Desert locust breeding grounds in East Africa: An ecological niche modelling approach

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Introduction

- Unprecedented invasion of desert locusts has been experienced in East Africa between 2019-2020.

- The voracious gregarious swarms feed on vegetation including key staple crops such as maize and sorghum as well as pasture.

- The invasion has seen many parts of the affected countries experiencing huge economic losses and food insecurity.

Introduction

- The behavior, ecology, and physiology of desert locusts is highly influenced by climatic conditions.
- After mating, the female desert locust lay eggs in soils at 10–15 cm below ground.
- Oviposition and subsequent breeding is influenced by factors such as soil type, soil moisture, surface air temperature, rainfall, and prevalence of vegetation.

Objective

- The study focused on:

- Developing a decision support tool to control the locust invasion from its breeding sites effectively.

- Understanding the influence of environmental variables on desert locust breeding grounds.

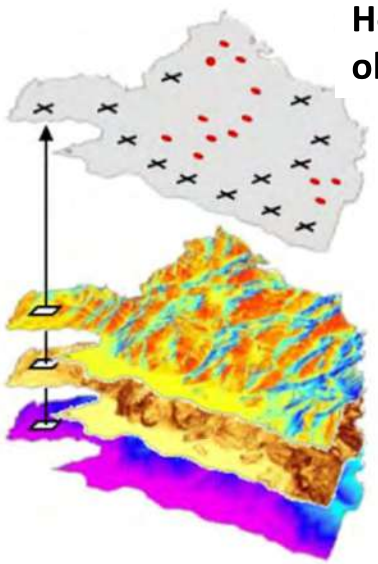
- Projecting the habitat suitability for breeding and oviposition of desert locusts to East Africa.

