Yves Dumont
UMR AMAP - CIRAD, FR-34980 MONTPELLIER
e-mail: yves.dumont@cirad.fr

Chikungunya: an unusual vector-borne disease. Overview and new research trends.

In 2006 Réunion Island faced a huge Chikungunya epidemic. Since then, in 2007, and more recently, in september 2010, a few cases of Chikungunya appeared in Italy and in South of France. Since the explosive epidemic in Réunion Island, our knowledges on the Chikungunya virus and its principal vector, *Aedes albopictus*, have increased (see [6] for instance). In some sense, Chikungunya is an unusual vector-borne disease: it has been proved that a mutation in the virus in 2005 has led to an increase in the probability of transmission from human to mosquito, and had also a strong impact on the life-span of infected mosquitoes [6], which may explain the explosive epidemic in 2006 in Réunion Island. All these biological assumptions have been taken into account in the models studied in [2,3]. After some theoretical works [1, 2] on the modeling of the epidemic and on the use of chemical vector control tools, like adulticides and larvicides, we recently have studied the "Pulsed" Sterile Insect Technique (SIT) as a biological alternative to insecticides, because mosquito can develop a resistance to insecticides [3]. Moreover SIT is known to be a species-specific environmentally nonpolluting method. In particular, we showed that frequent and small releases of sterile males can be efficient to control an epidemic, but only if it is considered early in the epidemic.

All published models are temporal models, i.e. they don't take into account the spatial component. Based on [2], we have filled this gap, considering a patchy model in order to take into account human displacements between cities in Réunion Island [1]. We have computed the Global Basic Reproduction Number, $\mathcal{R}_{0,G}$, for the patchy model, and we have showed that even if locally $\mathcal{R}_0$ is less than 1, $\mathcal{R}_{0,G}$ can be greater than 1, indicating that population displacements could have an effect on the global dynamic of the outbreak. For practical purposes, we show that vector control in cities where $\mathcal{R}_0$ is large, could be efficient to control globally the epidemic.

Finally, based on field experiments, we have include the spatial component in the modelling of the mosquito population. This leads to a complicate system of non linear partial differential equations [5]. The final aim is to "optimize" locally vector control by reducing the breeding sites or/and by using the Pulsed SIT. We will illustrate the presentation with numerical simulations.

References

[1] S. Bowong, Y. Dumont, and J.J. Tewa, A patchy model for the Chikungunya Disease in Réunion Island, submitted.

[2] Y. Dumont, F. Chiroleu and C. Domerg, On a temporal model for the Chikungunya disease: modeling, theory and numerics, Math. Biosci. **213** (2008), 70-81.

[3] Y. Dumont and F. Chiroleu, Vector Control for the Chikungunya Disease, Mathematical Bioscience and Engineering, **7**(2) (2010), 315-348.

[4] Y. Dumont and J.M. Tchuenche, Mathematical studies on the Sterile Insect Technique for the Chikungunya Disease and *Aedes albopictus*, submitted.

[5] Y. Dumont, and C. Dufourd, Spatio-temporal modeling of *Aedes albopictus* dispersal in Réunion Island. Application to the release of Sterile Insects, submitted to ECMTB 2011.

[6] E. Martin, S. Moutailler, Y. Madec, and A.B. Failloux, Differential responses of the mosquito Aedes albopictus from the Indian Ocean region to two chikungunya isolates, BMC Ecol. 10:8 (2010).