



## Summary

The present study explores the relationship between tsetse vegetation types and standardized land cover datasets, produced in compliance with the Land Cover Classification System (LCCS).

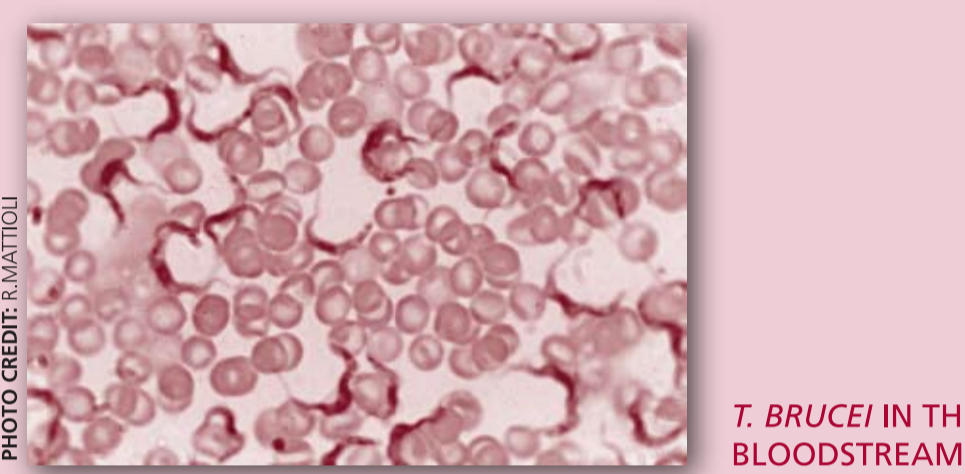
The analysis at continental level uses coarse resolution datasets (1-5 km) to explore the broad patterns of the association between tsetse fly and land cover.

At a higher resolution, the customization of national maps of land cover of eight tsetse infested East African countries (FAO - Africover) provides valuable input to support the planning and implementation of trypanosomiasis control interventions.

### BOX 1 THE PROBLEM OF TRYPANOSOMIASIS IN SUB-SAHARAN AFRICA

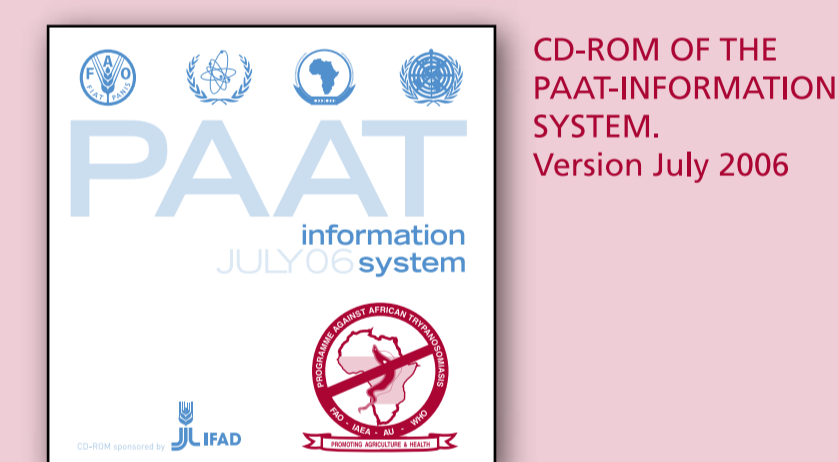
Tsetse-transmitted trypanosomiasis is an infectious disease unique to Africa, caused by various species of trypanosomes. The disease affects both people [Human African Trypanosomiasis (HAT) or sleeping sickness] and animals [Animal African Trypanosomiasis (AAT) or nagana] and occurs in 37 sub-Saharan countries covering more than 9 million km<sup>2</sup>, an area which corresponds approximately to one-third of the Africa's total land area. The infection threatens an estimated 60 million people and about 50 million head of cattle.

