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Mapping the economic benefits to livestock keepers from intervening against bovine trypanosomosis in Eastern Africa

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ABSTRACT

Endemic animal diseases such as tsetse-transmitted trypanosomosis are a constant drain on the financial resources of African livestock keepers and on the productivity of their livestock. Knowing where the potential benefits of removing animal trypanosomosis are distributed geographically would provide crucial evidence for prioritising and targeting cost-effective interventions as well as a powerful tool for advocacy. To this end, a study was conducted on six tsetse-infested countries in Eastern Africa: Ethiopia, Kenya, Somalia, South Sudan, Sudan and Uganda. First, a map of cattle production systems was generated, with particular attention to the presence of draught and dairy animals. Second, herd models for each production system were developed for two scenarios: with or without trypanosomosis. The herd models were based on publications and reports on cattle productivity (fertility, mortality, yields, sales), from which the income from, and growth of cattle populations were estimated over a twenty-year period. Third, a step-wise spatial expansion model was used to estimate how cattle populations might migrate to new areas when maximum stocking rates are exceeded. Last, differences in income between the two scenarios were mapped, thus providing a measure of the maximum benefits that could be obtained from intervening against tsetse and trypanosomosis. For this information to be readily mappable, benefits were calculated per bovine and converted to US$ per square kilometre. Results indicate that the potential benefits from dealing with trypanosomosis in Eastern Africa are both very high and geographically highly variable. The estimated total maximum benefit to livestock keepers for the whole of the study area amounts to nearly US$ 2.5 billion, discounted at 10% over twenty years – an average of approximately US$ 3300 per square kilometre of tsetse-infested area – but with great regional variation from less than US$ 500 per square kilometre to well over US$ 10,000. The greatest potential benefits accrue to Ethiopia, because of its very high livestock densities and the importance of animal traction, but also to parts of Kenya and Uganda. In general, the highest benefit levels occur on the fringes of the tsetse infestations. The implications of the models' assumptions and generalisations are discussed.

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1. Introduction

Interventions against tsetse and trypanosomosis in Africa should neither be planned nor implemented without considering the geospatial and biogeographic dimensions of the problem (Cecchi and Mattioli, 2009). Tsetse flies of different species occupy what is often described as the 'tsetse belt', which spans – Africa's humid and sub-humid zones. Spatial patterns are particularly important in the human form of the disease, which has long been recognised as occurring in distinct and relatively stable geographical foci (WHO, 1998). In recent years advances in spatial analysis have made it possible not just to predict a range of mapped variables, but also to combine them, by using geographic information systems (GIS). A number of key variables affecting trypanosomosis has been selected and brought together by FAO, most notably in the framework of the Programme Against African Trypanosomosis (PAAT) Information System. This has enabled the analysis not just of the correlates of tsetse distribution (climatic and land cover factors, for example) but also of the livestock and human populations affected. Recently the numbers of cattle and poor cattle-owners affected by animal trypanosomosis was estimated, by livestock production system, in Uganda (MAAIF et al., 2010) and a series of studies has mapped the distribution and risk of human trypanosomosis (Cecchi et al., 2009a, 2009b; Simarro et al., 2010, 2011, 2012a, 2012b).

After two decades, which saw a gradual reduction in the activities and capacities of both tsetse control departments and national veterinary services, and reduced surveillance for sleeping sickness leading to a widespread epidemic of the diseases, it was recognised that the problem of trypanosomosis was becoming seriously neglected on a continental scale. A declaration by the African Heads of State and Government in 2000 followed by the creation of a pan-African programme to deal with tsetse and trypanosomosis brought this issue back to the foreground. At the same time, measures were being implemented to control the massive resurgence of human African trypanosomosis (Simarro et al., 2008). Interest in larger scale interventions means that resource allocation and prioritisation are, more than ever, key issues. Thus, it is particularly important to add to our knowledge of the disease the economic component and, moreover, for that economic component to be spatially explicit.

Though data on costs and benefits of interventions are essential for decision-making, handling the economic aspects of the disease and its control has generally been regarded as especially complex. Knowledge about the impact of the disease on livestock productivity is patchy; based entirely on individual, site-specific studies yielding very variable results (Swallow, 2000; Shaw, 2004). In humans, although estimates of burden per affected individual now exist (Lutumba et al., 2007; Fèvre et al., 2008), variation in levels of under-diagnosis make it difficult to estimate a global burden. Historically, the economic analysis of African trypanosomosis began with estimates of the costs of control, progressing to studies on the impact on livestock productivity and to project-based benefit–cost studies for specific areas where disease control operations were undertaken (Shaw, 2004). Generalising from such work to look at the wider picture proved difficult, although work in Nigeria (Putt et al., 1980) suggested that field interventions on the fringes of the tsetse distribution yielded particularly high benefits, since livestock, especially cattle, were already in these areas and dealing with tsetse could be relatively cost-effective. However there was no spatially explicit information on these economic aspects. Assessments of the global magnitude of the problem have taken the approach of estimating uniform losses per bovine, and scaling these up based on estimated numbers of bovines in Africa's tsetse-infested areas. These have produced highly variable results, ranging from annual losses of US$ 0.7 billion (Kristjanson et al., 1999) to 4.5 billion (Budd, 1999). With a view to providing a more refined aid to decision making, maps of the economic benefits from removing trypanosomosis in cattle were developed, initially covering Togo, Ghana and Benin (Shaw et al., 2003), and subsequently extended to include Burkina Faso and Mali (Shaw et al., 2006).

The present study builds on that work, testing the approach used by extending it to a more diverse and complex set of cattle production systems in the Intergovernmental Authority on Development (IGAD) region, which includes six tsetse-affected east African countries: Ethiopia, Kenya, Somalia, South Sudan, Sudan and Uganda. A separate paper has explored the cost of controlling tsetse and trypanosomosis in the region (Shaw et al., 2013).

The focus of the study remains on cattle production systems for two reasons. Within the livestock economies of the region, it is estimated that cattle account for about 70% of ruminant livestock biomass in trypanosomosis-affected areas. Evidence-based information on disease impact is mostly available for cattle production systems, with only a handful of studies covering small ruminants (Swallow, 2000; Shaw, 2004). The emphasis of the study is on rural areas and the more extensive forms of traditional cattle rearing and smallholding practiced by the vast majority of livestock keepers in the region. This analysis thus aims to provide an insight into how trypanosomosis affects Africa's rural smallholders and traditional cattle keepers.

2. Materials and methods

The potential benefits from the removal of bovine trypanosomosis (equivalent to reducing the physical and financial losses due to the disease) were calculated by first using demographic herd parameters (birth, death and offtake rates) to project the cattle population numbers in a series of spatially defined production systems over a 20-year study period using 'with trypanosomosis' production parameters. Then, the output from the herd, in terms of milk, meat, animal traction and offtake was calculated and prices applied to estimate income year by year. The same procedure to calculate income was then repeated using the 'without trypanosomosis' production parameters. The difference between the two income streams gives the potential benefits from the disease's absence. These figures were estimated per bovine and applied to cattle population density maps, projected using herd growth and