REMOTE SENSING AND DYNAMIC MODELLING TO FORECAST RIFT VALLEY FEVER OUTBREAKS IN SENEGAL

Annelise TRAN [1,2*], Valérie SOTI[2,3], Mawlouth DIALLO[4], Danny LO SEEN[2], Pascal DEGENNE[2], Yaya THIONGANE[5], Jean-François GUEGAN[6], Didier FONTENILLE[6], Véronique CHEVALIER[1]

[1]CIRAD, UPR AGIRs, Campus International de Baillarguet, 34398 Montpellier Cedex5, France. Tel. +33 4 67 54 87 36, Email: annelise.tran@teledetection.fr
[2] CIRAD, UMR TETIS, Maison de la Télédétection, 34093 Montpellier Cedex5, France.
[3] CIRAD, UPR SCA, Campus de Lavalette, 34093 Montpellier Cedex5, France.
[4] Institut Pasteur de Dakar, BP 220, Dakar, Senegal.
[5] ISRA/LNERV, BP 2057, Dakar-Hann, Senegal
[6]IRD, UMR MIVEGEC, F34394 Montpellier, France.

ABSTRACT

Rift Valley Fever (RVF) is a vector-borne viral zoonosis, transmitted either through exposure to infected animals or through bites from infected mosquitoes, mainly from the *Aedes* or *Culex* genera. In semi-arid areas, water bodies, which are full during the rainy season, allow the development of *Aedes* and *Culex* mosquito species. In East Africa, RVF outbreaks are known to be closely associated with heavy rainfall events, which lead to an above normal abundance of the vectorial populations. In Senegal, there is strong evidence that the disease is endemic. Yet, the correlation found in East Africa between extreme rainfall events and RVF outbreaks occurrence is not valid. We propose here a modelling approach which makes use of remote sensing data to investigate *i)* the role of rainfall temporal distribution in RVF outbreaks and *ii)* the possibility to develop an early-warning system for RVF in Senegal.

The study area is an agropastoral zone located in Northern Senegal, a region characterized by a dense network of temporary water ponds which provide suitable breeding sites to RVF vectors. A pond hydrological model is combined with a mosquito population model to predict the abundance of the two main mosquito species involved in RVF virus transmission in Senegal (*Aedes vexans arabiensis* and *Culex poicilipes*). The hydrological model uses daily rainfall as input to simulate variations of pond surface areas. The mosquito population model is mechanistic, considers both aquatic and adult stages and is driven by pond dynamics. High spatial resolution remote sensing data are used to derive the hydrological and environmental characteristics of the ponds necessary to run the models.
Once validated using hydrological and entomological field data, the model was used to simulate the abundance dynamics of the two mosquito species over a 43 year period (1961-2003). Analyzing the predicted dynamics of mosquito populations with regards to the years of main outbreaks showed that the main RVF outbreaks occurred during years with simultaneous high abundances of both species. Daily satellite rainfall estimates (TRMM) were used as alternative to ground-measured rainfall data to develop a forecasting tool of RVF in Senegal.

Our study provides a mechanistic insight on RVF virus transmission in Northern Senegal. It highlights the complementary roles of *Aedes vexans* and *Culex poicilipes* mosquitoes in virus transmission and the potential of remote sensing and mechanistic modelling to develop an early-warning system of RVF outbreaks in Senegal.

KEYWORDS

Rift Valley Fever, Senegal, modelling, remote sensing, early-warning system.