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Hydro-economic assessment of biophysical drought impacts on agriculture

Mansi Nagpal, Jasmin Heilemann, Bernd Klauer, Erik Gawel, and Christian Klassert
Department of Economics, Helmholtz Centre for Environmental Research - UFZ, Leipzig, Germany (mansi.nagpal@ufz.de)

As climate changes globally and locally, the risk of temperature anomalies, heat waves and droughts have significantly increased. Studies have demonstrated that droughts exert adverse biophysical effects on crop production, posing an unprecedented threat to harvests and resulting in substantial economic losses in Europe. Assessing these biophysical drought impacts on agriculture is crucial for developing effective strategies for drought preparedness, mitigation, and adaptation. This paper contributes to this effort by presenting a framework to estimate economic costs associated with droughts that specifically captures the biophysical impact of climate change on crop output.

Existing analyses for drought damages in agriculture are developed for a specific drought event and primarily focus on the reduction in farmer's income or crop yields in drought events. In these assessments, the biophysical impacts of droughts are not isolated and evaluated from their effects on other economic variables such as output prices, resulting in inaccurate damages. Additionally, lack of single universal definition of drought adds complexity to estimating the costs of droughts. This paper is aimed to contribute by focusing on agricultural droughts, which occurs when variability in soil moisture affects plant growth and development. We simulate this biophysical effect of drought on crop yields by applying a statistical crop yield model to data on soil moisture, temperature and perception. This approach helps isolate the direct impact of drought on agriculture from other changes in aggregate economic production (e.g. business conditions, commodity prices) and farmer management decisions (e.g. intermediate input use). The simulated biophysical yield effects are then quantified into monetary terms to estimate economic damages of droughts. We further look into the relationship of the economic damages and the intensity of droughts to determine drought thresholds that lead to increased economic losses.

The results provide bottom-up estimates of the economic damages of drought induced water deficiency in agriculture across Germany for the years 2016-2020. The spatio-temporal patterns of drought impacts can be useful for drought policy planning at local and national level. The economic costs estimation framework could be valuable in estimating farmer compensations and loss and damage of droughts. The results of the study can provide reliable estimates of the costs of climate-change-related extreme weather events, which may help inform macroeconomic and integrated impact assessment models of economic losses (and gains).