Methodology

Data acquisition and pre-processing

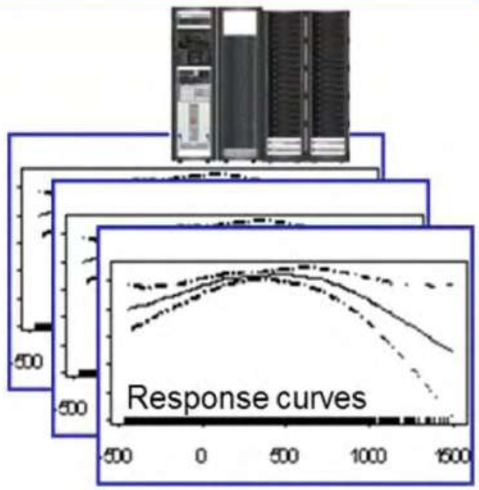
Ecological niche modelling

Spatial model outputs

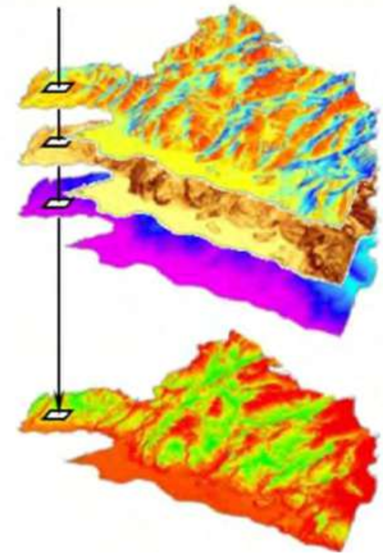


Hoppers field observations

Environmental variables



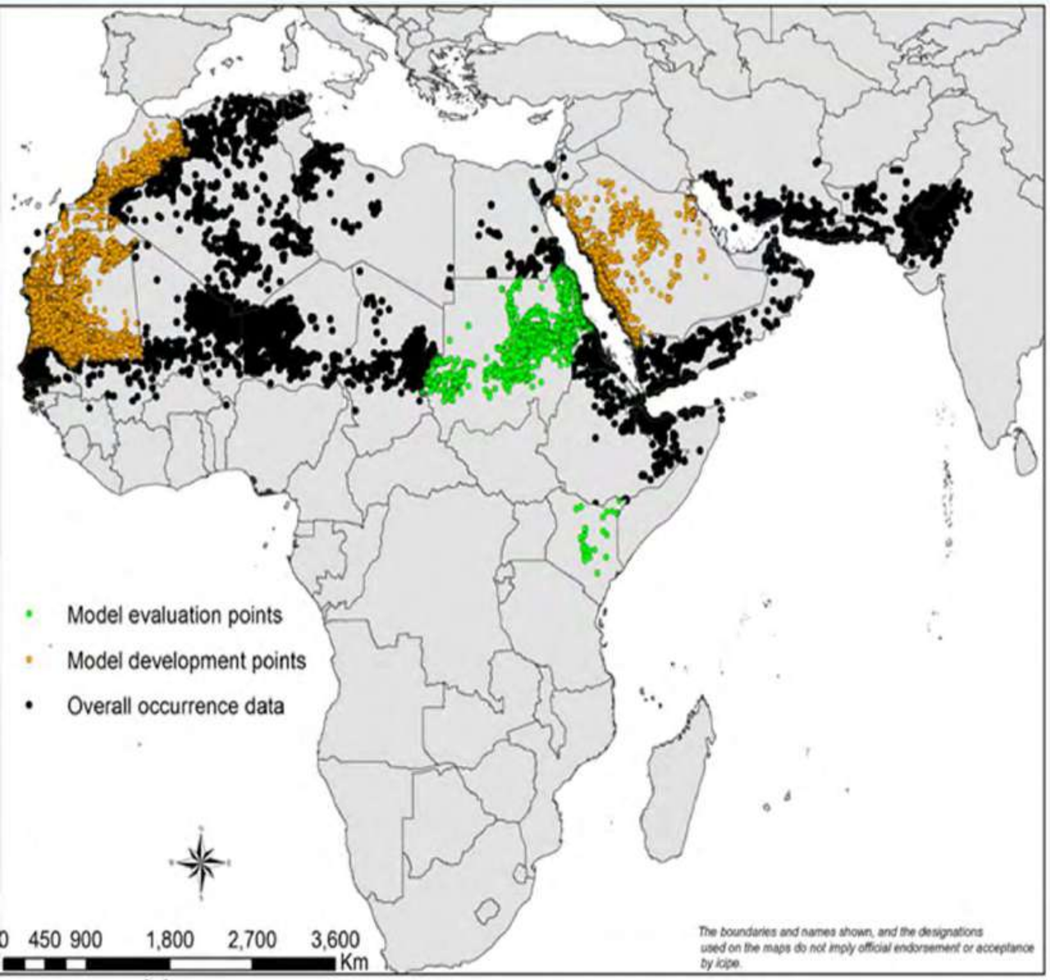
Maximum entropy(MaxEnt) approach



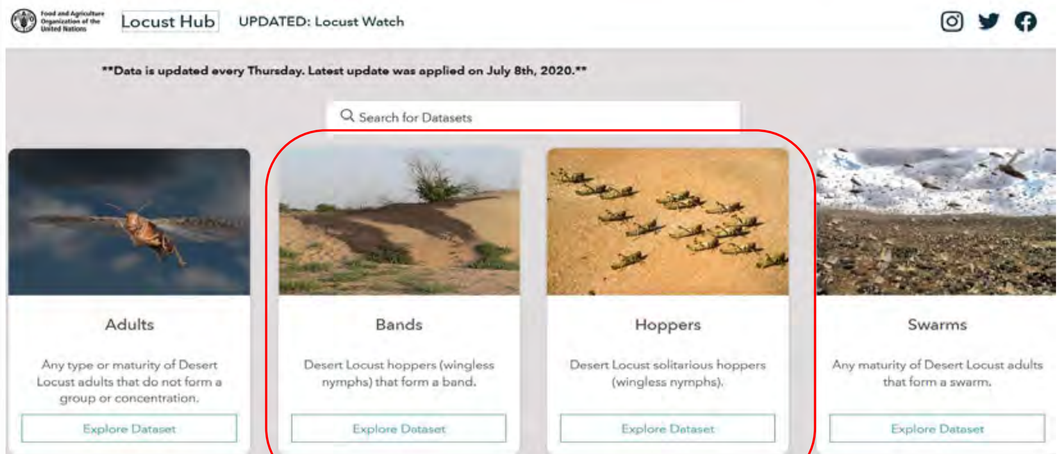
Predicted suitable breeding grounds distribution

