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Drought and food security – Improving decision-support via new technologies and innovative collaboration

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ABSTRACT

Governments, aid organizations and people affected by drought are struggling to mitigate the resulting impact on both water resources and crops. In this paper we focus on improved decision-support for agricultural droughts that threaten the livelihoods of people living in vulnerable regions. We claim that new strategic partnerships are required to link scientific findings to actual user requirements of governments and aid organizations and to turn data streams into useful information for decision-support. Furthermore, we list several promising approaches, ranging from the integration of satellite-derived soil moisture measurements that link atmospheric processes to anomalies on the land surface to improved long-range weather predictions and mobile applications. The latter can be used for the dissemination of relevant information, but also for validating satellite-derived datasets or for collecting additional information about socio-economic vulnerabilities. Ideally, the consequence is a translation of early warning into local action, strengthening disaster preparedness and avoiding the need for large-scale external support.

1. Main text

Key characteristics of drought, such as their naturally large spatial and temporal extent, the high number of people affected or the tremendous economic loss create both logistic and financial challenges. Although droughts and subsequent food insecurity rank high on the priority list of humanitarian aid organizations, the majority of online disaster portals focus on rapid onset disasters (e. g. floods or thunderstorms). A major drawback of operational drought forecasting systems is their inability to make reliable predictions regarding the location, magnitude and the kind of assistance needed in the medium to long term, i.e. several months in advance. Yet even in those situations where predictions were made, e.g. warnings of extreme drought conditions in the Horn of Africa during 2010/2011, there was still insufficient response on the ground (Funk, 2011). Moreover, the predictions of large-scale droughts even fail in industrialized countries such as the United States (Schiermeier, 2013). This is compounded by the fact that there is no commonly accepted definition of drought (Belal et al., 2012) and climate change impacts on global drought patterns (Trenberth et al., 2014) and global food security remain controversial and uncertain (Wheeler and Braun, 2013). At the same time the consideration of teleconnections, for instance the impact of anomalies in the sea surface temperatures of the Indian Ocean on drought events in the Horn of Africa (Tierney et al., 2013), add complexity to already sophisticated models. Finally, there are different kinds of drought (i.e. meteorological, agricultural and hydrological) that have different socio-economic implications so it is not possible to have a single physically measurable "drought-parameter" for all of these situations. In this paper we therefore concentrate on agricultural drought as the direct

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successor of meteorological drought and the predecessor of food insecurity in many regions around the globe (Food and Agriculture Organization, 2013).

Despite all these aforementioned challenges we argue that the underlying problem lies in the large gap between scientific findings and the user requirements of government authorities and aid organizations. Research is primarily and intrinsically focused on creating knowledge, which does not necessarily lead to applicable information in a humanitarian aid context. In particular in the field of complex technologies, such as satellite applications, this knowledge tends to remain difficult to access and to utilize by aid organizations. Although satellite-derived products such as rainfall estimates or vegetation indices are used by some of the larger early warning organizations such as the Famine Early Warning Systems Network (FEWS NET) (Funk and Verdin, 2010), there are many aid agencies that cannot effectively utilize this information to transform early warning into action. Moreover, end users prefer information that is tailored to their needs rather than the generic output of continental or even global drought portals.

