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# Standardizing land cover mapping for tsetse and trypanosomiasis decision making

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# Standardizing land cover mapping for tsetse and trypanosomiasis decision making

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# Contents

# Abstract

The habitat of tsetse fly (*Glossina* spp.) depends upon climatic conditions, host availability and land cover characteristics. In this paper, the Land Cover Classification System (LCCS), developed by the Food and Agriculture Organization (FAO) and the United Nations Environment Programme (UNEP), is proposed as a tool to harmonize land cover mapping exercises carried out in the context of tsetse and trypanosomiasis (T&T) research and control. The potential of land cover maps to describe and predict tsetse habitat at different resolutions is also explored.

In Chapter 1, the LCCS-compliant Global Land Cover 2000 (GLC2000) of Africa and the predicted areas of suitability for tsetse provided by the Programme Against African Trypanosomiasis Information System (PAAT-IS) were matched to study the relationship between land cover and the habitat of the three groups of tsetse flies (i.e. *fusca*, *palpalis* and *morsitans*). The results are in accordance with the literature (e.g. one single class, 'Closed evergreen lowland forest', accounts for about 40 percent of the *fusca* group habitat and for about 27 percent of the *palpalis* group habitat, while two savannah classes, i.e. 'Deciduous woodland' and 'Deciduous shrubland with sparse trees', cover more than 50 percent of the area suitable for the *morsitans* group). Limitations in the analysis due to the resolution of the datasets are discussed and possible future developments are pointed out.

In Chapter 2, a standardized legend for land cover mapping in T&T decision-making is proposed. Based on the products and methodology developed by the FAO Africover project, the legend derives from thematic aggregation of the land cover classes defined for the maps available for eight T&T affected countries (i.e. Burundi, Democratic Republic of the Congo, Kenya, Rwanda, Somalia, Sudan, United Republic of Tanzania and Uganda). The 26 classes legend summarizes more than 500 classes present in the original Africover databases and it allows delineation of tsetse habitat across several countries in a harmonized and coherent manner. The aggregation procedure and the proposed legend are fully documented and in line with LCCS principles and rules.

A review of the literature allowed suitability for tsetse to be matched with the standardized land cover classes. Even though it stems from the Africover maps of East Africa, the proposed legend and methodology are applicable to any area in Africa. The practical and conceptual difficulties posed by the validation of the estimated classes of suitability are discussed; in this regard, a method linking the datasets at different resolutions gave positive results. It is important to note that the literature-based suitability assigned to each class only relates to the land cover and does not translate directly into a more general environmental suitability; additional conditions of altitude, climate, availability of host animals and habitat integrity must be met for tsetse to be present. Thus, land cover should be regarded as one parameter in a thorough study of tsetse ecology, which calls for the integrated analysis of a set of geospatial layers, including land-use maps, temperature and humidity datasets, digital elevation models (DEMs), hydrological network, livestock and wild animals' density maps. However, the

paper shows that many of the environmental variables are to some extent implicit in or related to land cover, making it a key element in any tsetse habitat study.

In Chapter 3 one case study, namely Uganda, illustrates how country maps compliant with LCCS can be analysed in more detail and customized to better meet the requirements of tsetse habitat mapping.

Standardization of land cover mapping is an important step towards the harmonization of the Information Systems (ISs) and the Decision Support Systems (DSSs), based on the Geographic Information System (GIS), for trypanosomiasis intervention. The adoption of LCCS within T&T control programmes would also benefit regional cooperation and it would facilitate the use of existing and upcoming land cover maps. In this regard, the West African component of the Global Land Cover Network (GLCN) has planned the production of LCCS-compliant datasets for several countries.

The high resolution of the available and future land cover datasets (within a range of scales from 1:200 000 to 1:50 000) will make possible the production of a new generation of risk maps, based on a deeper understanding of the landscape and environmental dynamics that drive the distribution of tsetse in Africa. Habitat modifications are increasingly induced by human actions, either at a global scale, as in the case of climatic change, or at a local scale, as in the processes of urbanization and agricultural expansion. The challenges posed in the future by trypanosomiasis are likely to be shaped by those factors to the extent that no appropriate intervention can possibly be contemplated without considering them.