Source:Rpubs

Data acquisition

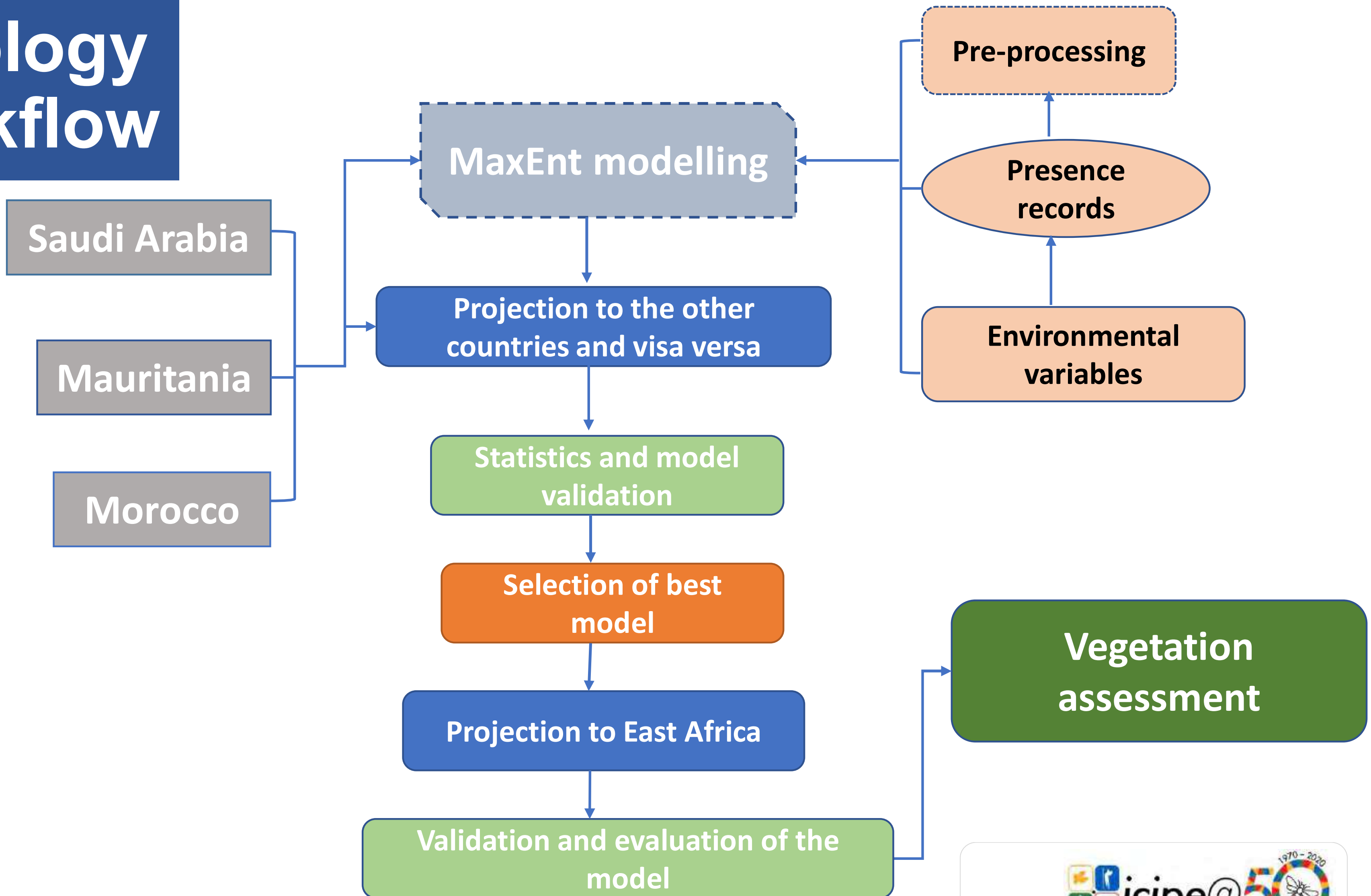


- Geo-referenced data(1985-2019) on Locust hoppers were sourced from FAO locust hub (https://locust-hub-hqfao.hub.arcgis.com/).



