A river-based model to predict riverine tsetse densities

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Introduction

In Burkina-Faso like in most sub-Saharan West-African countries infected by tsetse flies, Tsetse and African Animal Trypanosomoses (AAT) are a major hindrance to cattle breeding (Itard et al. 2003). Priority areas for control were defined through entomological and epidemiological studies (Hendrickx et al. 2004). The West-African cotton triangle, located at the West of Burkina faso, North of the Ivory coast and South of Mali, is considered as a priority area for T&T control. Our study site, the Mouhoun river basin, is located within this cotton triangle. Two riverine tsetse species, *Glossina palpalis gambiensis* Vanderplank 1949 (Diptera, Glossinidae) and *G. tachinoides* Westwood, 1850 are still present in quite high densities and keep on transmitting animal trypanosomoses (Bouyer et al. 2005, Bouyer et al. 2006).

In Burkina Faso, recent studies demonstrated the relation between the vegetation type and its disturbance level along the river on the one hand, and the abundance of riverine tsetse on the other hand, following a theory that had been described earlier regarding the ecotype (Morel 1983), and that has been completed by the integration of the human-driven disturbance (Bouyer et al. 2005).

A recent PATTEC initiative has been launch in the Mouhoun river basin (Fond Africain de Développement 2004), aiming at eliminating tsetse and trypanosomoses. The maps that are available on the PAAT-IS were used to design the initial area where baseline data collection would occur. These maps, consisting of probabilities of presence for the two involved species, however aim at selecting priority areas at regional scales rather than at local scale. In the present study, we compared the predictions of the PAAT-IS models to field data collected during various research projects lead by CIRDES and then proposed a new model based on the analysis of the landscapes surrounding the hydrographical network, and aiming at predicting tsetse densities.

Material and Methods

To compare the predictions of the PAAT-IS models (precision of 1*1km) to field data, we merged the probabilities of presence of tsetse into ten classes with a range of 0.1 (from 0 to 1). We then affected the corresponding probabilities to 764 trapping sites (CIRDES data) where tsetse densities had been measured thanks to biconical traps. Finally, we plotted the percentage of traps within each class of probability that effectively caught tsetse against the probability classes.

We then proposed a methodology based on riverine tsetse ecology to predict tsetse apparent densities on the main course of the Mouhoun river and some of its tributaries which were randomly selected. First, the surface of water around the river course, could be correlated to the ecotype of riverine forest (guinean, sudano-guinean and sudanese) (Bouyer 2006). Second, a landscape approach consisting in the identification of homogeneous clusters regarding the composition of the landscape neighbouring the river course (fig. 1), in terms of land use classes, allowed classing the river course in three disturbance levels (disturbed, half-disturbed and natural). The methodology was extensively described elsewhere (Bouyer et al. 2006, Guerrini and Bouyer 2007).

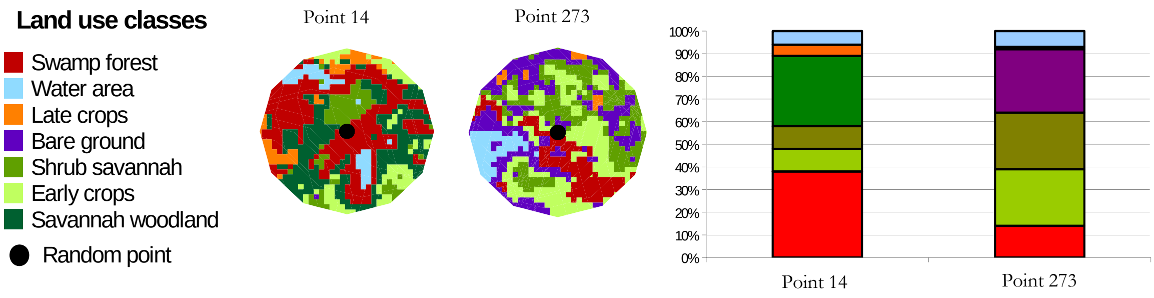

Fig. 1 Example of landscape composition (in term of land-use units), around two points randomly generated along the river course

The two information on riverine forests (ecotype and disturbance levels) were then crossed to obtain homogeneous landscapes where the apparent densities of the two species were implemented thanks to 689 trap locations which were used as learning sites (Guerrini and Bouyer 2007). The obtained tsetse densities were then mapped in standard classes and compared to a validation data set (66 trapping sites) for each tsetse species, thanks to Kendahl's correlation test, since tsetse densities didn't harbour normal distributions.

