



## Vulnerability of maize, barley, and wheat yields to growing season temperature and socioeconomic indicators in Morocco

Soumia Achli<sup>1</sup>, Terence Epule Eplule<sup>1</sup>, Driss Dhiba<sup>1</sup>, Abdelghani Chehbouni<sup>1,2</sup>, Salah Er-Raki<sup>2</sup>, and Wiam Salih<sup>1</sup>

<sup>1</sup>Mohamed VI Polytechnic University, International Water Research Institute, Morocco (soumia.achli@um6p.ma)

<sup>2</sup>Mohamed VI Polytechnic University, Center for Remote Sensing and Applications, Morocco

Africa's agricultural growth will be complicated by climate change, which is expected to worsen already difficult conditions. In many cases, agricultural yields are becoming more volatile due to deteriorating weather conditions. Climate change is likely to exacerbate severe extreme events by increasing temperatures and further altering rainfall patterns. In Morocco, the historical record depicts a situation characterized by increasing temperatures and diminishing precipitation, which often ends up in severe drought episodes and affects crop production. This study investigates the vulnerability of wheat, barley, and maize to fluctuations in growing season temperature as well as socioeconomic proxies of adaptation capacity such as literacy and poverty rates in Morocco at both national and sub-national scales. A composite vulnerability index is adopted in this research; it posits that vulnerability is a function of the exposure index, sensitivity index, and adaptive capacity index. FAOSTAT and the yield gaps Atlas provided the national and sub-national crop yield data required to compute the sensitivity index. The world bank climate portal is utilized to obtain mean annual growing season temperature data at both national and subnational scales and is used to calculate the exposure index. Finally, the world bank, figshare, and MPR archives are used to acquire proxy data on adaptive capacity in the form of literacy and poverty rates. The results indicate that wheat has the lowest vulnerability index and the highest adaptive capacity index, while barley has the highest vulnerability index and the lowest adaptive capacity index. Maize falls somewhere in the middle with median indexes. Another notable observation is that the coefficient of determination  $R^2$  for all crops is generally very low, indicating that temperature during the growing season is a very strong yield determinant. Sub-nationally, Vulnerability indexes and normalized growing season temperature decrease as one moves northwards, whereas the adaptive capacity index increases. Also, at each latitude northward wheat records the lowest vulnerability index and the highest adaptive capacity index as well as, the second-highest normalized growing season temperature after maize. Furthermore, these findings have significance for establishing climate change adaptation or coping techniques, cereal responses, and adaptation to variation in temperatures, as well as the mechanisms underlying heat tolerance development and socioeconomic indicators for key crops that should be included in the Moroccan Agricultural Transformation Agenda.