AI 2025
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Smarter Maps for a Warmer World: AI Approaches in Environmental Modelling

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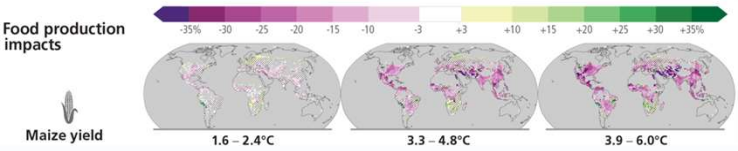
Introduction

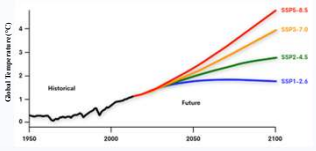
Maize production in Sub-Saharan Africa must triple to meet the needs of future generations. The region's heavy reliance on rainfed farming makes crops highly vulnerable to temperature and rainfall changes. Maize, the main cereal crop, is grown on over 40 million hectares and provides a major food source for more than half of the countries. With the population expected to double in the next 30 years, cereal demand is projected to triple [1].

Global trends add to this challenge: agriculture must increase production of staple crops like maize, wheat, and rice by about 70% by 2050 to feed an additional 3.5 billion people. Yet rising temperatures, shifting rainfall, and more frequent extreme weather events are expected to reduce yields, especially in tropical and subtropical regions [2].

Projected climate impacts show significant maize yield losses across key production regions, including much of Sub-Saharan Africa (purple areas in the map indicate yield declines) [4].



Understanding climate change impacts on maize areas is key for building resilience and ensuring food supply [5]. This study applies a presence-only model (MaxEnt) to map current maize suitability in Sub-Saharan Africa and project changes under 2050 climate conditions. Using environmental data and machine learning, the analysis identifies potential shifts in cultivation areas, providing insights to support climate-resilient agricultural planning.



Methods

1 DETERMINE STUDY AREA

Focused on seven maize-producing countries in Sub-Saharan Africa.

2 GATHER CLIMATE DATA

- Bioclimate Baseline Layer 1970-2000
- Bioclimate Projected Layer by 2050

3 COLLECT MAIZE PRESENCE DATA

- GFSAD (Global Food Security-Support Analysis Data)
- SPAM (Spatial Production Allocation Model)

4 PREPARE MODELLING POINTS

- Created 100,000 random sample points for training.

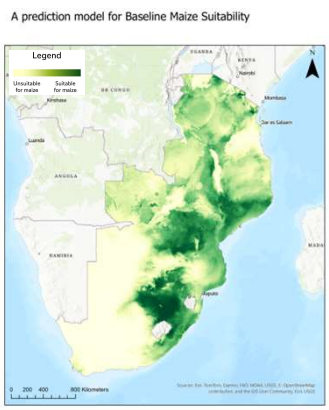
5 TRAIN THE MODEL (MAXENT)

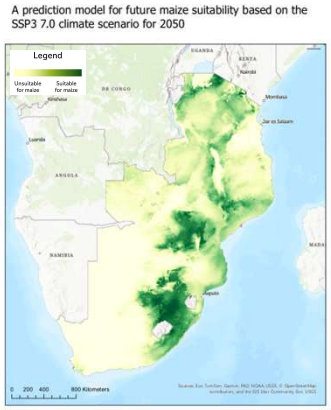
- Baseline Bioclimate Variables
- Project Future Suitability Based on SSP3-7.0

Result & Discussion

The study compared current and future maize suitability across the region. The model was trained with 100,000 maize presence points and 19 baseline bioclimatic variables, achieving about 70% accuracy, sufficient for ecological modelling.

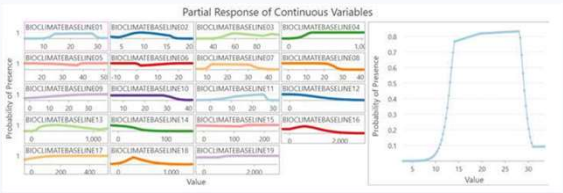
Using projected 2050 climate data under SSP3-7.0, the model predicted major reductions in suitable maize-growing areas, especially in the south, where future conditions are expected to be increasingly unfavorable.





The Partial Response Of Continuous Variables chart summarizes and visualizes the impact of each bioclimate variable on the probability of presence of maize.

Annual mean temperature strongly influences maize suitability. Maize suitability is highest at moderate temperatures (15–25 °C) and declines sharply under hotter conditions.



Limitations: Predictions relied only on bioclimatic variables, excluding soil, topography, land use, socioeconomic factors, and pest pressures. Only one climate scenario (SSP3-7.0) and timeframe (2050) was considered. Future work should integrate multiple climate scenarios and additional variables for more robust predictions.

Conclusion

The comparison between baseline and future maps (SSP3–7.0) shows a significant decline in suitable maize-growing areas by 2050. Even small cropland losses can threaten national food security, particularly in regions dependent on smallholder farming. The results highlight how key climate factors, especially extreme temperatures, influence maize suitability.

Prediction modelling helps anticipate these shifts, supporting adaptation strategies to reduce the risks of climate change.

Reference & Acknowledgment

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This poster is based on work prepared for the Spatial Ecology course at the University of Bayreuth, using materials from the Esri training course GIS for Climate Action. Data preparation, analysis, and mapping were carried out with Python and ArcGIS Pro.