

Applications of ecological niche modelling for mapping the risk of Rift Valley fever in Kenya

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Geographical area of study: Kenya



Outline

- Background and objectives
- Methodology
- Outputs
- Discussion
- Conclusion

Background

✘ Rift Valley fever (RVF) is an acute febrile arthropod-borne zoonotic disease

✘ **Aetiology:** RVFV, family *Bunyaviridae* , genus *Phlebovirus*.

✘ **RVF History in Kenya :**

✓ 1912- first report of RVF-like disease in sheep

✓ 1931-Virus isolation and confirmation (Daurbney *et al.*, 1931)

✓ 2006/2007-last outbreak in Kenya

Background

RVF niche

- ✓ *El Niño/Southern Oscillation* (ENSO) –causing flooding
- ✓ soil types- solonetz, solanchaks, planosols
- ✓ Elevation-less than 1100m asl
- ✓ Natural Difference Vegetation Index (NDVI)- 0.1 units more than 3 months
- ✓ Vector- *Aedes*, *Culicine*, and others
- ✓ *Temperature*

(Linthicum *et al.*, 1999; Anyamba *et al.*, 2009; Hightower *et al.*, 2012; Bett *et al.*, 2013)

Objective

Map RVF potential distribution

- ✓ Disease occurrence maps
- ✓ This study used ecological niche modelling:
 - Uses presence data
 - Shows potential areas where RVF can occur