2. Sometimes being an expert is not enough

The crucial question is: What can science do to efficiently support the decision-making process? One logical and promising solution is the integrated combination and adaptation of existing technologies, including different satellite-based systems. Organizations such as EUMETSAT (the European Organisation for the Exploitation of Meteorological Satellites) or NOAA (National Oceanic and Atmospheric Administration) provide a vast variety of satellite-derived datasets that are available operationally, on a near real-time basis and free of charge (or with a minimal and low-cost receiving station). In addition to some of the more commonly used remote sensing products, datasets derived from microwave sensors can be provided at a spatial resolution that is worth considering in order to complement or replace in-situ measurements. These datasets often compensate for weaknesses of local measurements such as poor coverage and the lack of spatial consistency. Although a spatial resolution of 25 kilometers (e. g. for soil moisture derived from a radar sensor) does not allow investigations at a field scale, such datasets can nonetheless provide an added value, particularly in areas with incomplete or biased rainfall measurements (Dinku et al., 2007; Thiemig et al., 2012). Monthly weather predictions are available, for instance from the European Centre for Medium-Range Weather Forecasting (ECMWF). However, seasonal forecasts are extremely complex due to uninterrupted chaotic processes in our atmosphere (e. g. wind speed and direction, variations in air pressure or heat transfer) and only available to scientific users. All of these products require an in-depth understanding of atmospheric and biophysical processes along with the technical knowledge to deal with large datasets – an understanding and capacity that many users do not have.

The interaction of environmental drought-inducing key parameters (rainfall, temperature, soil moisture, evapotranspiration, vegetation) is fairly well understood. One major problem is that large-scale preparations require reliable forecasts several months in advance, which are currently not certain enough. Another issue is that agricultural drought constitutes just one possible root cause of food insecurity. In many cases famine is promoted by high levels of vulnerability caused by interacting socio-economic issues, such as political unrest, and increasing or unstable food prices. In fact, the methods for monitoring environmental anomalies and their socio-economic manifestations hardly overlap. In order to create a holistic monitoring system it is recommended that researchers collaborate more closely with end users in a multi-disciplinary approach. Fig. 1 illustrates this approach and identifies the current weak connections.

3. The integration of three technological developments for improved decision-support

There are a number of ongoing technological developments that could support drought risk reduction. Here we will focus on three complementary tasks that could be better integrated to improve decision-support. The first is the improvement of agricultural drought monitoring through exploitation of satellite-derived soil moisture. The second is gaining a better understanding of the uncertainty of long-term weather forecasts and how this information can be integrated with satellite-derived soil moisture. The third is the integration of non-environmental information via smartphones. Each of these is discussed in more detail below.

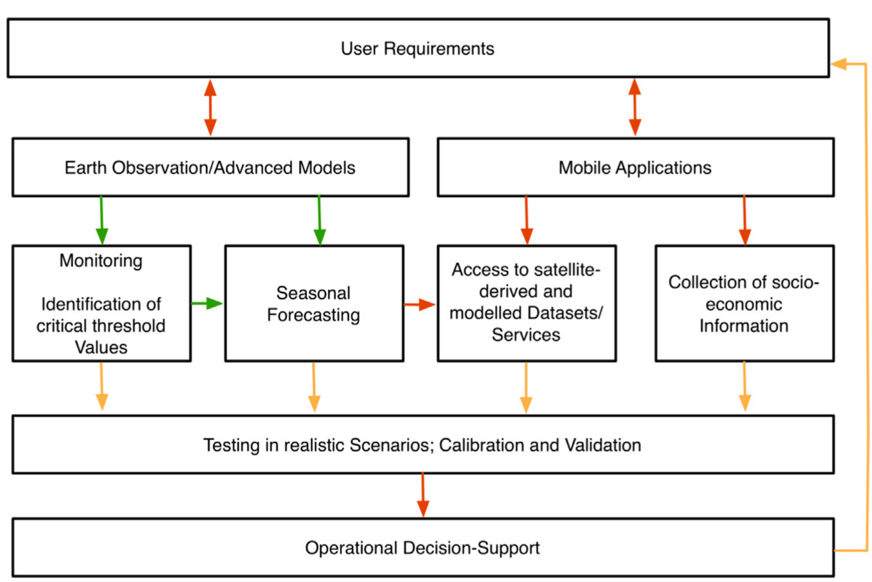

Fig. 1. Proposed framework for an operational decision-support system that considers state-of-the-art earth observation, advanced models and mobile applications based on user requirements (established connections are illustrated in green, moderate connections in orange and weak connections in red).

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