

Climate-Related Risk Modelling of Banana Xanthomonas Wilt (BXW) Disease Incidence within Cropland Area of Rwanda

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Background

- Rwanda, densely populated with 12.5 million people in 2018, heavily depends on bananas for food and income. However, BXW disease threatens up to 100% yield loss, with no effective controls. Our study evaluates the vulnerability of Rwandan banana farms to BXW, considering current and 2050s climate conditions.

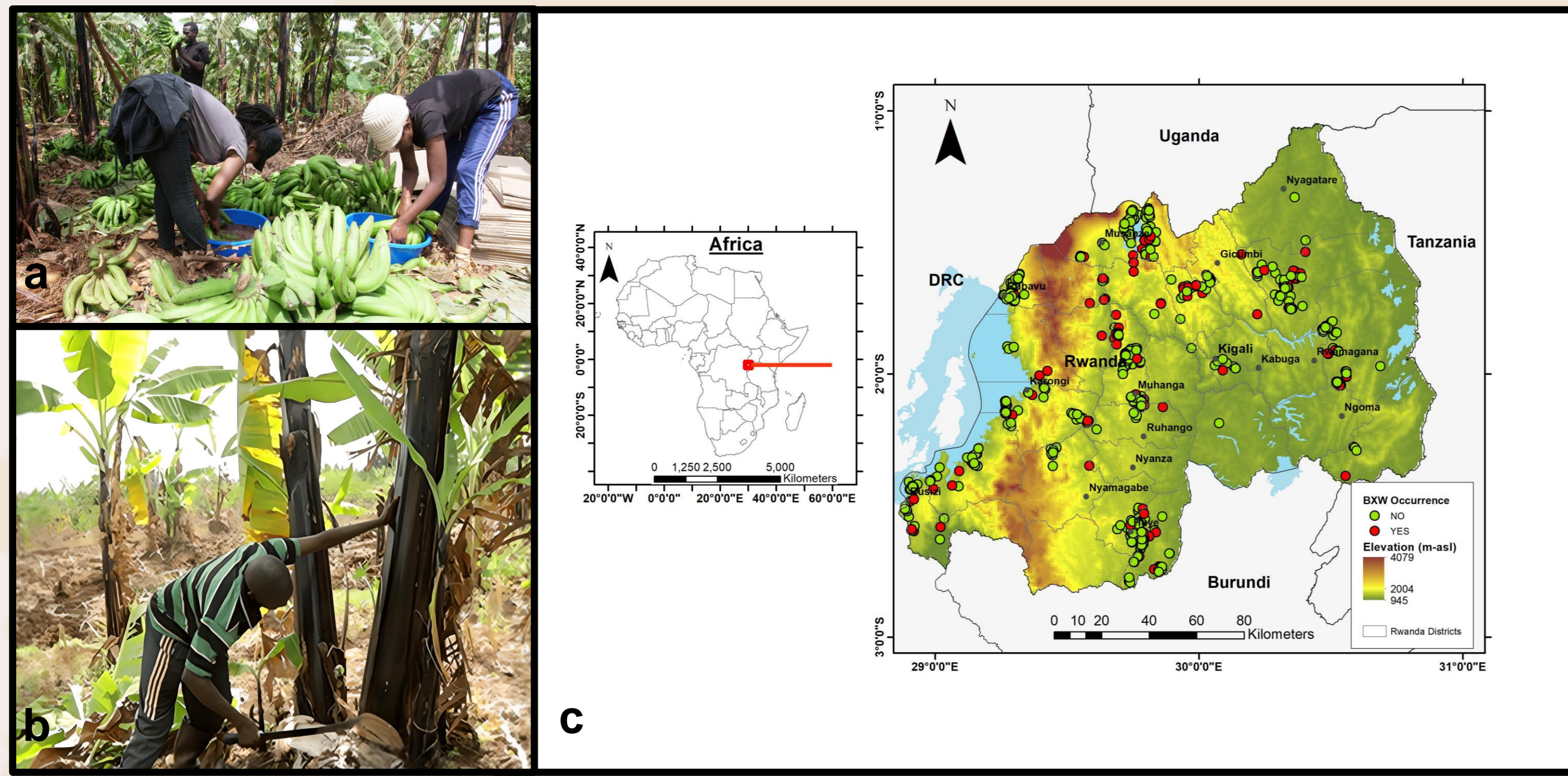


Fig 1. a) Farmer harvesting banana. b) Farmer clearing BXW infested banana mats. c.) Recent Report of BXW Incidence in Rwanda. The red-filled circles indicate the presence of BXW and the green-filled circles indicate the non-detection of BXW.