Results

Figure 2 shows the percentage of sites where tsetse were caught by class of probability (PAAT-IS available models). The predictions were better for *G. palpalis gambiensis* than *G. tachinoides*, and for high-probability classes than low-probability classes. In Burkina Faso, these predictions were used to choose the first block were baseline data collection would occur (PATTEC National Program). From these comparisons with a local data set available in CIRDES, it appears that the sampling area of the first block may have been over-estimated by at least 40%, leading to important economic loss.

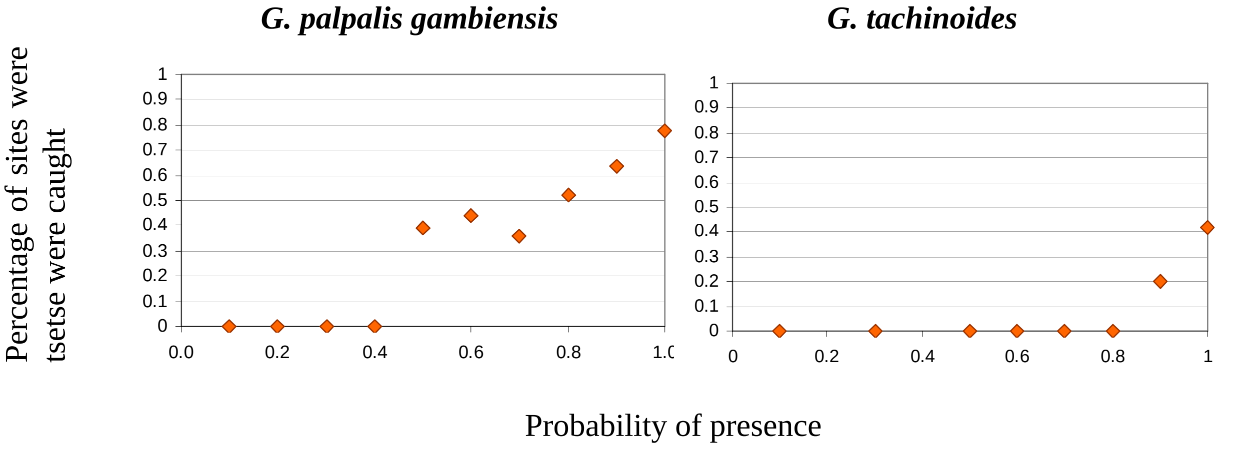

Fig. 8 Percentage of sites where tsetse were caught (764 trapping sites) by class of probability (PAAT-IS available models)

The correlation between the water surface classes (0-1, 1-11, 11-38 hectares) and the corresponding river forest ecotypes (respectively guinean, sudano-guinean and Sudanese) was very satisfactory, with an overall good classification of 75% of the sites, the mistakes being mainly located in the nearest ecotype. Figure 3 presents the distribution of these ecotypes along the river course. The figure also presents the various level of distubance of the peri-riverine landscapes along the Mouhoun river loop, classed in three categories: natural, half-disturbed and disturbed, corresponding respectively to protected forests, their borders and crops or pasturizing areas.

