 1 shows the distribution of the observed categorical response variable (impact=1 and no impact=0) versus one metric predictor variable (SPEI-9). The curve is the result of a logistic regression model fit and shows the predicted likelihood (probability) of occurrence of an impact report. Figure 2 shows the Goodness of Fit for similar models for different predictors (i.e. different SPI and SPEI accumulation periods). SPI-6 and SPEI-6 and higher result in the best model fits.Figure 3 shows the result of a model built for multiple predictor variables. The best model includes several drought indicators. SPEI-9 shows the highest partial correlation. Figure 4 shows the predicted likelihood of an impact report occurrence based on the best multiple logistic regression model.

Limitations: So far, 1913 Drought Impact Reports, from the year 1905 to 2012, for fifteen different impact categories have been entered. All entries are referenced to a certain NUTS (Nomenclature of Units for Territorial Statistics) region and level. As the EDII database represents only a sample of all reports that may exist, not having a drought impact report does not necessarily mean that there was no impact. We predict impact reports as proxy for drought impacts. In this first risk model application, impact reports from 1970 to 2012 were summed annually and cross categorical to reduce sampling biases. Indicator values were averaged on the national level for Europe.

RESULT



Modelled likelihood of impact report

Applying the likelihood of occurrence to certain climate conditions of separate years (Figure 5), certain patterns emerge in the predicted likelihood of occurrence of a report(hence impact) during particular climate conditions. Many known European drought events with impacts are represented by a higher likelihood. However, likelihood for some known drought impacts for 1976 for the Iberian Peninsula and 2002 for Scandinavia appears to low.

Concluding, the proposed approach is suitable to detect the probability of drought impact reports occurrence. Modeling needs to be improved further by:

- subdivision into impact categories
- increased spatial resolution: from country to NUTS level (reference size has to be detected, e.g. Belgium)
- spatial separation of characteristic zones (e.g. Multiyear
- increased temporal resolution: from annual to monthly impact report data
- determination of best predictors (drought indicators).

But most important is a further contribution to the EDII database across Europe.

(1) Chair of Hydrology, University of Freiburg veit.blauhut@hydrology.uni-freiburg.de (2) Institute for Atmospheric and Climate Science, ETH Zurich lukas.gudmundsson@env.ethz.ch

(3) We acknowledge the E-OBS dataset from the EU-FP6 project ENSEMBLES (http://ensembles-eu.metoffice.com) and the data providers in the ECA&D project (http://www.ecad.eu)",„Haylock, M.R., N. Hofstra, A.M.G. Klein Tank, E.J. Klok, P.D. Jones and M. New. 2008: A European daily high-resolution gridded dataset of surface temperature and precipitation. J. Geophys. Res (Atmospheres), 113, D20119, doi:10.1029/2008JD10201"

DROUGHT R&SPI