EGU21-6972, updated on 25 Oct 2021
https://doi.org/10.5194/egusphere-egu21-6972
EGU General Assembly 2021

Improved detection of flash droughts using hyper-resolution hydrological modeling

Noemi Vergopolan[1], Julio E. Herrera-Estrada[2], Justin Sheffield[3], Lyndon Estes[4], and Eric F. Wood[1]
[1]Princeton University, Civil and Environmental Engineering, Princeton, NJ, United States of America (noemi@princeton.edu)
[2]Descartes Labs, USA
[3]School of Geography and Environmental Science, University of Southampton, UK
[4]School of Geography, Clark University, USA

Drought is the most threatening natural hazard for agriculture. Between 1983 and 2003, drought led to a cumulative agriculture production loss of 166 billion U.S. dollars globally, thus monitoring and forecasting capabilities are essential for adaptation and preparedness. Soil moisture simulations play an indispensable role in reconstructing historic drought conditions and predicting future scenarios. However, there is a spatial scale gap between the resolution of soil moisture-based drought indices (10–25 km) and typical farm field sizes (1–2 ha). This spatial-scale gap hampers drought indices' applicability for capturing and monitoring flash and local-scale agricultural droughts, particularly over heterogeneous landscapes and smallholder farming.

This work presents a novel approach that uses hyper-resolution modeling and machine learning to identify droughts, characterize their topologies, and evaluate detection rates. We present a case-study for Zambia, where we simulated the root zone soil moisture at a daily 30-m resolution between 1981–2018 using the HydroBlocks land surface model. Using these simulations, we computed a weekly percentile-based drought index, defining it as in drought when the index dropped below the 20th percentile. Given the space and time location of the drought conditions, we applied a Hierarchical Density-Based Spatial Clustering of Applications with Noise (HDBSCAN) algorithm to determine space- and time-connected clusters/events. We analyzed the topology of 7712 drought events, with a minimum 10-km2 coverage and two weeks duration. Our results showed that 88% were flash droughts (lasting less than one month), 82% were local events (less than 1,000 km2), and 62% were local flash droughts happening during the growing season (October–May). We performed a synthetic spatial scaling analysis to compute the change in detection rate across spatial resolutions. When considering drought conditions over at least 1,000-km2, our results showed that 10–50 km spatial resolution data missed 19 to 44 % of drought conditions captured with 30-m resolution data. This work demonstrates how current capabilities are likely underestimating droughts, and it highlights the urgent need to monitor and forecast droughts at a high spatial resolution. Such refined data can critically benefit local-scale drought mitigation and food security policy design.