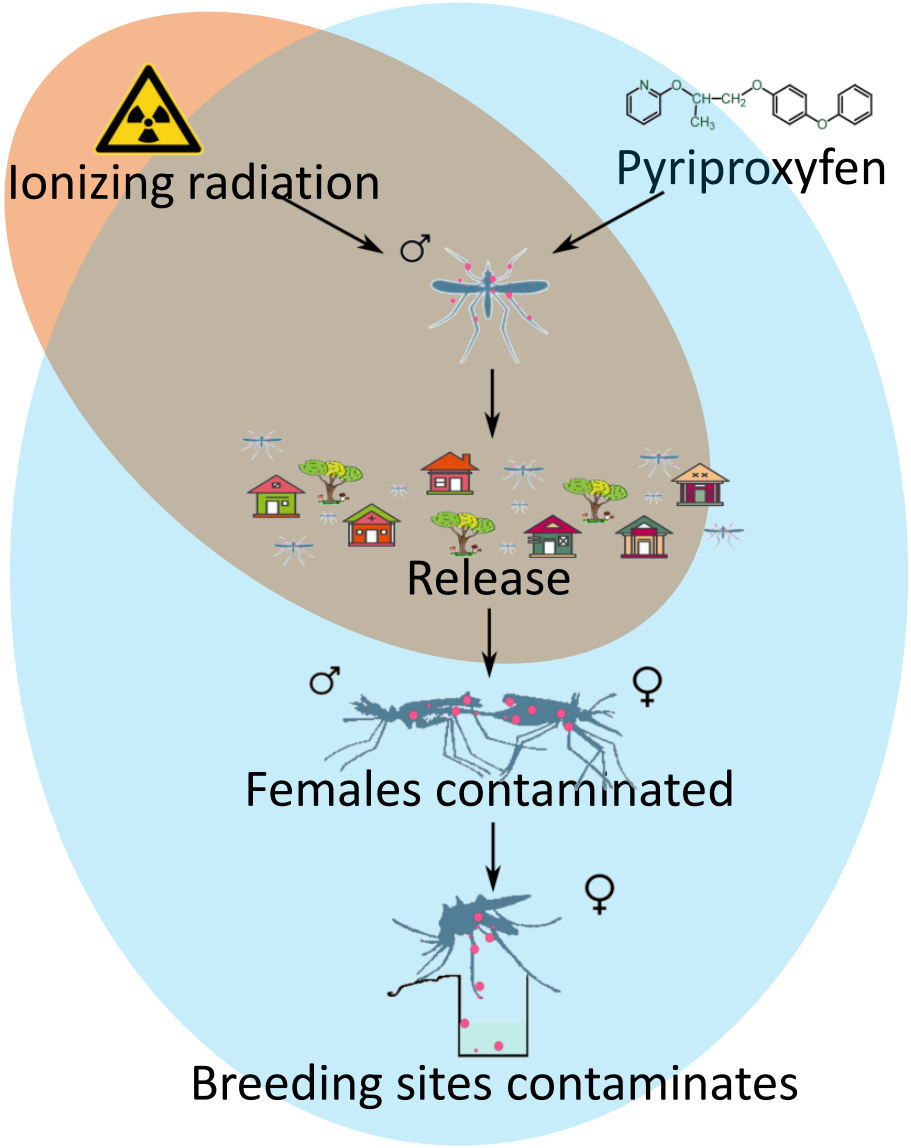
Modeling effects of alternative control methods on the tiger mosquito population at the Reunion island