Source: Programme Against African Trypanosomiasis - Information System (PAAT-IS)



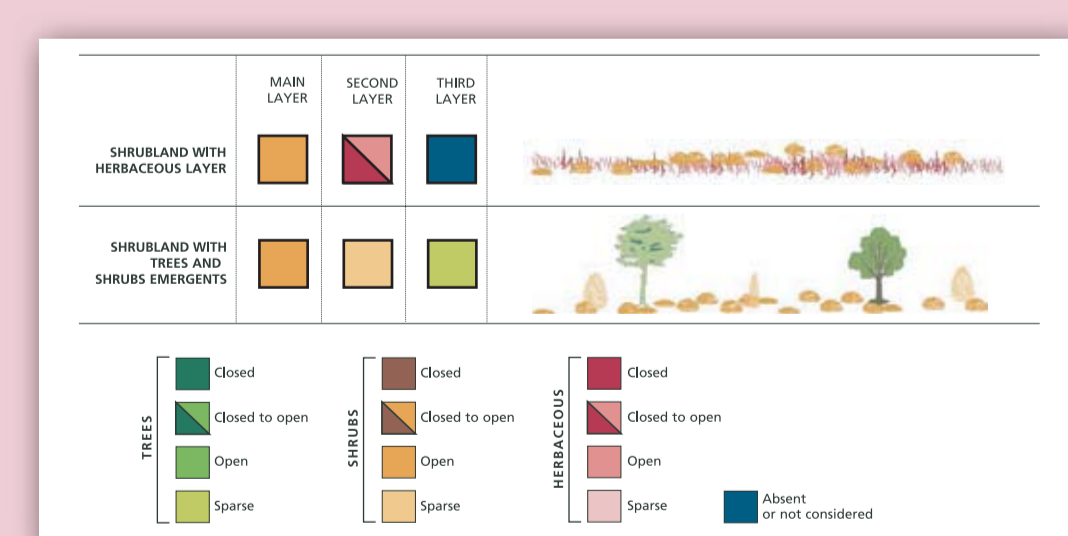
### BOX 2 PROGRAMME AGAINST AFRICAN TRYPANOSOMIASIS (PAAT) AND ITS INFORMATION SYSTEM (PAAT-IS)

PAAT is a forum to harmonize and coordinate the activities of its four mandated international organizations [the Food and Agriculture Organization of the United Nations (FAO), the World Health Organization (WHO), the International Atomic Energy Agency (IAEA) and the Inter-African Bureau for Animal Resources of the African Union (AU-IBAR)], in relation to tsetse, human and animal trypanosomiasis and associated sustainable agriculture and rural development. The PAAT Information System ([www.fao.org/ag/paat-is.html](http://www.fao.org/ag/paat-is.html)) includes technical and scientific publications and GIS datasets to guide strategic decisions on tsetse and trypanosomiasis management in sub-Saharan Africa.



### BOX 3 LAND COVER CLASSIFICATION SYSTEM (LCCS)

LCCS is developed by the Food and Agriculture Organization of the United Nations (FAO) and the United Nations Environment Programme (UNEP). It enables comparison of land cover classes regardless of mapping scale, land cover type, data collection method or geographic location. Currently, LCCS is the only universally applicable land cover classification system in operational use. LCCS is inherently flexible, applicable to all climatic zones and environmental conditions, and compatible with other classification systems. These characteristics have given LCCS the potential to be accepted as the international standard. The approval process to become a standard of the International Organization for Standardization (ISO) is in progress.



Note: Text and image adapted from *Land Cover Classification System - Classification Concepts and User Manual - Software version 2*. Revised by A. Di Gregorio, FAO, Rome (2005).

## Continental level

Based on both their morphological and ecological characteristics, the 31 tsetse (*Glossina*) species and subspecies accord to 3 subgenera or groups, i.e. the subgenus *Austenina* (*fusca* group), the subgenus *Nemorhina* (*palpalis* group) and the subgenus *Glossina* s.s. (*morsitans* group) (Newstead *et al.*, 1924). The broad definition of 'forest', 'riverine' and 'savannah' flies is commonly accepted for the *fusca*, *palpalis* and *morsitans* groups respectively.

