

Agricultural resilience to a severe drought in the Yangtze River Basin, China

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Abstract: Since July 2022, the Yangtze River basin has been experiencing the most severe drought event since 1961, when complete meteorological observations were first recorded (Ma et al., 2022). While numerous studies have been carried out to analyze the individual components of the drought, most of them focus on the hydrological or ecological consequences without the performance of agricultural resilience.

The objective of this paper is to evaluate the performance of agricultural resilience in the 2022 mega-drought in the Yangtze River basin. Our main approach involves simulating the yield of the three major grains from 2003 to 2022 and calculating the multi-year drought situation in the Yangtze River basin using the drought index PDSI and VHI. By combining the drought index analysis with the yield results, we can analyze the role of human activities in mitigating the impact of disasters such as drought on crop yield.

To achieve this goal, we first quantified the production of China's three staple crops (maize, wheat, and rice) at a 0.1° grid cell resolution using the PML-V2 model (Zhang et al., 2019) driven by climatic, underlying surface, crop harvesting area, and phenological data. This study simulated the yields of maize, wheat, and rice in the Yangtze River basin from 2003–2022 using state-of-the-art meteorological forcings (CMFD) as well as MODIS albedo, emissivity, and leaf area index data. Gross primary production (GPP) and actual evapotranspiration (AET) were the initial outputs of the PML-V2 model. The crop production and its total were obtained by the product of the GPP, harvest index, and planting areas and the product of AET and planting areas, respectively. We estimated the annual average values of the yields of the three major crops in the Yangtze River basin from 2003 to 2022 and found that the mega-drought in 2022 did not cause significant yield losses; calculated the average state of the drought index for different crops during the growth period using phenological data; analyzed the multi-year yield results with the corresponding drought index (PDSI/VHI) for sensitivity analysis.

Our results indicate that the drought event in the Yangtze River basin started in July 2022 and continued to develop, leading to some degree of agricultural crop yield loss. However, the yield loss was not aggravated compared to the situation in previous years, which may be due, on the one hand, to the misalignment between the timing of the drought and the critical growth period of crop growth and, on the other hand, to the implementation of effective drought mitigation measures.

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Keywords: *Yangtze River basin, megadrought, drought mitigation, PML-V2 model, drought index*