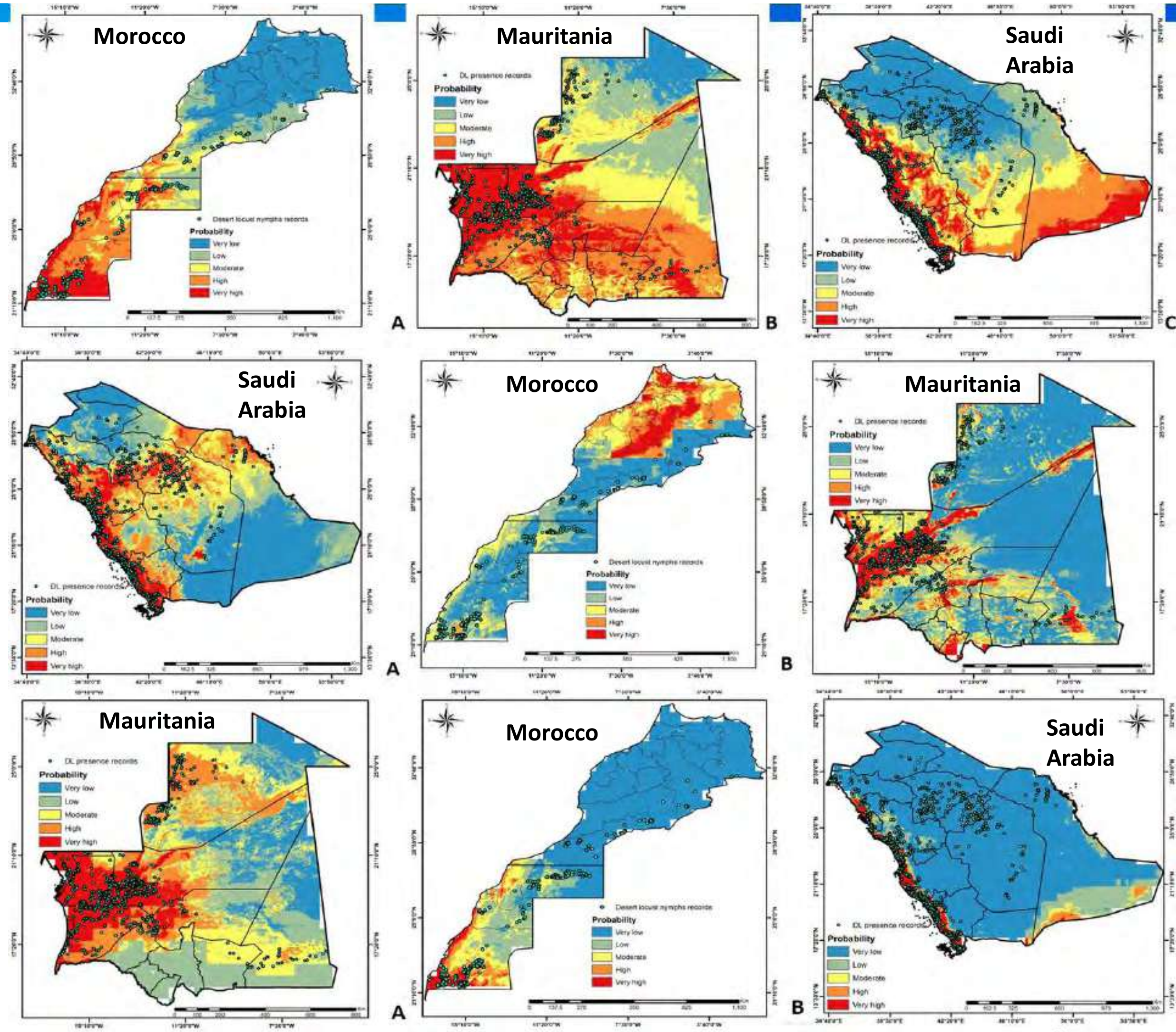
Variable	Data source
Temperature(monthly long-term average)(Dec-Mar)	Worldclim
Rainfall(monthly long-term average) (Dec-Mar)	Worldclim
Soil moisture(long term average)	NOAA
Sand content(5 - 15cm depth)	ISRIC

