Review of "Measuring extremes-driven direct biophysical impacts in agricultural drought damage"

The authors address the complicated question of accurately estimating the direct impacts of droughts on agricultural yields. In doing so, they tackle a number of issues that confound the drought estimates, including the co-occurrence of other extreme weather events, the regional heterogeneity in occurrences and effects that limit the viability of national aggregated measures and the presence of indirect effects that come from secondary and tertiary impacts. Using Germany as the backdrop, they find that the direct impact of droughts amounts to 781 million euros in the period investigated, accounting for 60% of reported yield losses in drought years, going as far as 97% of total damage when the focus is on rice yields in 2018. They also find a discrepancy when comparing national aggregated estimates to regionally estimated losses, suggesting a preference for regional estimates.

Some issues remain and are addressed below

1. The first issue I came across while reading was confusion on what exactly was being investigated. For the first few pages, I assumed the purpose was an investigation of the impact of agricultural droughts measured by soil moisture, but after a few pages, the phrase "extreme weather on agriculture during drought years" gave the impression that the investigation was a secondary effect of other extreme weather events during drought years. After reading, I am convinced that the paper is just about the impact of drought (first, with a combination of other extremes investigated in section 4.4), if I am mistaken, it adds to the confusion I had while reading through. Simplifying the text and stating precisely what was investigated would be ideal.

2. The measure of damage in equation 1 itself may be over or underestimating drought effects in its current form. With the impact being the difference between the expected revenue and the actual revenue, it ascribes this difference in its entirety to drought effects, which may not be entirely true. It is the classic diff-in-diff argument. For the damage equation to be solely due to droughts, the authors current approach would necessitate that in non-drought years, expected outcomes ALWAYS match the realized outcomes. I am doubtful that this is true, and as such, any shortfalls in non-drought years would imply that negative drought effects are overestimated while any windfalls (realized yields greater than expected) would underestimate the drought effects. Therefore, I suggest that the damage be estimated as

$$D_t = \sum_{c=1}^{8}\left(\overline{R_{expected,c,t}} - R_{actual,c,t}\right) - \frac{1}{T}\sum_{t=1}^{T}\sum_{c=1}^{8}\left(\overline{R_{expected,c,t}} - R^{ND}_{expected,c,t}\right)$$

   Where the additional term is the average difference between expected revenue and realized revenue in T non drought years in the study. This way, any non-drought related discrepancies can be correctly accounted for.

3. In equation 2, using the current price to estimate expected revenue might be problematic given that others have found that extreme weather events have their own distinct impact on prices (Berhanu & Wolde, 2019; Felix & Romuald, 2012; Ray, 2021). It may be beneficial to use in year prices adjusted for inflation to estimate expected revenues. If the idea was to allow for the focus to be just on yields, then I would recommend just leaving prices out entirely. Including prices would mean that expectations are driven by two sources: expected yields and expected prices, both of which can be separately impacted by domestic and external weather shocks.

4. The statistical crop yield model shows a regression that included several weather extremes on the right-hand side, but did not discuss how the drought contribution to yield was extracted or what it in fact looks like. Some descriptive statistics would be helpful here. Is drought driven yield just beta*drought? Is the dependent variable in subsequent analysis yields as a result of droughts? More exposition on what exactly was done to generate the variable of interest would be ideal.

5. The study simultaneously addresses two separate issues in its spatial disaggregation exercise. From my reading, the study disaggregates crops, as well as the country and it is not clear which of these is responsible for the differential when compared to national figures. This is especially true as the only differences come when crops are broken out and investigated individually. To summarize, would the national estimate lead to the same discrepancy without spatial disaggregation if the damage of each crop is investigated separately? (Basically, is the difference a result of disaggregating crops or spatial disaggregation)

Some typos…

Page 2 line 64: underestimates should be underestimate

Page 2 line 77 "…are derived from **a** the…" delete "a"

Page 3 line 97 "casual" should be "causal"

References

Berhanu, M., & Wolde, A. O. (2019). Review on climate change impacts and its adaptation strategies on food security in sub-Saharan Africa. *Agricultural Socio-Economics Journal*, 19(3), 145–154.

Felix, B., & Romuald, K. S. (2012). Rainfall shocks, food prices vulnerability and food security: Evidence for sub-saharan african countries.

Ray, C. A. (2021). The Impact of Climate Change on Africa's Economies.