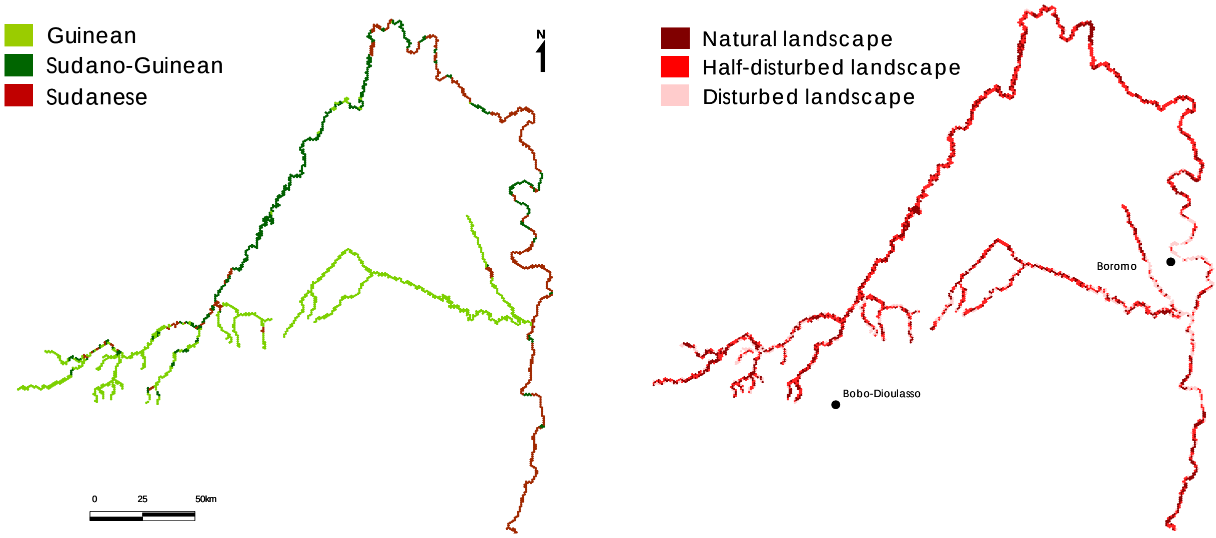

Fig. 3 Maps of the river ecotypes (left) and levels of disturbance (right) along the Mouhoun river loop, Burkina Faso

The crossing of these two layers allowed implementing maps of the apparent densities of *G. palpalis gambiensis* and *G. tachinoides* along the main course of the Mouhoun river and two of its tributaries (the Leyessa and the Balé), thanks to the learning sites (fig. 4).

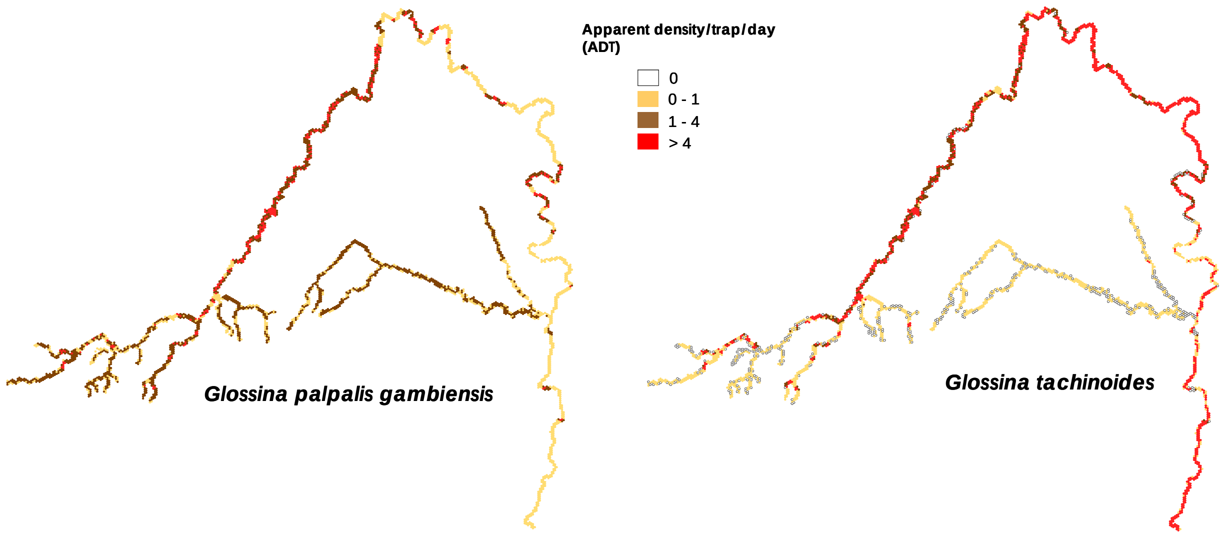

Fig. 4 Apparent densities by trap and by day of G. palpalis gambiensis (left) and G. tachinoides (right) along the Mouhoun river loop, Burkina Faso

The predictions of our models were compared to an independent validation data set. We observed a very good correlation between our model outputs and the field data (Kendall Test, *G. palpalis gambiensis* : tau=0.37, z=4.19, p=2.831e-05 ; *G. tachinoides* : tau=0.39, z=4.67, p= 3.036e-06). However, our predictions of absence of tsetse were not always confirmed, constituting an opposite tendency from the PAAT-IS models.

Discussion/Conclusion

Our models still need some improvement, especially to detect areas from which tsetse are absent. However, they gave good predictions of tsetse densities along the river course at a basin scale, thus alighting the necessity to take the river network into consideration to map riverine tsetse densities. The combination of such models to the present regional-scale models (PAAT-IS) might allow improving the predictions of tsetse distributions at a local scale. It is fundamental for national teams undertaking PATTEC control programs. However, it will be possible only if local teams share their local data thanks to network information systems like PAAT-IS.

A good mapping of this hydrographic network should be undertaken before any trapping attempt when riverine tsetse species are involved and present PATTEC sampling protocols should be adapted these species.

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