THE APPLICATION OF ECOLOGICAL NICHE MODEL TO MAP OUT THE RIFT VALLEY FEVER RISK AREAS IN KENYA

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DECLARATION

I hereby declare that this thesis is my original work and has not been presented for a degree in any other University.

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ABSTRACT

Rift Valley fever (RVF) is an acute, mosquito-borne zoonotic viral disease of economic importance caused by a virus of the *Phlebovirus* genus, *Bunyaviridae* family that mainly affects ruminants and humans. It causes abortion in gravid animals and high mortality in young animals, characterized by massive hepatic necrosis and pantropic haemorrhage. Rift Valley fever-like disease in livestock was first reported in Kenya in 1912. Numerous studies have shown close relationship between climatic conditions and outbreaks of Rift Valley Fever. *Aedes* and other mosquito species such as *Culex* are the vectors responsible for the disease transmission in both animals and humans.

Various studies carried out to map RVF distribution using a variety of approaches including the use of disease occurrence maps, statistical models which uses presence and absence data e.g. the logistic regression method. However, acquiring correct absence data is not easy and hence maps generated from standard statistical models might not be a true representation of the disease distribution. In this study ecological niche modeling (ENM) was used to model the supporting niche of RVF and determine the distribution of RVF in Kenya using Genetic Algorithm for Rule set Production (GARP) and Random Forest (RFs) which are programs that use presence-only data.

The data were collected at two levels; primary and secondary data collection. For primary data it was acquired by using Global Positioning System (GPS) for georeferencing and also through questionnaire administration to specific farmer affected by RVF in the RVF hotspot areas as per the records obtained from the Director of Veterinary Services (DVS). Secondary data collection included environmental variables which were used as the input data. They included: land use, soil type, elevation, vegetation index (obtained after downloading from
Moderate Resolution Imaging Spectroradiometer (MODIS) satellite spanning from October 2006 to March 2007), rainfall and temperature for the same period of time as the satellite imagery. Of the sampled data ENM was done using Bioclim, GARP and RFs mainly for comparison purposes. In GARP, 70% was used to train the model and 30% to test the model. A parallel analysis that used logistic regression model was done to identify statistical relationships between predictors used in the ENM model and the outcome. This is because ENM are good for prediction but not for analyzing mathematical relationships between variables. The results showed factors that were significant at 95% confidence interval for the outbreak of RVF were; open to closed forests having a crude OR of 1.93, Solonetz soil type having OR of 1.6 and NDVI having OR of 4.66. A one unit increase in temperature decreases the risk of RVF by 10%, and a change in altitude from ≤500 to 500 - ≤1000 is associated with 94% decrease in outbreak of RVF.

Analysis of the questionnaire data showed that 27.38% of the areas visited had human cases of RVF. The key livelihood activities were: crop farming (contributing 30%) and livestock keeping (35%). The result from ENM mapped the expected distribution of RVF in Kenya. The model was evaluated using the Area Under Cover (AUC) statistic and partial Receiver Operating Characteristic (pROC). The estimates generated from GARP were 0.82 for AUC and 1.77 for pROC respectively indicating that the model predicted the RVF distribution satisfactorily. The results will be used to improve the already existing maps and for better planning of mitigation measures.