Methodology

Two way

>ENM

>Logit

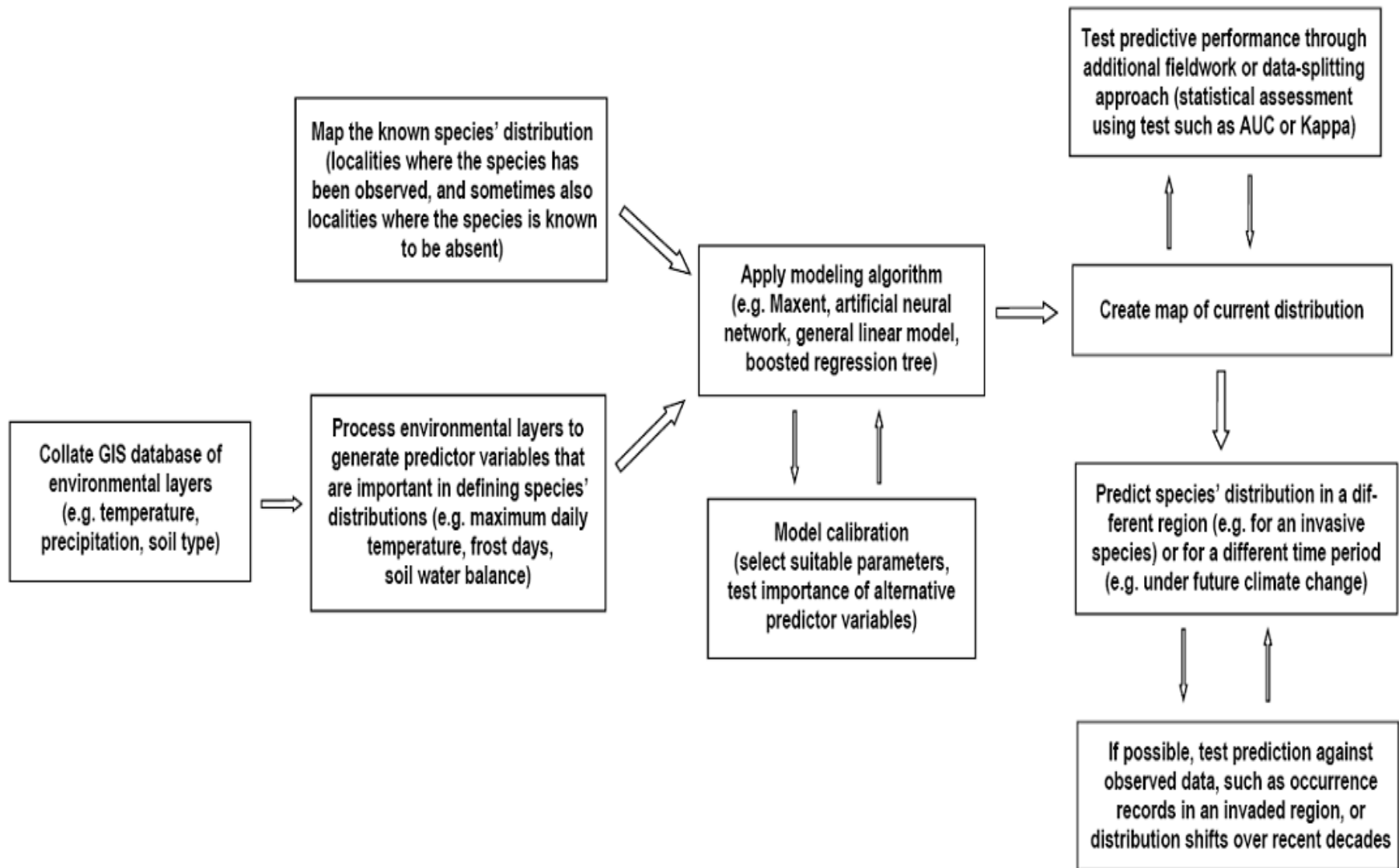
Methodology

>ENM

Strategy for estimating the actual or potential geographic distribution of a species; is to characterize the environmental conditions that are suitable for the species and then identify where suitable environments are distributed in space

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Methodology



ENM

✓ **Environmental layers**

- Land use and land cover maps
- Precipitation
- NDVI
- Temperature
- Elevation
- Soil types

✓ **Occurrence data**

- Data describing the known distribution of a species(RVF) exist in a GIS format – point data (lat long)

ENM

✓ Algorithms(GARP)

Genetic Algorithm for Rule set Production (GARP); an open modeller software creates ecological niche models for species

GARP algorithm was used to map the actual and potential distribution of Rift Valley fever distribution in Kenya and result compared to random forest cover

Uses rules of selection, evaluation, testing and incorporation or rejection in modeling

ENM

✓ Evaluation

Assess the accuracy (Confusion matrix)

- Area Under Cover (AUC)

> Defined by plotting sensitivity against 1 specificity across the range of possible thresholds of 0.82

Swets (1988) and Manel et al. (2001) AUC of 0.5 – 0.7=poor, 0.7 – 0.9=moderate and >0.9 is high performance

- A partial receiver operating characteristic (ROC) analyses AUC prediction with a value of 1.77 (0= not good, at 1.0=very good and 2.0=excellent)

