Crop productions face increasing pressures from a growing world population and a changing climate. Crop yield, i.e. production per unit area, can have a high variability in time as a result of different economic and environmental factors. We focus on climate and seek to quantify the influence of extremes on maize crop yield, with special emphasis on yield drops following dry spells in major producing countries.

**RESEARCH QUESTIONS**

- How well are drops in maize yield explained by dry spells?
- Is there a link between these drops in yield and the producer’s GDP?

**DATA**

We carried out the analysis at the gridcell scale, globally - considering the world’s top 10 maize producing countries over the period 1970-2014. We link agricultural and climate data at a common grid scale of 5 arcmin (~10 by 10 km). The analysis is limited to rainfed crops, as irrigated (20% of global maize areas) ones are generally less prone to yield drops from climate extremes.

**Agricultural data**: We use information on crop areas, crop production, and crop yield.

**Spatial data** (at 5 arcmin) – with reference to the year 2000: rainfed maize areas (ha) from the MIRCA2000 dataset (Portmann et al., 2010); maize yield (tons/ha) from the dataset proposed in Monfreda et al. (2008).

**Temporal data** (at the country scale) – from 1970 to 2014: maize yield (tons/ha) from the statistical database of the FAO (FAOSTAT).

Sowing and harvesting dates of crop seasons at the grid-cell scale were also retrieved from the MIRCA2000 dataset.

**Climate data**: Global gridded Standardized Precipitation and Evaporation (SPEI) (Vicente-Serrano et al. 2010) at spatial resolution of 0.5 degrees (SPEI-base v2.5) was regressed to 5 arcmin to match agricultural data. The SPEI index (SPEI=0) wet (dry) summarizes climate information on the basis of historical data of precipitation and temperature at the time step of 1 or more months. We consider SPEI -1 -3 -6 -9 -12 month steps.

**RESULTS**

**SENSITIVITY ANALYSIS**

Finding the SPEI-month window and the crop season period that maximizes the concurrence of yield drops and SPEI=0:

- For each combination we express the angle between the centre of mass of (events with SPEI<0) and the negative x-axis (SPEI<0),
- and the percentage of events falling in the 3rd quadrant (SPEI<0.5, Yld-dist<0).

**CLIMATE-YIELD LINK**

There is a clear pattern 1st-3rd quadrant, suggesting that in general:

- Years with negative yield correspond to seasons in which the SPEI was negative.
- Conversely, to positive yield one could expect that better than normal crops would bring about increases in yield.

Exceptions exist, e.g. in 1993 in the US Midwest the yield decreased substantially as a result of flooding in the area throughout the summer.

Other events in the 2nd or 4th quadrant may result from policy tracks, variations in demand and stock, or other political or economical causes.

**GDP ROLE IN VULNERABILITY TO YIELD LOSS**

The lower the angle center of mass to negative x-axis, the higher the vulnerability to negative drops (dry spells).

- Angles within 10° include both emerging economies like India, South Africa, Brazil, but also the USA with the highest GDP pc.
- Other high GDP countries like France and Canada seem to be less sensitive than the USA to yield losses from dry spells.

- There may be a bias because the results are weighted with the production, so countries that produce more drive the choice of SPEI-month window and period of crop-season.

**CONCLUSIONS**

The occurrence of dry spells can cause substantial drops in maize yields, especially during the second half of the crop season. Generally, major climate-driven drops are observed in countries with higher GDP pc (and generally higher yields). This echoes the findings by Laski et al. (2016) using events from the EM-DAT database. Technically developed agricultural systems experience the largest reductions in yield from climate extremes, possibly because yield maximizing strategies are less considered in higher income countries.

**FUTURE WORK**

Analysis of other crops (soybeans, wheat) will provide further understanding on the signature of climate extremes on yields considering also the wet spells (SPEI>0), whose occurrence may damage the crop, especially during the sowing/growth stage (Urban et al., 2015).

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