Spatial modelling of mosquito vectors for Rift Valley fever virus in Northern Senegal: integrating satellite-derived meteorological estimates in population dynamics models

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Supplementary Information File S1: Sensitivity analysis

A sensitivity analysis (SA) was carried out to assess the sensitivity of the model to the parameters (Table 1), for the three species, namely *Aedes vexans*, *Culex poicilipes*, and *Culex tritaenyorhynchus.*

We used the OAT (One-factor-at-a-time) Morris method (Morris, 1991), as revised by Campolongo (1999). The variation space of each parameter (Table S1) was defined by their value +/- 10%. We used the maximum abundance of mosquitoes (peak value) as output of the simulation. The SA estimates the effects of a single parameter by sampling the parameter space and obtaining a distribution of the elementary effects of the parameter considered on the output. From that distribution, mean (μ*, calculated on absolute values) and variance (σ) are calculated from that distribution. A high mean indicates a parameter with an important effect on the output, whereas a large variance indicates either a factor interacting with another factor, or a factor whose effect is non-linear.

Table S1. Parameters and initial conditions for the sensitivity analysis

Parameter	Definition
β_1	Number of eggs laid per ovipositing nulliparous female
β_2	Number of eggs laid per ovipositing parous female
σ	Sex-ratio at emergence
γ_{Aem}	Development rate of emerging adults (day^{-1})
γ_{Ah}	Transition rate from host-seeking to engorged adults (day^{-1})
γ_{Ao}	Transition rate from ovipositing to host-seeking adults (day^{-1})
μ_{em}	Mortality rate during emergence (day^{-1})
μ_r	Mortality rate related to seeking behaviour (day^{-1})
μ_E	Minimum egg mortality rate (day^{-1})
μ_L	Minimum larvae mortality rate (day^{-1})
μ_P	Minimum pupae mortality rate (day^{-1})
κ_L	Minimum environment carrying capacity for larvae (larvae ha^{-1})
κ_P	Minimum environment carrying capacity for pupae (pupae ha^{-1})
Td	Minimal length of desiccation period for *Aedes* eggs (days)
Start	First day of the favorable season
End	Last day of the favorable season
n0	Initial population

Results

In Figure S1a, different groups of parameters can be distinguished: a first group of parameters with low μ* and σ values indicating a low effect on the outputs and a linear relation without interaction; a second group with intermediate μ* (<0.5) and low σ values indicating a linear relation without interaction; and a last group with high μ* and σ values (Figure S1a).

Overall, most parameters have an influence on the output 'peak value', indicating that the models could not be simplified. They have no impact on the date of the peak.

The models for *Ae. vexans* and *Cx. poicilipes* are more sensitive to the parameter values than the model for Cx. *tritaeniorhynchus.*

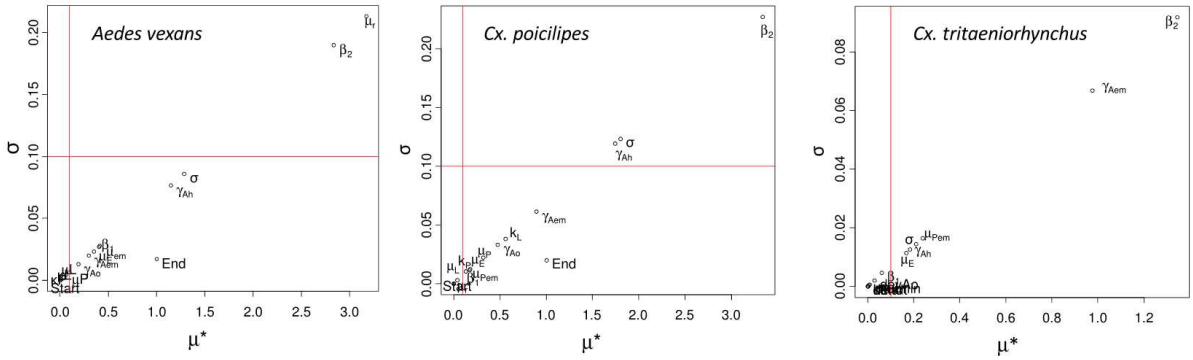

Figure S1a. Results of the Morris OAT sensitivity analysis for *Aedes vexans, Culex poicilipes,* and *Culex tritaenyorhynchus.* The model output is the maximum abundance of adult mosquitoes. The graph represents the average of elementary effects in absolute values (μ*) according to their standard deviation (σ) to model outputs. The red lines delimit the space in three types of parameters: i) those with negligible effects (μ*<0.1), ii) those with linear effects on the output, and without interaction between parameters (σ <0.1), iii) those with interactions and/or nonlinear relationship (μ* >0.1 and σ >0.1).

SA results for *Ae. vexans*

The parameters having the more impact on the peak value of *Ae. vexans* are the mortality rate related to seeking behavior, the number of eggs laid per ovipositing parous female, the sex-ratio at emergence, the transition rate from host-seeking to engorged adults, and the last day of the favorable season.

SA results for *Cx. poicilipes*

The parameters having the more impact on the peak value of *Cx. poicilipes* are the number of eggs laid per ovipositing parous female, the sex-ratio at emergence, the transition rate from host-seeking to engorged adults, the development rate of emerging adults, and the last day of the favorable season.

SA results for *Cx. tritaeniorhynchus*

The parameters having the more impact on the peak value of *Cx. tritaeniorhynchus* are the number of eggs laid per ovipositing parous female, the transition rate from host-seeking to engorged adults, the mortality rate during emergence, the development rate of emerging adults, the transition rate from host-seeking to engorged adults and the egg mortality.

Supplementary Information Figure S1: Comparison of observed (red dots) and predicted (black lines) mosquito population dynamics in the three study ponds (Nacara, Djidou and Diaby) of Younoufere study area, Ferlo, Senegal, 2014–2016