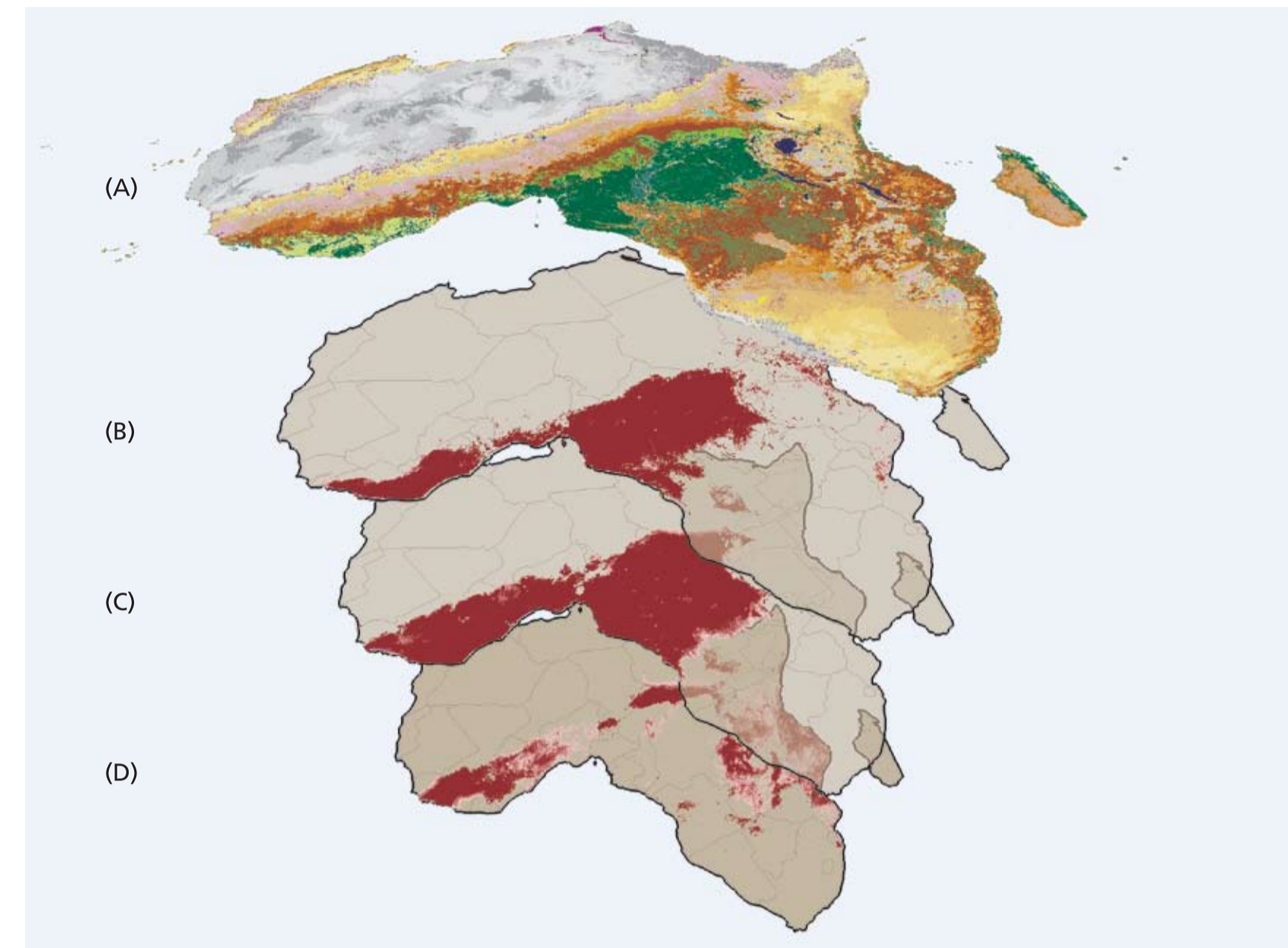
### Tsetse distribution maps

The spatial distribution of the three groups was derived from the predicted areas of suitability (PAS) for tsetse flies as produced in 1999 for the FAO-PAAT Information System (Wint & Rogers, 2000). The PAS resolution approximates 5 km at the equator and covers the whole of sub-Saharan Africa. The maps reflect the probability of environmental suitability at group (subgenus) level (see Figure 1B, C, D). For our analysis, the probability threshold of 50 percent was applied to discriminate suitable from unsuitable areas.