Methodology and workflow



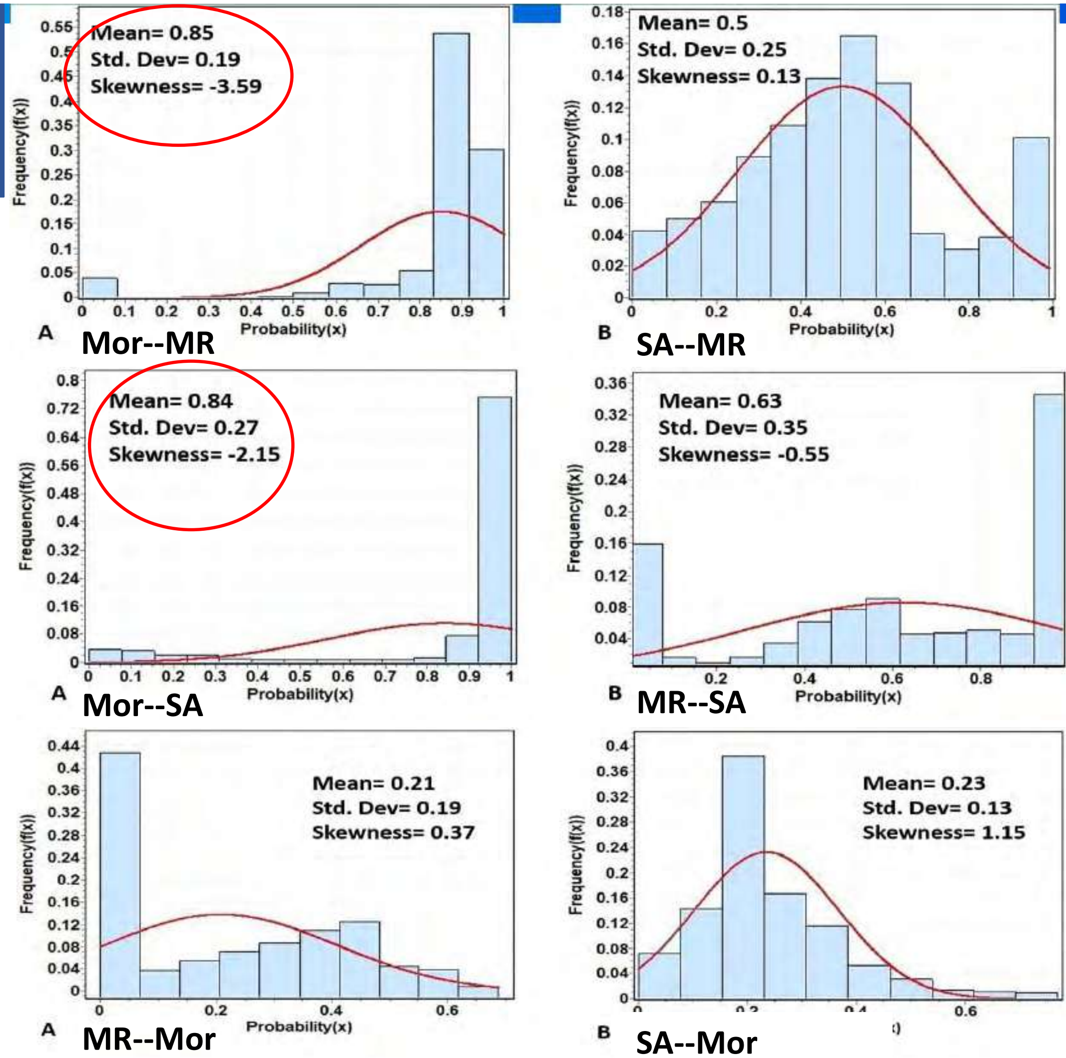
Results

- Morocco performed the best in projecting the breeding sites in Mauritania and Saudi Arabia.
- Independent presence records were used to validate the projected models.