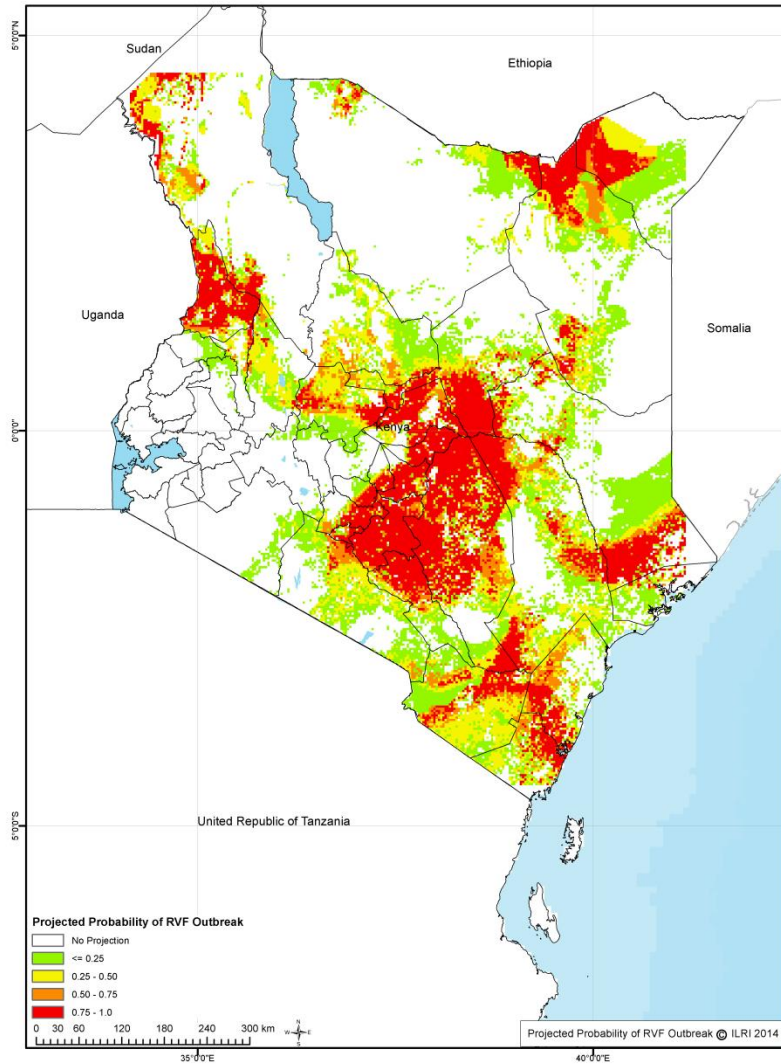
ENM

- ENM output was compared with random forest (covers more spatial areas and shows consistency)
- Jackknife analysis = Variable analysis

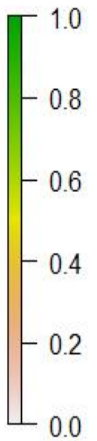
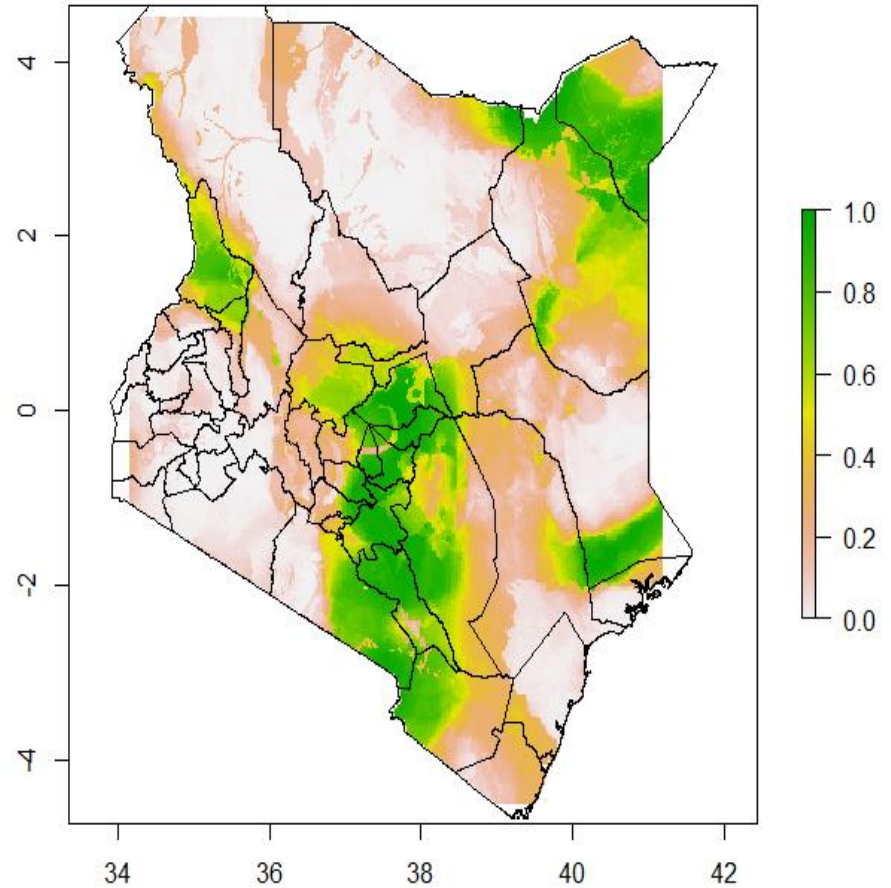
LOGIT

- 2-year data(2006-07)
- Case-control design cases(grid 25 by 25km +ve (20%) control)
- Done to rank variables contributing to output
- Input (soil, rain, NDVI, elevation, temperature)