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# Acronyms

| | |
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| ATSR | Along Track Scanning Radiometer |
| COCTU | Coordinating Office for Control of Trypanosomiasis in Uganda |
| DEM | Digital Elevation Model |
| DFID | Department for International Development |
| DMSP | Defense Meteorological Satellites Program |
| DSS | Decision Support System |
| ERGO | Environmental Research Group Oxford |
| ERS | European Remote Sensing Satellite |
| FAO | Food and Agriculture Organization |
| FAOSTAT | FAO Statistical Database |
| GIS | Geographic Information System |
| GLC2000 | Global Land Cover for the year 2000 |
| GLCN | Global Land Cover Network |
| IFAD | International Fund for Agricultural Development |
| IS | Information System |
| ISO | International Organization for Standardization |
| HAT | Human African Trypanosomiasis |
| JERS | Japanese Earth Resources Satellite |
| JRC | Joint Research Centre |
| LCCS | Land Cover Classification System |
| MMA | Minimum Mappable Area |
| NFPI | National Focal Points Institution |
| PAAT | Programme Against African Trypanosomiasis |
| PAAT-IS | Programme Against African Trypanosomiasis-Information System |
| PATTEC | Pan African Tsetse and Trypanosomiasis Eradication Campaign |
| ppm | parts per million |
| RGB | Red-Green-Blue |
| SPOT | Satellite Pour l'Observation de la Terre |
| SWALIM | Somalia Water and Land Information Management System |
| T&T | Tsetse and trypanosomiasis |
| TALA | Trypanosomiasis and Land-use in Africa |
| TDS | Total Dissolved Solids |
| TM | Thematic Mapper |
| UNEP | United Nations Environment Programme |
| UTM | Universal Transverse Mercator |
| WGS 84 | World Geodetic System 1984 |

# Introduction

An accurate and detailed knowledge of the habitat of tsetse flies (*Glossina* spp.) is of paramount importance for planning and implementing T&T intervention activities. Remote sensing and GIS proved extremely powerful in describing tsetse distribution at continental and regional scale (Rogers and Randolph, 1993; Rogers *et al.*, 1996; Hay *et al.*, 1996; Robinson *et al.*, 1997; FAO, 2000; FAO/IAEA Joint Division, 2001; Rogers and Robinson, 2004). The high revisit frequency of several meteorological satellites allowed the application of sophisticated techniques (e.g. temporal Fourier analysis) that appeared able to depict with remarkable statistical accuracy the distribution of virtually all tsetse species in Africa. These studies produced predictions of environmental suitability for tsetse that are capable of supporting an informed selection of priority areas for intervention. Nonetheless, the instruments and methods used to study tsetse distribution at low resolution cannot be directly applied at larger scales. This is as a result of the intrinsic trade-off between spatial and temporal resolution of available earth-observation satellites; higher resolution sensors are characterized by a much lower revisit frequency.

When moving on from the selection of priority areas for intervention to the actual planning and implementation of tsetse control projects over specific areas, the available continental and regional tsetse distribution maps are no longer sufficient (Hendrickx *et al.*, 2001a) and there is a need to produce or collect baseline datasets, among which high resolution maps of land cover are of prime importance.

There is an increasing volume of literature regarding the application of high resolution satellite images in relation to various aspects of the T&T problem (Kitron *et al.*, 1996; Wilson *et al.*, 1997; Reid *et al.*, 1997; Reid *et al.*, 2000; de la Rocque *et al.*, 2001; Hendrickx *et al.*, 2001b; Bourn, 2003; De Deken *et al.*, 2005; Bouyer *et al.*, 2006). In most researches, remotely sensed data have been used to depict the vegetation cover of potential tsetse habitats and to study land cover/land-use dynamics and how they relate to trypanosomiasis intervention. In these studies, land cover maps cover a limited area within the affected country and they are produced using ad hoc classification systems. This makes it difficult to compare the analyses from different locations and to extrapolate the outcomes over wider areas. The lack of standardization in the land cover mapping exercises carried out in the context of T&T intervention also hinders the use of existing and future multipurpose land cover databases that are being produced in the framework of different international initiatives (i.e. GLCN and GLOBCOVER).

The aim of this paper (which expands on the study by Cecchi *et al.*, in press) is to promote the application of the FAO/UNEP LCCS within T&T management activities and to demonstrate the potential of high resolution, multipurpose land cover databases in support of the fight against African trypanosomiasis