Geophysical Research Abstracts
Vol. 18, EGU2016-16685-2, 2016
EGU General Assembly 2016

Soil Moisture Anomaly as Predictor of Crop Yield Deviation in Germany

Michael Peichl, Stephan Thober, Reimund Schwarze, Volker Meyer, and Luis Samaniego
Helmholtz Centre for Environmental Research (UFZ), Economics, Leipzig, Germany (michael.peichl@ufz.de)

Natural hazards, such as droughts, have the potential to drastically diminish crop yield in rain-fed agriculture. For example, the drought in 2003 caused direct losses of 1.5 billion EUR only in Germany (COPA-COGECA 2003). Predicting crop yields allows to economize the mitigation of risks of weather extremes. Economic approaches for quantifying agricultural impacts of natural hazards mainly rely on temperature and related concepts. For instance extreme heat over the growing season is considered as best predictor of corn yield (Auffhammer and Schlenker 2014). However, those measures are only able to provide a proxy for the available water content in the root zone that ultimately determines plant growth and eventually crop yield. The aim of this paper is to analyse whether soil moisture has a causal effect on crop yield that can be exploited in improving adaptation measures.

For this purpose, reduced form fixed effect panel models are developed with yield as dependent variable for both winter wheat and silo maize crops. The explanatory variables used are soil moisture anomalies, precipitation and temperature. The latter two are included to estimate the current state of the water balance. On the contrary, soil moisture provides an integrated signal over several months. It is also the primary source of water supply for plant growth. For each crop a single model is estimated for every month within the growing period to study the variation of the effects over time. Yield data is available for Germany as a whole on the level of administrative districts from 1990 to 2010. Station data by the German Weather Service are obtained for precipitation and temperature and are aggregated to the same spatial units. Simulated soil moisture computed by the mesoscale Hydrologic Model (mHM, www.ufz.de/mhm) is transformed into Soil Moisture Index (SMI), which represents the monthly soil water quantile and hence accounts directly for the water content available to plants.

The results indicate that wet and dry soil moisture anomalies have a causal effect on crop yields. However, the effects vary in magnitude and direction for each crop depending on the month. For instance dry soil moisture anomalies in July, August and September reduce silo maize yield more than ten percent with respect to average conditions. Extreme wetness, however, increases silo maize yield in the same time period. A negative effect is observed for winter wheat during this period for both wet and dry anomalies. The reduction due to dry anomalies is smaller for winter wheat than for silo maize.

This study shows that the impact of soil moisture anomalies varies dependent on months and crops. These evolving patterns provide new insights to improve adaptation measures for extreme soil moisture conditions.

References

Auffhammer, M., and W. Schlenker. 2014. “Empirical studies on agricultural impacts and adaptation.” Energy Economics 46:555–561.

COPA-COGECA. 2003. “Assessment of the impact of the heat wave and drought of the summer 2003 on agriculture and forestry.” In Committee of Agricultural Organisations in the European Union General Committee for Agricultural Cooperation in the European Union, Brussels. p. 15.