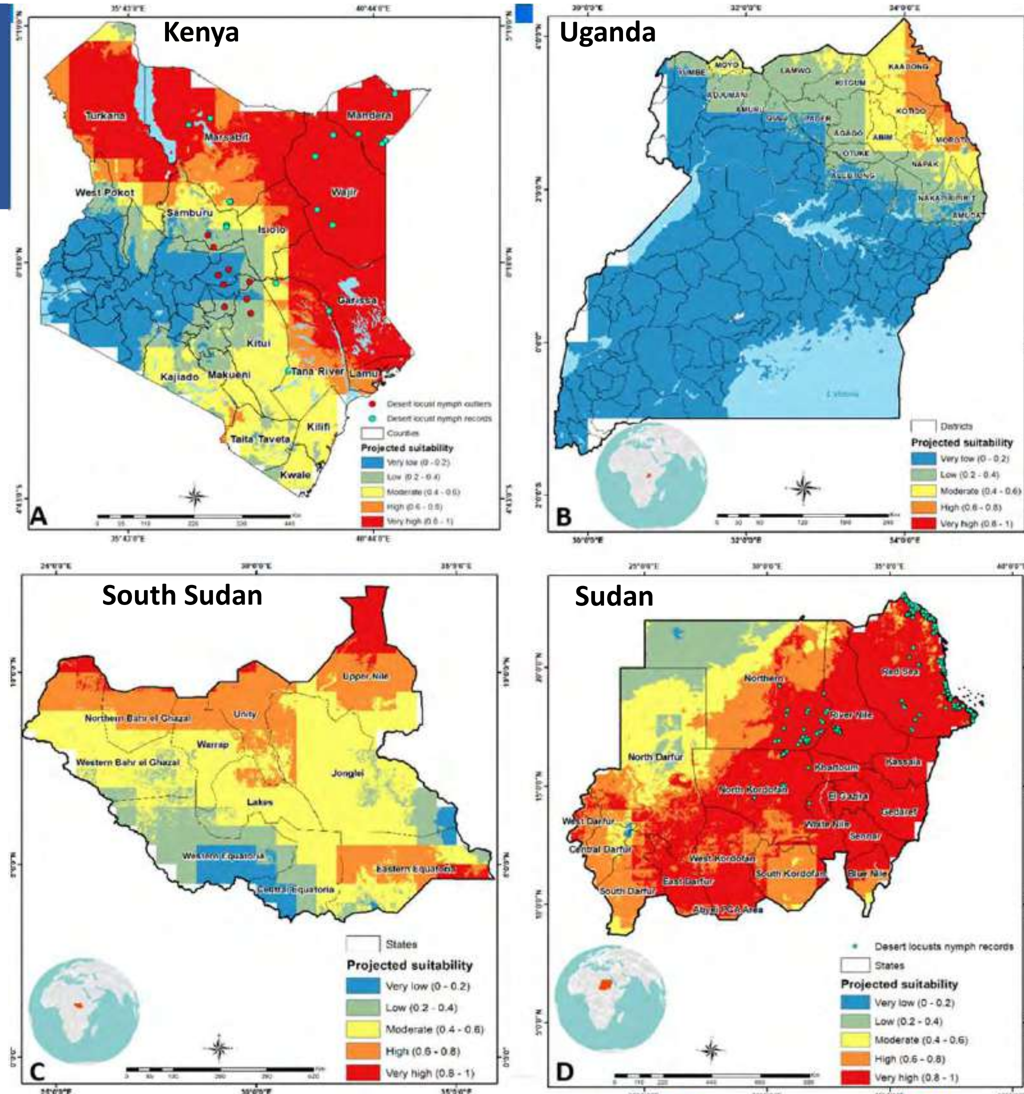
Statistics and model validation

- Histogram and normal distribution fitting curves were developed to assess the model performance.
- Morocco model projecting to Mauritania and Saudi Arabia had the highest mean of 0.85/0.84 and a skewness of -3.59/0.27 respectively.
- Morocco model was used to project the breeding regions in East Africa.