Objectives

To provide early warning and guide action towards control of BXW disease in Rwanda by assessing –

- The climatic and environmental risk factors that have the most influence on the spread of BXW
- Magnitude and direction of BXW occurrence risk under current and future climate scenarios within banana land area

Methods

Data Collection

Occurrence data (Oct 2018 to Feb 2022) - through surveys and the BXW app (www.ict4bxw.com).
Environmental variables: Historical, current and future climate data

Data Analysis

Data cleaning and transformations (30 arc seconds resolution, WGS 84 projection).
Mapped to only croplands regions

Risk Modelling

BXW locations were combined with environmental variables to predict the spatial risk of BXW occurrence using Maxent (version 3.4.1).

- Historical climate data - WorldClim (Fick and Hijmans 2017); Future climate data for 2050s - CCAFS (RCPs; 6.0 and 8.5) (Ramírez-Villegas and Jarvis 2010); Croplands data - NASA (Xiong et al. 2017).

Farmers can independently access BXW information, including on-farm diagnosis and mitigation steps, through the BXW app (available on Android Play store) and other scalable digital tools (IVR and chatbot). This study leveraged nationally crowd-sourced (and surveyed), spatially explicit incidence data.

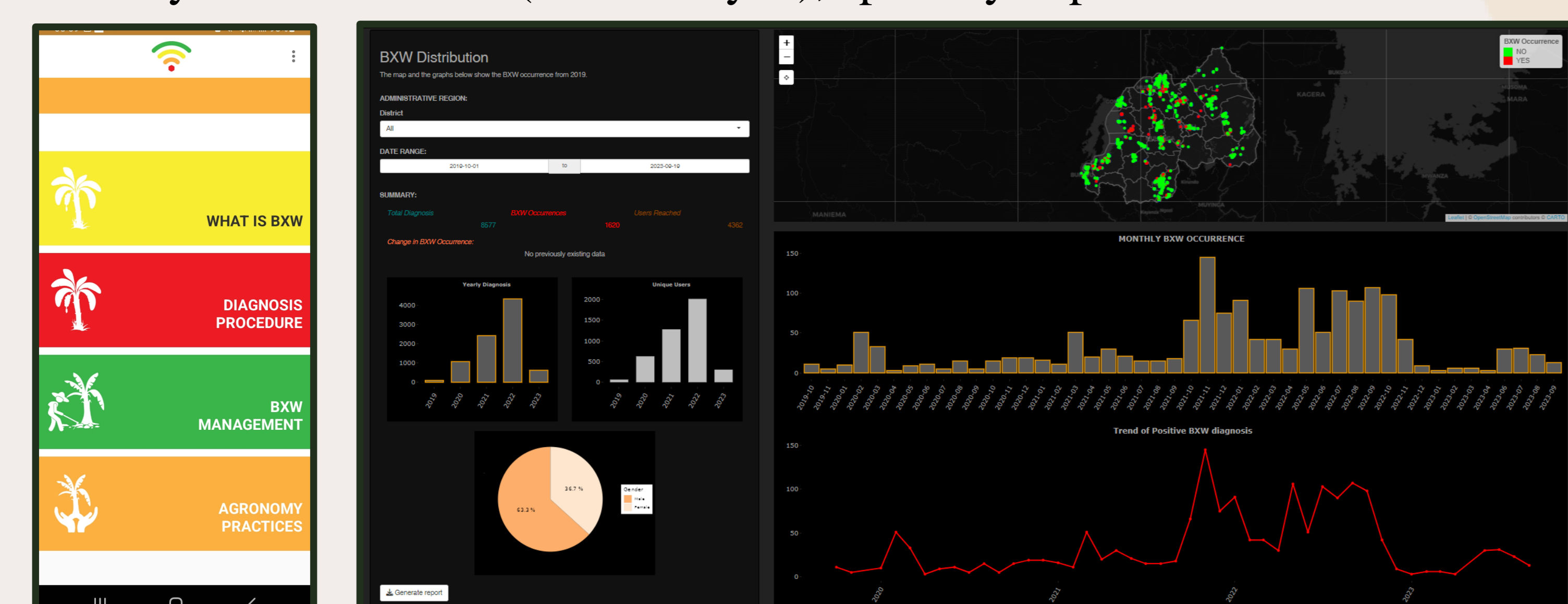


Fig 2. Front-end user interface for the android-based BXW App and back-end surveillance dashboard national real-time tracking

Results

- Precipitation of the coldest quarter, average maximum monthly temperature, annual precipitation, and elevation were strongest predictors, explaining 21.1 %, 13 %, 12.6 %, and 9.4 % of the observed incidence variability.

