Eighth Workshop Dynamical Systems Applied
to Biology and Natural Sciences DSABNS 2017
Évora, Portugal, January 31st - February 3rd, 2017

A MECHANISTIC MODEL OF TSETSE FLY POPULATION DYNAMICS IN SPACE AND TIME CALIBRATED ON OBSERVED DATA IN SENEGAL

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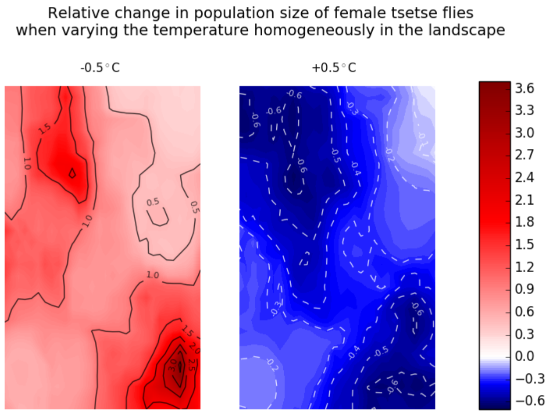
The tsetse fly complex (*Glossina* spp.), vector of trypanosomes, has been named "The Poverty Fly" or "Africa's Bane". This vector transmits the parasite responsible for sleeping sickness in humans and nagana disease in livestock. The suppression of human and animal trypanosomoses would substantially help the development of sustainable and productive cattle farming systems in sub-saharian Africa, decreasing hunger and poverty in those regions. Unfortunately, all previous attempts to produce vaccines against African trypanosomes were only partially successful. Moreover, the use of trypanocidal drugs is not sustainable due to the development of resistance of the parasite to available drugs that were developed more than 40 years ago. It is therefore widely recognized that eradicating tsetse flies would be the easiest way to get rid of trypanosomiasis. The challenge in the last decades was to design programs that could sustainably control fly populations in different regions of Africa. Given the contrasted outcomes of these programs, there is still a need for a better understanding of the spatio-temporal dynamics of this vector. Mathematical and computer-based simulation models provide a useful tool to help stakeholders in their decision-making, complementing field observations and laboratory experiments. Our objective was to predict the spatio-temporal dynamics of tsetse fly populations thanks to an original modelling approach in order to identify the drivers of fly population persistence.

We developed a deterministic, mechanistic model accounting for the biological characteristics

 ISBN: 978-989-98750-3-6



of the target pest and the environmental complexities of the infested area. The population was structured by sex and stage (pupae, teneral and non-teneral adults), in addition to space. The landscape consisted of $250\text{m} \times 250\text{m}$ cells of heterogeneous carrying capacity, estimated with a species distribution model based on presence/absence data. Temperature from weather stations had to be transformed to fit the "perceived" temperatures in fly resting places. The life cycle was influenced by temperature and fly density, whereas spatial dynamics was led by density and relative quality of neighbouring cells. Dispersal, mortality and development rates were parametrized with laboratory experiments, experts' opinion and literature. The model was applied on *Glossina palpalis gambiensis*, the species present in the Niayes area of Senegal.

A sensitivity analysis was performed on the model to identify the parameters influencing the most fly population dynamics. The striking result was that population equilibrium was particularly sensitive to temperature (Figure). It is thus paramount to develop methods to accurately estimate the temperature in micro-environments where tsetse fly lives in order to achieve trustworthy predictions. Besides, mortality and development of adult females stood out as key factors driving population persistence.

Provided enough data is available to adapt the model to specific study sites and species, our model includes all the features needed to guide regional management strategies. In the future, we aim to test different control methods in our simulations, such as sequential aerosol technique (SAT), traps and targets (TT), insecticide-treated livestock (ITL), and sterile insect technique (SIT), keeping in mind that climate change could have a significant impact on the population as well.

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