Marion Haramboure

E^2M^2 2019

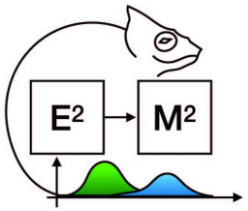


- Insecticide-based mosquito population control is now suboptimal

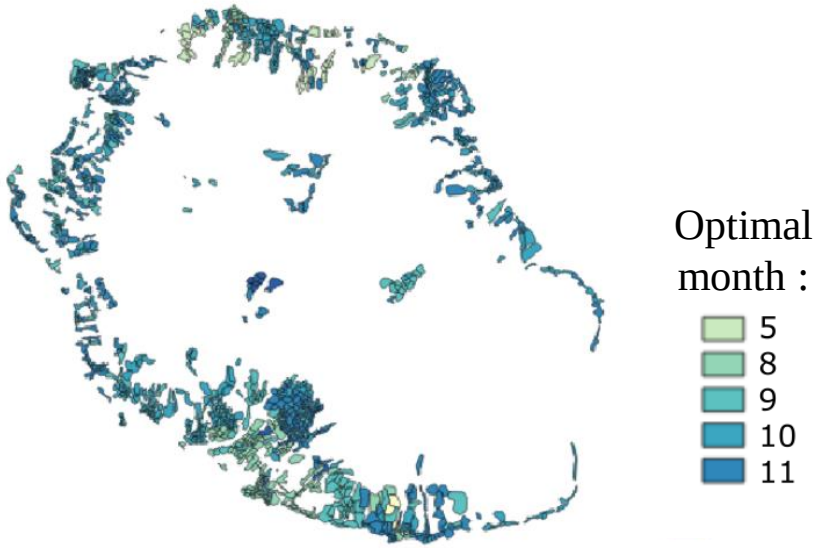
- Alternative methods to **control mosquitoes' densities**:

SIT (Sterile Insect Technique) → Reduction of the viable offspring

Boosted SIT → Pyriproxyfen disrupts the emergence of the pupae



What is the difference between the optimal date to begin the control of mosquitoes with the SIT and the boosted SIT method?



Optimal month to begin the SIT at the Reunion Island in 2013,

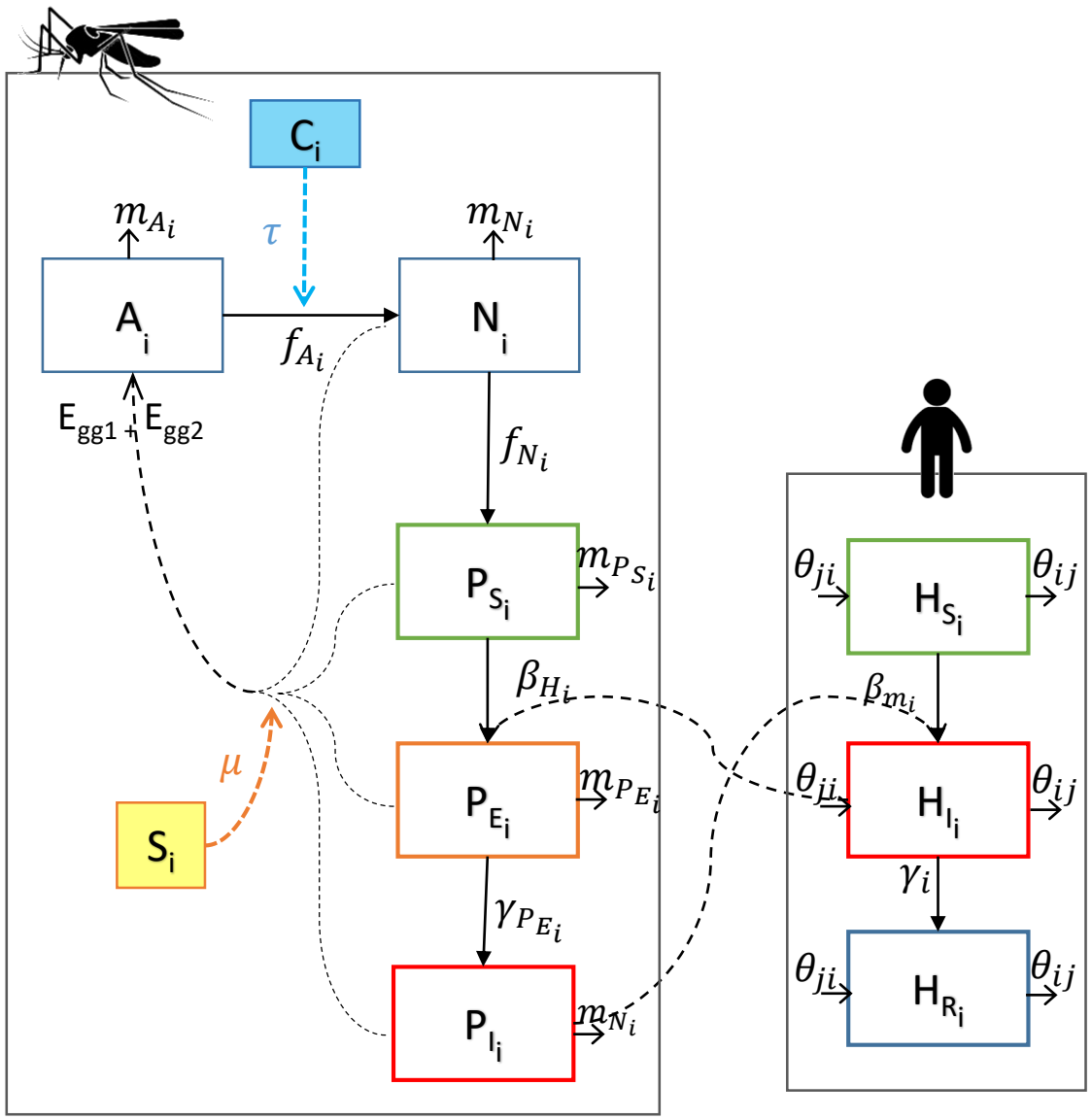
H0:
The optimal date of release is the same between the two methods