### Land cover of Africa

As regards the land cover, a medium resolution map was used: the Land Cover of Africa for the year 2000 (Mayaux *et al.*, 2004), produced in the framework of the project Global Land Cover 2000 (GLC2000). The spatial resolution of GLC2000 is approximately 1 km at the equator and it documents a total of 27 land cover categories (see Figure 1A).

FIGURE 1. LAND COVER OF AFRICA; PROJECT GLOBAL LAND COVER 2000 (A). PREDICTIVE MAPS OF TSETSE DISTRIBUTIONS: *FUSCA* GROUP (B), *PALPALIS* GROUP (C), *MORSITANS* GROUP (D).



### Results

By overlaying the PAS and GLC2000 it was possible to estimate the land cover of the habitat of the three subgenera of *Glossina* (Figure 2). For each land cover class it was also possible to assess the relevant suitability for tsetse as percentage of surface affected by tsetse inside the land cover class (Table 1). The shared variance ( $r^2$ ) between the tsetse habitat and land cover classes (chi-square test) is presented in Table 2.

FIGURE 2. LAND COVER OF THE HABITAT OF THE THREE GROUPS (SUBGENERA) OF *GLOSSINA*

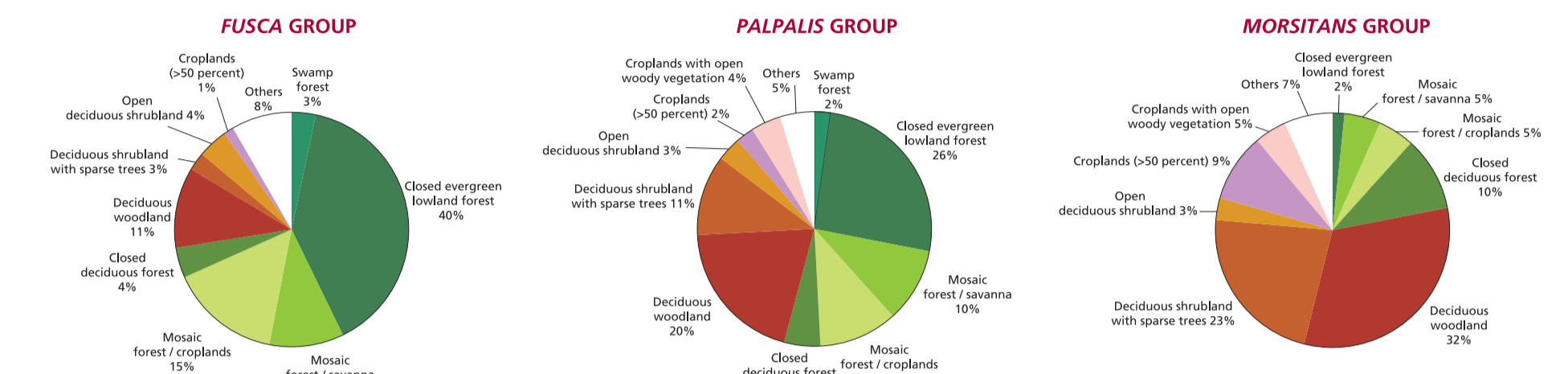


TABLE 1. PERCENTAGE OF SURFACE AFFECTED BY TSETSE FOR THE LAND COVER CLASS

Land cover class (GLC2000)	Area affected by tsetse for each land cover class (%)		
	Fusca	Palpalis	Morsitans
Closed evergreen lowland forest	95.3	97.5	3.8
Degraded evergreen lowland forest	94.9	97.9	8.3
Submontane forest (900-1500 m)	80.4	84.6	14.2
Montane forest (>1500 m)	21.8	18.0	14.8
Swamp forest	100.0	100.0	3.0
Mangrove	47.4	45.1	38.8
Mosaic Forest / Croplands	82.3	83.4	26.7
Mosaic Forest / Savannah	61.5	53.8	39.8
Closed deciduous forest	14.8	26.9	34.3
Deciduous woodland	15.9	44.6	45.1
Deciduous shrubland with sparse trees	6.4	41.9	36.0
Open deciduous shrubland	16.4	21.3	12.1
Closed grassland	11.1	11.2	11.9
Open grassland with sparse shrubs	2.4	0.7	4.0
Open grassland	1.7	0.5	0.8
Sparse grassland	0.7	0.1	0.2
Swamp bushland and grassland	7.5	11.4	32.3
Croplands (>50%)	2.3	7.2	16.8
Croplands with open woody vegetation	0.5	28.0	20.1
Irrigated croplands	4.1	12.5	17.8
Sandy desert and dunes	0.0	0.0	0.0
Stony desert	0.0	0.0	0.0
Bare rock	0.1	0.2	0.1
Salt hardpans	1.2	0.7	3.5
Cities	16.4	21.2	5.8