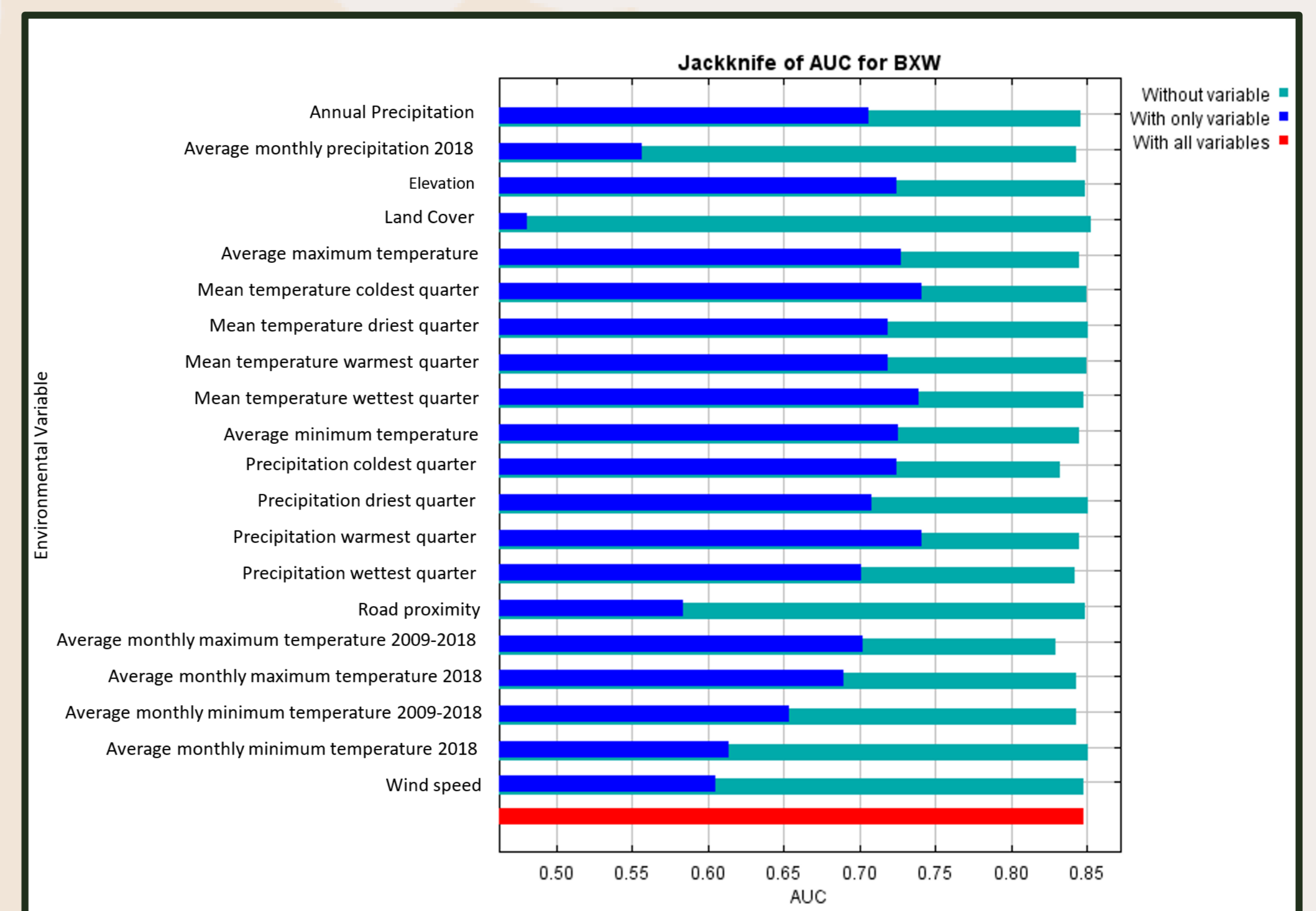


Fig 4. Relative importance of selected environmental variables.

