

Decadal Climate Variability and Global Food Security: A Case Study of Impacts of Decadal Climate Variability on Crop Yields in the Missouri River Basin

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There is a long history of decadal climate variability (DCV) in many parts of the world. Several decade-long droughts in the North American Great Plains occurred in the 1890s, the 1930s, the 1950s, the 1980s, and the years since 2001-02. There are instances of socio-economic-political instability in Brazil due to multiyear to decadal droughts. The suffering caused by the Sahelian droughts in the 1970s-1980s-1990s is well-known. Multiyear to decadal droughts in India in the early 1900s, the mid-1960s to early 1970s, the 1980s, and the late 1990s-early 2000s; and floods in the 1880-1890s, the 1930s-1940s-1950s, and the recent years are also well-known. In some of these regions, multiyear to decadal droughts and floods have been associated with major DCV phenomena such as the Pacific Decadal oscillation (PDO), the tropical Atlantic gradient (TAG) oscillation, and the Atlantic Multidecadal Oscillation. Since droughts and floods can make major impacts on food production, it is possible that DCV phenomena contribute to global food insecurity/security via their impacts on food production. This is especially relevant now because global population and food consumption are increasing, agricultural production in major producing countries, such as India, is stagnant or falling, and buffer stocks of food grains are at an all-time low level. Major, simultaneous, DCV-related decreases in food production in major producing countries can have a devastating impact on global food security, with consequent potential for socio-economic and political upheavals. Therefore, it is very important and urgent to assess impacts of DCV phenomena on global food production, and develop models and methodologies for multiyear to decadal prediction of possible climate impacts on global food production.

In this contributed paper, as a case study to illustrate assessment of DCV impacts on crop yields, we will present results from a NOAA-funded project to study DCV impacts on the Missouri River Basin (MRB) water resources and agriculture. Records available from 1950 onwards show that multiyear droughts and floods in that region are attributable to combinations of phases of three DCV phenomena, viz: the PDO, the TAG oscillation, and the Indo-Pacific Warm Pool (WP) variability. The Erosion Productivity Impacts Calculator model (EPIC) is used in our study to simulate yields of dryland corn, winter wheat, spring wheat, sorghum, and soybeans. Taking into account the increasing yields due to improving agricultural technology since 1950, we found that departures of crop yields from the increasing average yields were well-simulated and that these departures can be largely attributed to the three DCV phenomena mentioned above. In some MRB sub-regions, crop yields can change as much as 40% of the average yield due to DCV-related hydro-meteorological anomalies. Thus, major DCV phenomena appear to make significant impacts on hydro-meteorology and crop yields in the MRB. The methodology developed in this project can be used with EPIC and other well-calibrated crop models in other major food-producing regions of the world to assess DCV impacts on agricultural production and possibly estimate future, multiyear to decadal production if future evolution of major DCV phenomena can be predicted.

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