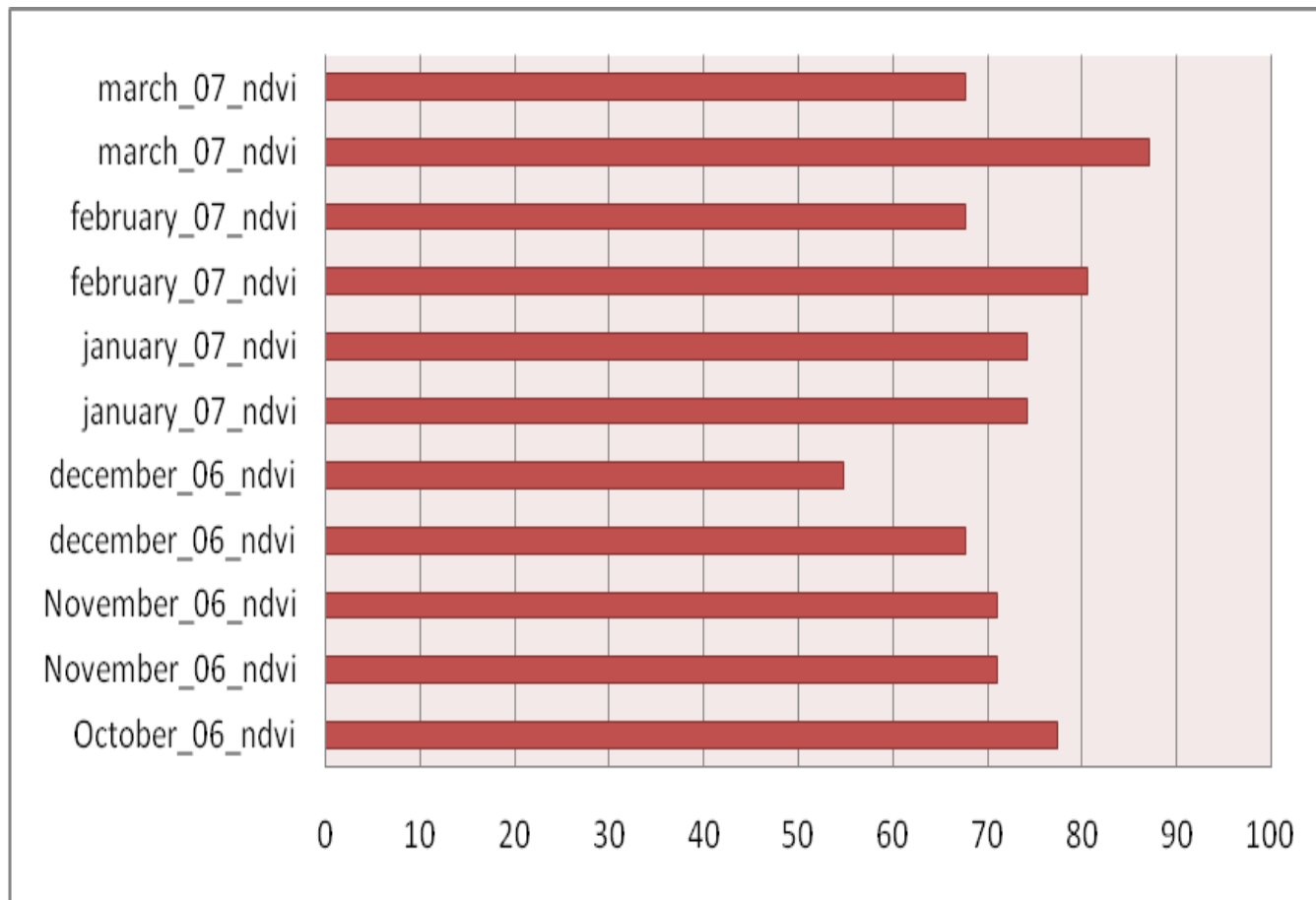
Output



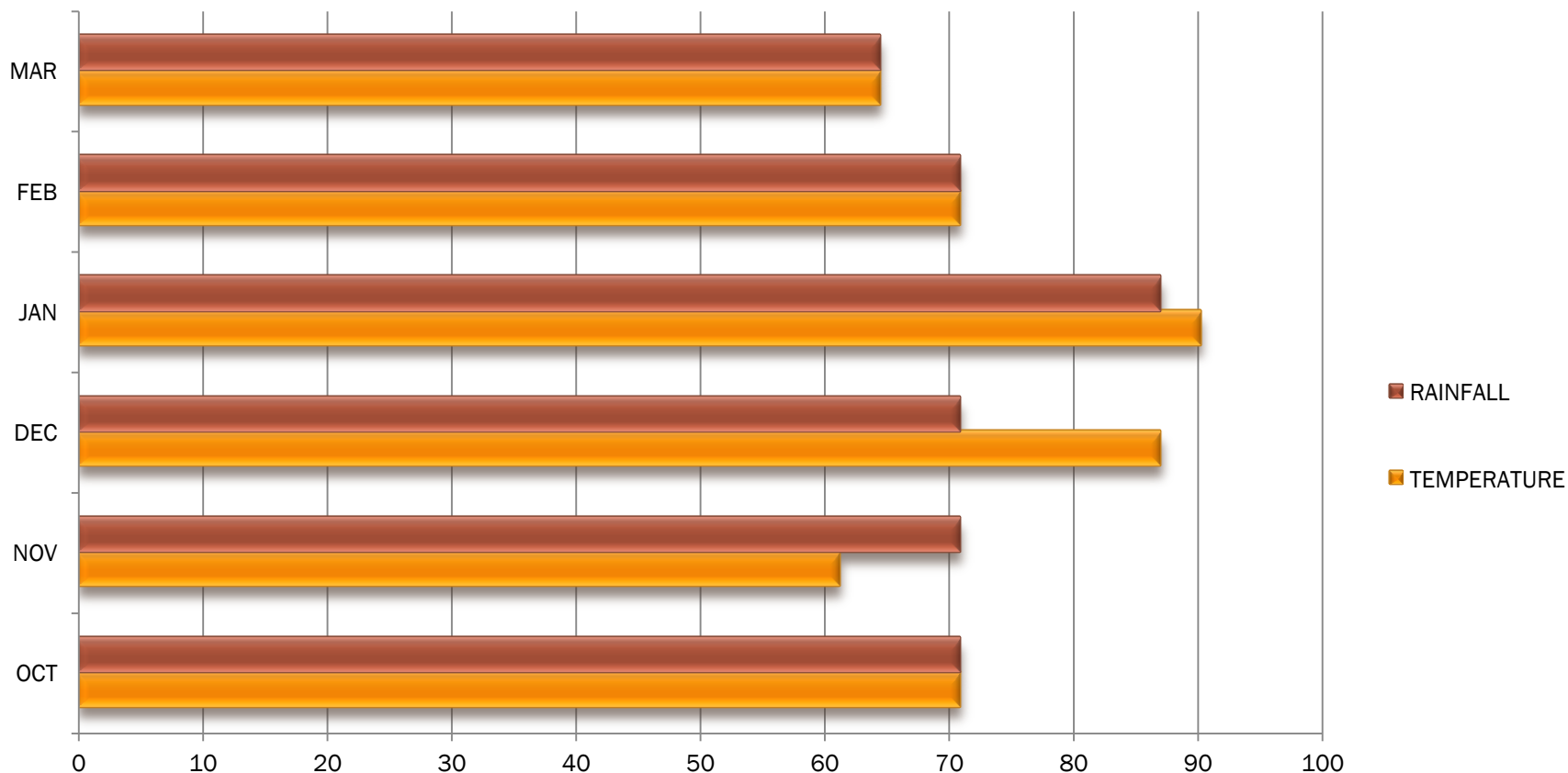
RVF distribution map using Random Forest



Jackknife Output NDVI variables



Jackknife Output rainfall and temperature



Discussion

- ENM only shows spatial distribution areas of the disease but doesn't show variable contribution to output (correlation)
- Shows potential and high-risk areas where disease can occur
- Both models important shows consistency
- Logit done = ranks variable contribution to output and shows relationship between variables

Conclusion

This will help policymakers to know which areas to focus their attention and put plans in place when the outbreak occurs again

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