TABLE 2. SHARED VARIANCE ( $R^2$ ) BETWEEN THE HABITAT OF THE THREE TSETSE FLY GROUPS AND LAND COVER CLASSES OF THE LAND COVER OF AFRICA OF THE YEAR 2000

Tsetse group	$r^2$
Fusca	0.56
Palpalis	0.47
Morsitans	0.19

### Discussion

The results of the analysis at continental level confirm the central role of land cover in shaping the habitat of tsetse flies in Africa. They also demonstrate that GLC2000 units are capable of accurately translating the different vegetation requirements of the three fly groups.

## National level

### High resolution land cover datasets: Africover

The resolution of the available land cover datasets at continental level (GLC2000) is not up to the challenges posed by the planning and implementation of tsetse and trypanosomiasis intervention activities. On the other hand, the Africover project delivered high resolution, multi-purpose land cover maps of 10 countries in East Africa, among which eight are affected by trypanosomiasis (Burundi, Democratic Republic of the Congo, Kenya, Rwanda, Somalia, Sudan, Uganda and United Republic of Tanzania). Overall, more than 500 land cover classes are defined in the Africover maps.

### Standardized legend for tsetse habitat mapping

For this study, LCCS was used to develop a legend of 26 land cover classes tailored for tsetse habitat mapping (Table 3). The legend was used to customize the original Africover databases through the process of thematic aggregation, which enhances the information of some key classes and generalizes or omits unnecessary information related to other land cover aspects. Thus, a seamless, multinational, standardized land cover map for tsetse and trypanosomiasis decision making was derived (Figure 3).

### Land cover suitability for tsetse

Based on a review of the literature, the suitability for tsetse of each standardized land cover class was estimated (Table 3). The correspondence between GLC2000 and Africover datasets allowed a preliminary validation of the estimates. Positive results were obtained for the *fusca* and *palpalis* groups, while for the *morsitans* group the interpretation of the results is more complex.

