

## ***Interactive comment on “A quantitative analysis to objectively appraise drought indicators and model drought impacts” by S. Bachmair et al.***

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The authors are to be congratulated on developing and deploying the European Drought Impact Report Inventory over the course of the Drought R & SPI project; the English co-authors of this paper, as well, have been carrying out long standing, important work reconstructing the chronology and impacts of drought episodes in the United Kingdom. To summarize the content of this paper, surface-water storage responds rapidly to changes in high frequency precipitation events daily or across the season, but soil moisture responds more slowly and is thereby only influenced by longer term precipitation deficits (perhaps weekly or within a season), causing agricultural droughts. On the other hand, groundwater storage responds very much more slowly in comparison with soil moisture and is usually changed by changes in precipitation extending

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from the seasonal to annual and interannual time scale. The groundwater response lags behind those in surface water and soil moisture, and groundwater takes significantly longer to be replenished and recover (Bloomfield and Marchant 2013). Any type of activity in which groundwater is involved such as recharge of base flow of streams will thereby be impacted by a protracted drought that diminishes groundwater supply. The subsequent declining water levels in rivers can impede river transportation, water supplies drawn from rivers (or the groundwater source), or impact thermal power plants drawing water from rivers. Other activities, such as seasonal or annual agricultural would also be impacted by soil moisture over a shorter, seasonal time scale. The authors also attempt to construct multiple indicators for these stores of water, i.e., groundwater level percentiles and streamflow percentiles. By assembling impact data, the authors are able to corroborate and test these relationships.

Unfortunately, subsequent to deployment of the RF methodology, the authors begin expressing drought in terms of a single drought variable which conflicts with their earlier approach taken within the paper of using multiple indicators to monitor more of drought's different impacts. On top of that, single drought indicators (Standardized Precipitation Index or Standardized Precipitation Evapotranspiration Index) are then identified as possible “triggers,” a so-called threshold in a drought management plan at which some form of remediation is evoked. Why is identification of a single threshold with a so-called “drought trigger” a misstep? Realistic proactive drought management plans are prepared in extensive workshops or surveys in which the subgroups within a population are identified through interviews or surveys, in order to discern the vulnerable population group subject to the highest hazard. Furthermore, during different drought episodes, different subgroups may be affected (the very multiple processes identified in some of the impact reports by the authors). However, the problem is that preparation of the European Drought Impact report Inventory is a very labor-intensive process. In addition, the project is not continually funded as is the Drought Reporter in the USA. As a result, the authors do not have a sufficiently high sample size; correspondingly, they are required to “scale up” to the NUTS1 level in order to increase their

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sample size. Even at the coarse spatial level of a federal state in Germany, they are only able to discern the differences between hydrological impacts and "other impacts," given the somewhat small sample size (sample size is larger for specific drought episodes, such as the 2003 European heat wave and the 2011 drought episode). Drought management plans—especially designation of triggers—has to be from the ground up, identifying all the groups affected. Having data based at the state level only, and not having access to data at finer spatial scales (for example, NUTS2 and NUTS3) (due to lack of adequate sample size), the discussion of "thresholds" and "triggers," particularly for local, high resolution, site specific activities such as impedance of waterborne navigation and power plant outages (i.e., "hydrological" impacts), is not germane and relevant.

The authors are to be commended for attempting to examine the cross correlation among different stores of water versus their hydrological and agricultural impacts entries. I'm proposing to the editor that the sections of their paper dealing with single indicator drought thresholds and triggers be dropped.

The authors are to be commended for attempting to examine the cross correlation among different stores of water versus their hydrological and agricultural impacts entries. I'm proposing to the editor that the sections of their paper dealing with single indicator drought thresholds and triggers be dropped (see below), but allowing the remainder of the paper to continue, the correlation and machine learning technique sections testing the relationships among drought indicators and, among the three categories of drought impacts: that of total drought impacts, "hydrological" drought impacts, and drought impacts other than hydrological. The authors are invited to offer local evidence, at the NUTS3 scale, that triggers can be developed out of their numerical frequency of impacts data (or alternatively through detailed case study in individual droughts) at that higher spatial resolution.

The real main conclusion of their study is: "Agricultural and hydrological drought impacts were generally best linked to shorter and longer SPI (and SPEI) time scales,

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respectively. Here, shorter and longer refer to 1-4 (Germany) and 7-8 months (England)." Having multiple time scales present means that a drought management plan needs to be formulated with accommodation made for the different time scales over which impacts manifest. A drought management plan would have in place different remedial actions operative over different time scales.

The authors could, as well, conclude with an assessment of how many reports actually be required (how larger a sample size) in order to resolve drought impacts at the NUTS2 and NUTS3 level.

Please also note the supplement to this comment:

<http://www.hydrol-earth-syst-sci-discuss.net/12/C5495/2015/hessd-12-C5495-2015-supplement.pdf>

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