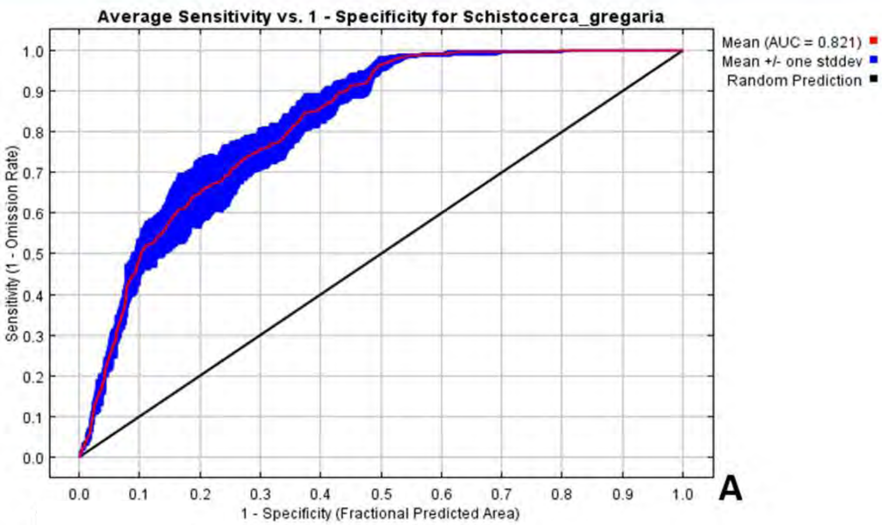


Projection to East Africa

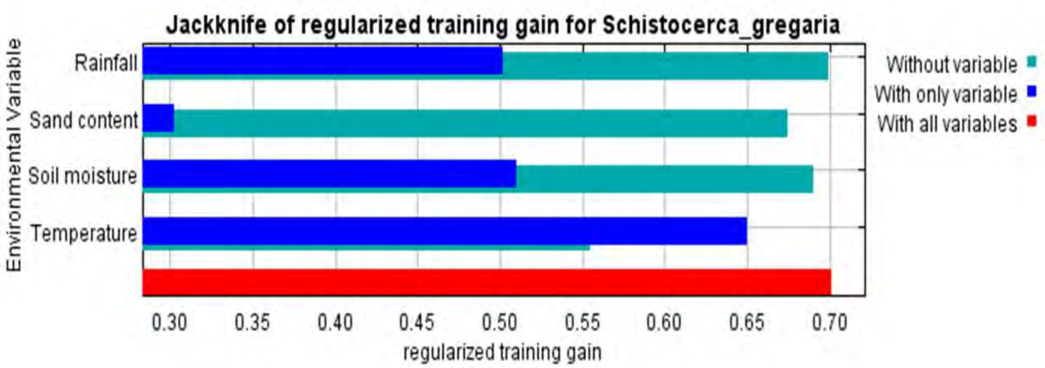
- Vast areas of Kenya and Sudan, northeastern regions of Uganda, and southeastern and northern regions of South Sudan are at high risk of providing a conducive breeding environment for the desert locust.
- Geo-referenced data recorded in Kenya and Sudan were overlaid on the model for validation.