FIGURE 3. AFRICOVER LAND COVER MAPS CUSTOMIZED FOR TSETSE HABITAT MAPPING

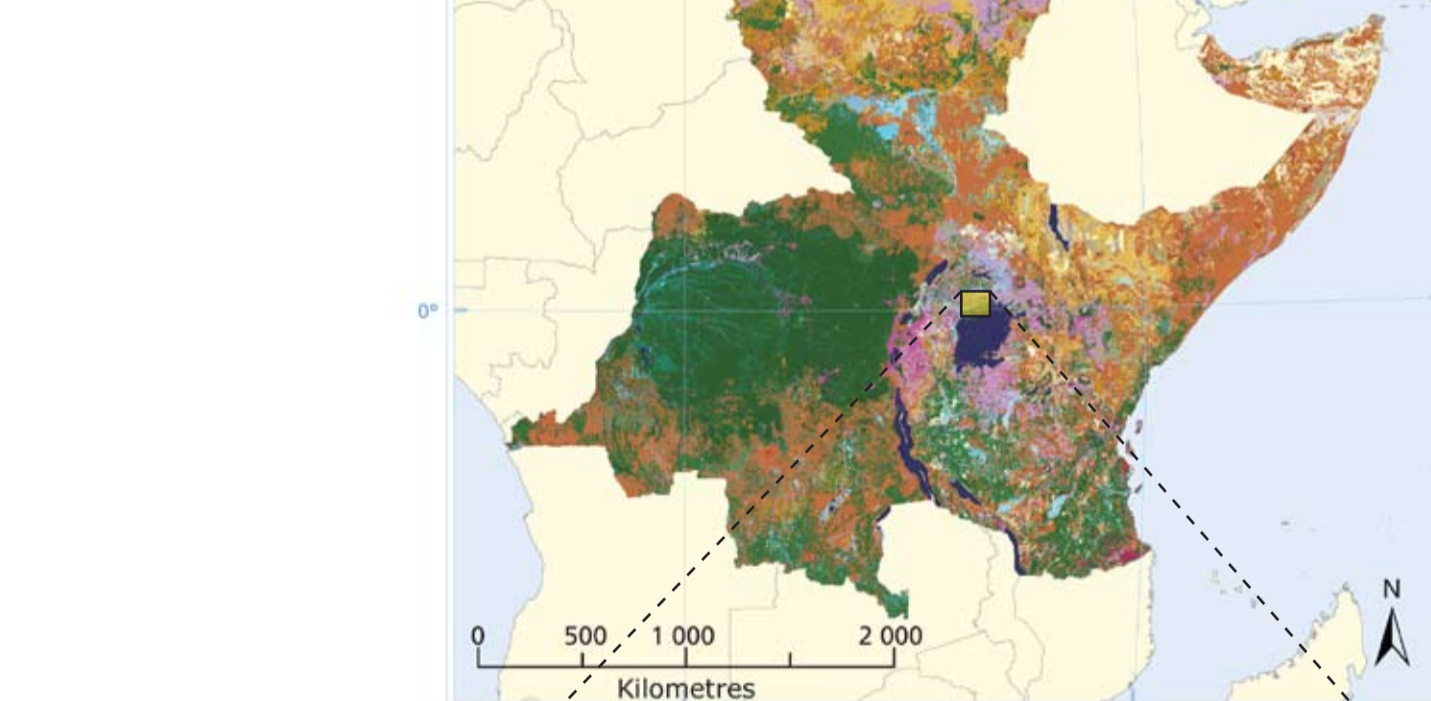
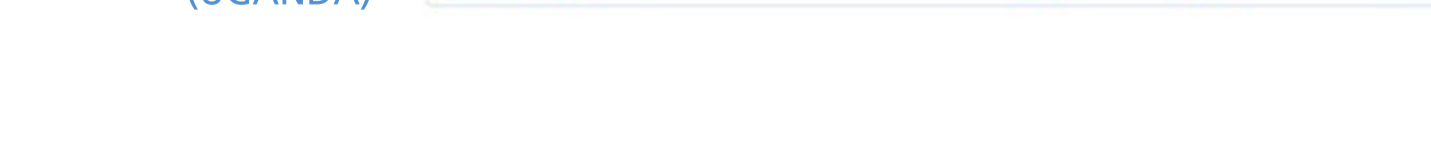


FIGURE 4. AFRICOVER LAND COVER MAP CUSTOMIZED FOR TSETSE HABITAT MAPPING OF THE AREA AROUND KAMPALA (UGANDA)



Class name	Suitability for tsetse groups		
	Fusca	Palpalis	Morsitans
Forest plantations and tree plantations	1	2	1
Shrub crop	1	1	1
Herbaceous crops	0	1	0
Vegetated urban areas	1	2	1
Forest	1	3	2
Woodland	1	2	3
Closed Woody vegetation	1	2	2
Open Woody vegetation	1	1	2
Thicket	1	1	2
Shrubland	0	1	2
Grassland	0	0	0
Shrub savannah	0	1	1
Tree savannah	0	1	2
Sparse trees	0	0	1
Sparse shrubs	0	0	0
Sparse herbaceous vegetation	0	0	0
Fields Rice	0	0	0
Closed swamp	3	3	1
Open swamp	2	2	2
Woody vegetation on flooded land	1	2	1
Shrubs on flooded land	1	2	1
Herbaceous vegetation on flooded land	0	1	0
Artificial surfaces	0	0	0
Bare soil	0	0	0
Water bodies	0	0	0
Snow	0	0	0

TABLE 3. STANDARDIZED LAND COVER LEGEND FOR TSETSE HABITAT MAPPING AND LITERATURE-BASED ESTIMATES OF SUITABILITY (3: HIGH, 2: MEDIUM, 1: LOW, 0: NIL)