High-Risk Areas

- Regions vulnerable to BXW occurrence under the current climate include parts of western, northern, and southern Rwanda, suggesting that a consistent, rainy, and warm climate is more favorable for BXW spread.

Implications

- Predicted BXW occurrence area is likely to increase in the future and exacerbate banana land area and yield losses.

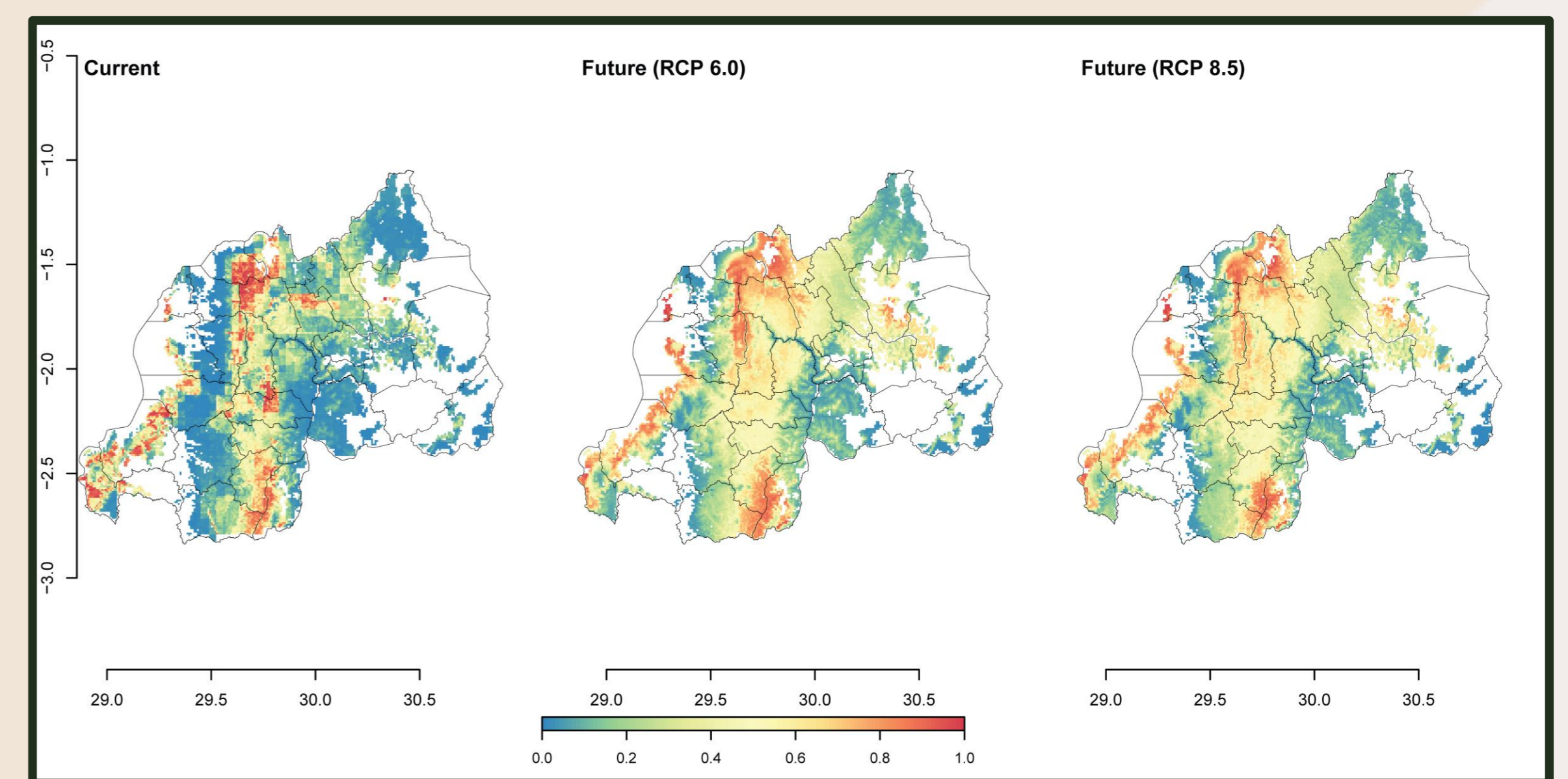


Fig 5: BXW risk in Rwanda for current climate and future climate (2050s) for RCP 6.0 and 8.5 scenarios