Data:

- Optimal_month (response): integer, normal
- Method_control (predictor): factor, 2 levels (TIS / boosted TIS)
- Year (predictor): integer

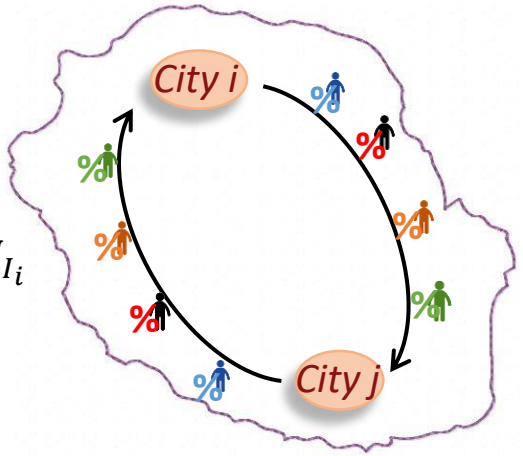
Model:
glmer.nb(Optimal_month~Method_control+(1|Year))

How the control of mosquito population could impact transmission of the dengue ?



$$
\begin{cases}
\dfrac{dA_i}{dt} = \left(E_{gg1}N_i + E_{gg2}P_{tot_i}\right)\dfrac{1}{1+\mu S_i}\left(1+\dfrac{A_i}{K}\right) - \left(\dfrac{1}{1+\tau C_i}f_{A_i} + m_{A_i}\right)A_i \\
\dfrac{dN_i}{dt} = \sigma\dfrac{1}{1+\tau C_i}f_{A_i}A_i - \left(f_{N_i} + m_{N_i}\right)N_i \\
\dfrac{dP_{S_i}}{dt} = f_{N_i}N_i - \left(\beta_{H_i}H_{I_i} + m_{P_{S_i}}\right)P_{S_i} \\
\dfrac{dP_{E_i}}{dt} = \beta_{H_i}H_{I_i}P_{S_i} - \left(\gamma_{P_{E_i}} + m_{P_{E_i}}\right)P_{E_i} \\
\dfrac{dP_{I_i}}{dt} = \gamma_{P_{E_i}}P_{E_i} - m_{N_i}P_{I_i}
\end{cases}
$$

$$
\begin{cases}
\dfrac{dH_{S_i}}{dt} = -\beta_{m_i}H_{S_i}P_{I_i} - \theta_{ij}H_{S_i} + \theta_{ji}H_{S_j} \\
\dfrac{dH_{I_i}}{dt} = \beta_{m_i}H_{S_i}P_{I_i} - \theta_{ij}H_{I_i} + \theta_{ji}H_{I_j} - \gamma_i H_{I_i} \\
\dfrac{dH_{R_i}}{dt} = \gamma_i H_{I_i} - \theta_{ij}H_{I_i} + \theta_{ji}H_{I_j}
\end{cases}
$$



Next steps

Automata cellular (for mosquito) with an agent based model (for human)

- Review some assumptions
- Program in R
- Develop a mechanistic model at the local scale

Thanks !