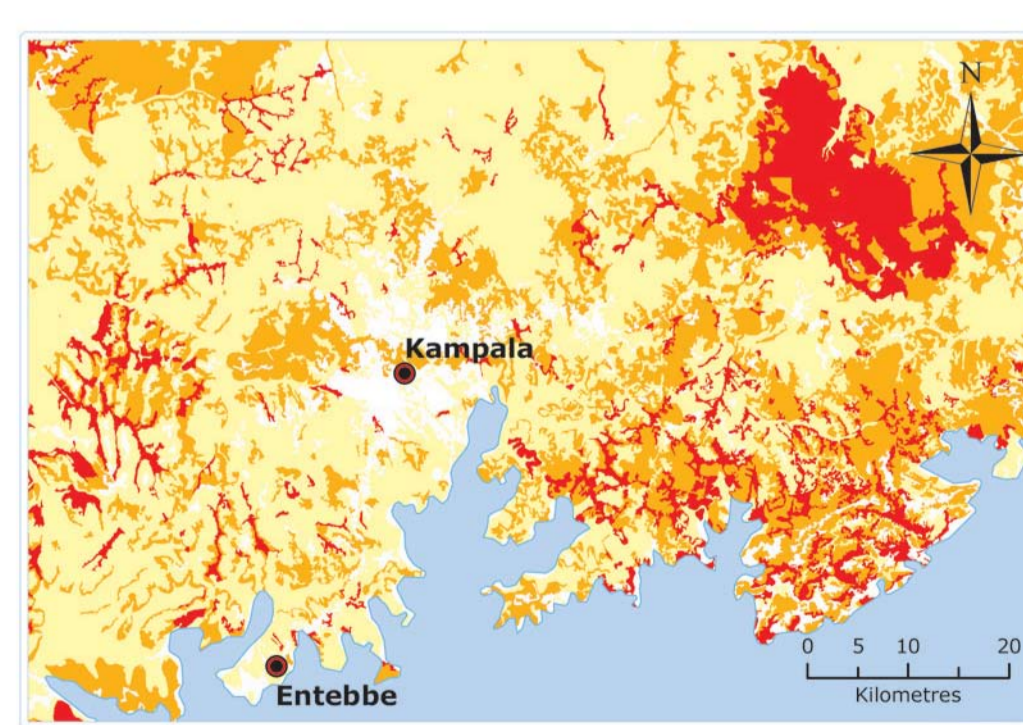


FIGURE 5. LAND COVER SUITABILITY FOR TSETSE FLIES OF THE *PALPALIS* GROUP, 'RIVERINE FLIES'; THE MAP IS BASED ON AFRICOVER AND REFLECTS THE LITERATURE-BASED ESTIMATES OF SUITABILITY SHOWN IN TABLE 3

## References

Di Gregorio, A. 2005. *Land Cover Classification System (LCCS), version 2: Classification Concepts and User Manual*. Food and Agriculture Organization of the United Nations, Rome, Italy. Also available on <http://www.glc2000.org/>

Mayaux, P., Bartholomé, E., Fritz, S. & Belward, A. 2004. A new land-cover map of Africa for the year 2000. *Journal of Biogeography*, 31, 861-877.

Newstead, R., Evans, A.M. & Potts, W.H. 1924. *Guide to the study of tsetse-flies*. Liverpool School of Tropical Medicine, Liverpool, UK.

Wint, W. & Rogers, D. 2000. *Predicted distributions of tsetse in Africa*. Consultancy Report for the Animal Health Service of the Animal Production and Health Division of the FAO. FAO, Rome, Italy. Available on <http://www.fao.org/ag/paat-is.html>

## Conclusion

The study demonstrates the potential of standardized, multi-purpose land cover maps, released in the public domain, for deriving novel, detailed maps of tsetse habitat suitability at a much improved scale, thus offering unprecedented opportunities to assist tsetse habitat mapping across and within countries. The maps may be applied in subsequent phases of tsetse and trypanosomiasis intervention projects, including planning of entomological surveys, actual tsetse interventions, monitoring and mitigation of environmental impacts and land use planning of reclaimed areas.

