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Modelling the impacts of extreme weather events on crop yields using water balance and satellite sensor data

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Managing weather related risks in cropping systems includes strategies to share the risk such as insurance schemes. Advances in satellite sensor technology and interpolated regional weather data enable insights in the relationship between extreme weather events and yields losses which in turn offers possibilities for area-yield insurance schemes.

Extreme weather events during sensitive phenological stages of the growing season differed significantly ($p < 0.05$) between low and high crop yields (Gobin, 2012; Gobin, 2018). Spatial return levels confirmed the exceptionality of 2016 and 2018 as extreme wet and dry years with high return periods and yield impacts (Gobin and Van de Vyver, 2021). We investigated the importance of weather data, satellite sensor-derived vegetation indices and water balance simulations in estimating crop yields of winter wheat, potato and sugar beet for the period 2016-2018. The water balance simulations were performed with the Aquacrop model, while the yield simulations were realised with the machine learning technique random forest regression. Results for winter wheat showed that NDVI series did not respond to crop yield affecting weather conditions (Vannoppen and Gobin, 2021). Weather and/or soil water depletion during sensitive phenological stages in combination with the NDVI integral during the growing season explained up to 57 of late potato, 66% of winter wheat, 68% of early potato and 84% of sugar beet yield variability.

Machine learning techniques proved valuable in estimating crop yields thereby elucidating the importance of weather conditions during sensitive crop stages. The crop yield models developed make use of commonly available remote sensing indicators and weather data, and are commensurate with regional scale decision making.

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