Model evaluation and variable importance



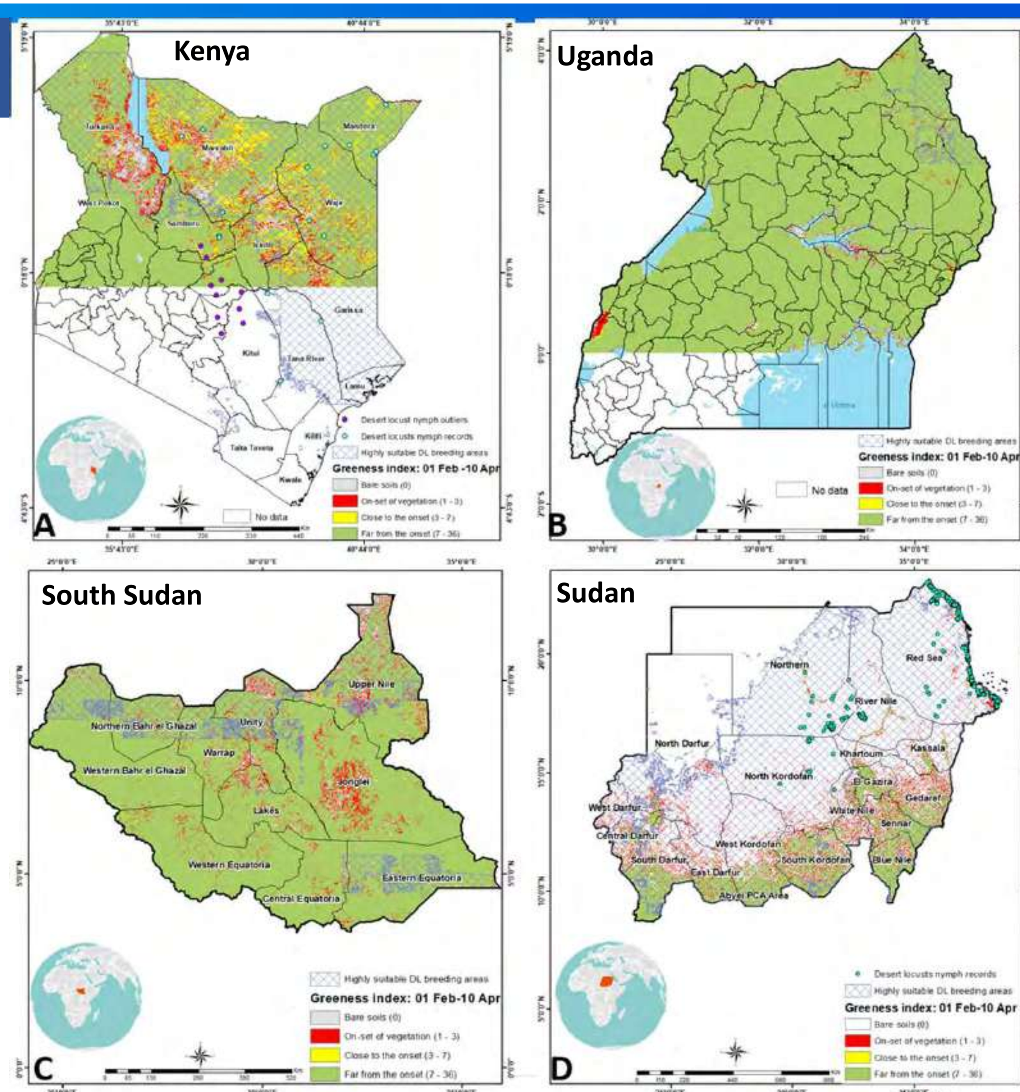
- Accuracy of the models was tested using the receiver operated characteristics (ROC) by analyzing AUC
- AUC values > 0.7 demonstrate high model prediction performance (Mohammadi et al., 2019)



- Temperature and soil moisture decreases the model value of gain the most when it is omitted therefore indicating its significance to the suitability of breeding grounds.

Vegetation analysis

- A 10-day greenness index dataset was used assess the emergence of vegetation from Feb – April 2020.
- The desert locust projected model was overlaid on the vegetation index maps.
- The analysis helped to dynamically detect the progression of the changes of breeding locations due to the temporal variation of the on-set of vegetation in East Africa.



Conclusions

- The maps provide a decision support tool that will guide survey teams to effectively monitor potential breeding areas.
- This analysis has been crucial in understanding the habitat niches of the desert locust breeding sites and the environmental variables influencing its distribution.
- This information will guide in preparedness and prioritization of ground surveillance on desert locust breeding and deployment of best-bet solutions for effective management of desert locust.
- It is critical to strengthen ground and aerial surveillance efforts to identify potential breeding sites for timely and effective management of hopper bands.

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Abstract

Desert locust outbreak in East Africa is threatening livelihoods, food security, environment, and economic development in the region. The current magnitude of the desert locust invasion in East Africa is

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