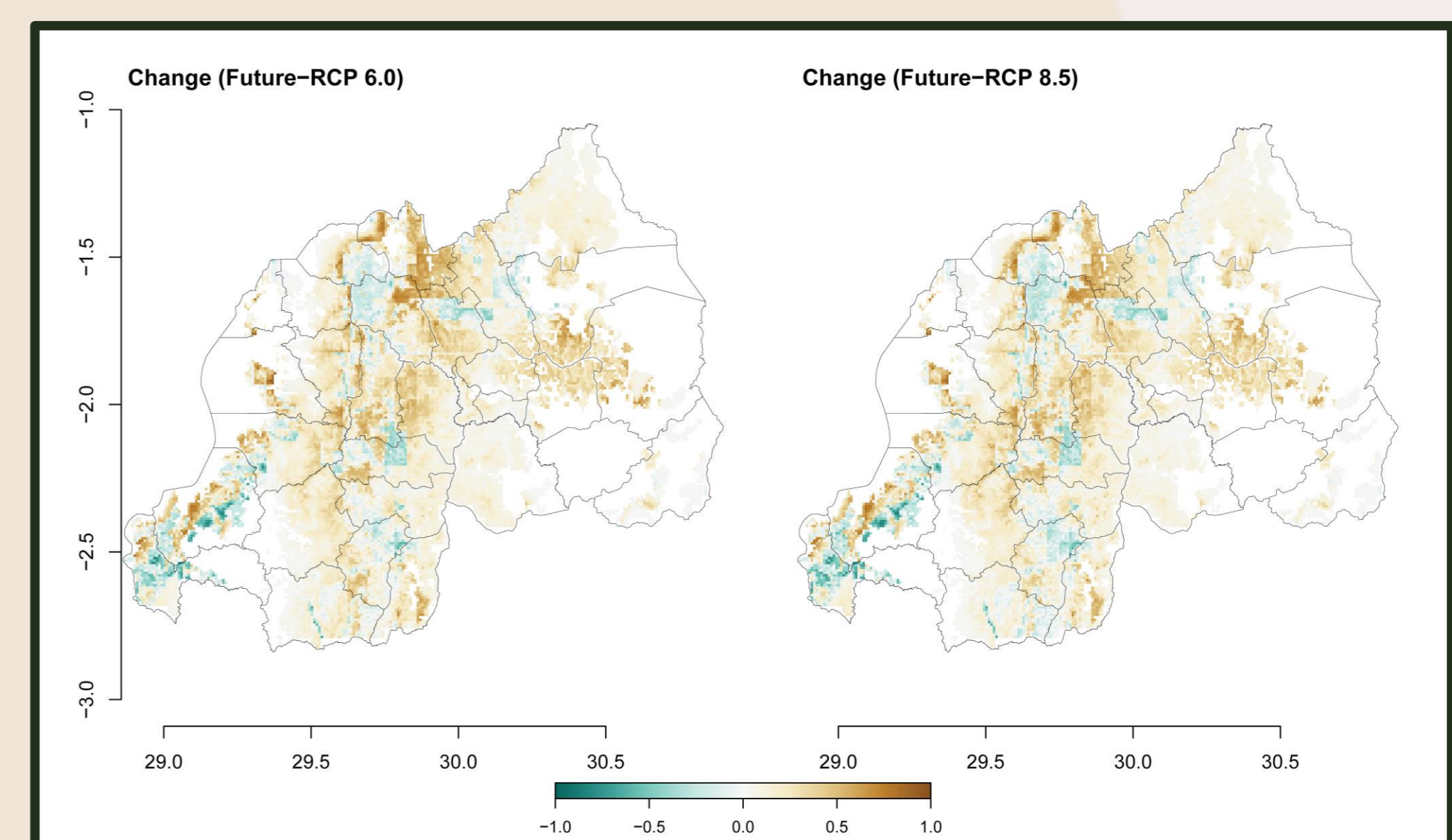


Fig 6: Change in BXW occurrence risk in future climate for RCP 6.0 and RCP 8.5, relative to current climate.

Conclusion

- Findings support evidence-based extension delivery and proactive national early warning on emerging risk.
- More users using the BXW app can provide more representative data, helping to proactively control BXW and other crop diseases in Rwanda, especially with changing cropping systems.