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## Impact of climate change-driven vector expansion on the epidemiology of trypanosomosis in bovines

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### Abstract

Trypanosomosis commonly referred to as nagana in livestock is a vector-borne haemoparasitic disease transmitted by tsetse flies (*Glossina* spp.) that imposes devastating economic losses on cattle production across sub-Saharan Africa. Climate change is altering the distribution and abundance of tsetse populations by shifting temperature and humidity envelopes to higher altitudes and into regions previously considered tsetse-free. This research investigated the current prevalence, species distribution, and haematological impact of bovine trypanosomosis across four ecological zones in the central Kenyan highlands, including two zones where tsetse presence had not been documented before 2020. A cross-sectional survey of 196 cattle from 24 herds was conducted between February and August 2024. Buffy coat examination, thin blood smears, and ITS1-PCR were used for parasite detection. Tsetse trapping with biconical traps was performed concurrently at 48 sites. Overall prevalence by PCR was 28.1% (55/196), with *Trypanosoma congolense* accounting for 47 of positive cases (85.5%), *T. vivax* for 31 (56.4%), *T. brucei* for 12 (21.8%), and mixed infections for 8 (14.5%). Prevalence increased significantly with decreasing altitude: 8.9% in the highland zone (>1,800 m), 21.2% in the midland zone (1,200-1,800 m), 39.3% in the lowland zone (<1,200 m), and 50.0% in the riverine corridor ( $p<0.001$ ). Tsetse apparent density averaged 4.7 flies/trap/day in the lowland, 2.1 in the midland, and 0.3 in the highland zone the last representing a newly colonised altitude band. Mean packed cell volume was 31.2% in highland cattle versus 21.1% in riverine cattle, with 63.2% of riverine animals falling below the 24% anaemia threshold. These findings provide field evidence that climate-mediated tsetse range expansion is introducing trypanosomosis into previously unaffected Kenyan highland communities, with significant implications for livestock health surveillance and vector control strategy.

**Keywords:** Trypanosomosis, tsetse fly, glossina, climate change, vector expansion, bovine, kenya, pcr, packed cell volume, epidemiology

### Introduction

Trypanosomosis is an infectious disease of vertebrates caused by flagellated protozoan parasites of the genus *Trypanosoma*, transmitted cyclically through the bite of infected tsetse flies (*Glossina* spp.) and, for certain species, mechanically by biting flies such as *Tabanus* and *Stomoxys* <sup>[1]</sup>. In cattle, the disease manifests as chronic wasting, progressive anaemia, reduced milk yield, impaired draught power, and in severe cases death, making it one of the single greatest constraints on livestock productivity across approximately 10 million square kilometres of sub-Saharan Africa <sup>[2]</sup>. The geographical range of tsetse-transmitted trypanosomosis has historically been bounded by climate: *Glossina* species require specific combinations of temperature (18-32°C), humidity (>50% relative humidity), and vegetation cover to complete their reproductive cycle and sustain viable populations <sup>[3]</sup>. For decades, the central Kenyan highlands above 1,800 metres were considered tsetse-free because mean temperatures fell below the lower thermal threshold for larviposition and pupal development. However, temperature records from the Kenya Meteorological Department show that mean annual temperatures in the central highlands have increased by 0.8 to 1.2°C since 1990, and minimum night-time temperatures the critical limiting factor for tsetse survival at altitude have risen even faster <sup>[4, 5]</sup>. Several modelling exercises have predicted that these warming trends would push the tsetse belt 200 to 400 metres upslope by 2030, exposing immunologically

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Naive cattle populations to trypanosomosis for the first time [6]. Scattered reports from Uganda, Ethiopia, and Tanzania have already documented tsetse captures and trypanosome infections at altitudes previously considered safe, but rigorous field surveys combining parasitological, molecular, and entomological data across a defined altitudinal gradient in Kenya are lacking [7, 8]. The present research addressed this gap through a cross-sectional survey that spanned four ecological zones highland, midland, lowland, and riverine corridor in central Kenya. The objectives were to determine the prevalence and species composition of bovine trypanosomosis by PCR at each altitude, to quantify tsetse apparent density across the gradient, and to assess the haematological impact of infection on cattle in zones with differing histories of tsetse exposure.

## Material and methods

### Material

A total of 196 cattle were sampled from 24 smallholder herds across four ecological zones in Murang'a and Kirinyaga counties, central Kenya, between February and August 2024. The highland zone (>1,800 m;  $n = 45$  cattle from 6 herds) included areas with no prior record of tsetse. The midland zone (1,200–1,800 m;  $n = 52$  from 6 herds) bordered historically known tsetse habitat. The lowland zone (<1,200 m;  $n = 61$  from 6 herds) and the riverine corridor along the Tana River tributaries ( $n = 38$  from 6 herds) had longstanding endemic trypanosomosis. Breeds were predominantly East African Zebu crosses, with some Friesian and Ayrshire crosses in the highland and midland zones. Animals were selected by systematic random sampling within each herd, targeting adult cattle (>2 years). The Institutional Animal Ethics Committee of the Nairobi Institute of Tropical Veterinary Medicine approved the research (NITVAM-IAEC-2023-042).

### Methods

Blood (10 mL) was collected from the jugular vein into EDTA and plain Vacutainer tubes. Packed cell volume (PCV) was measured by the microhaematocrit centrifugation method

(12,000 × g, 5 minutes). The buffy coat was examined microscopically for motile trypanosomes (dark-ground/phase-contrast buffy coat technique). Thin blood smears were Giemsa-stained and examined at 1,000× for species identification. DNA was extracted from buffy coat samples using the Qiagen DNeasy Blood and Tissue Kit. ITS1-PCR was performed using genus-specific primers targeting the internal transcribed spacer 1 region of ribosomal DNA, which allows simultaneous detection and species differentiation based on amplicon size [9]. PCR products were resolved on 2% agarose gels stained with ethidium bromide. Entomological surveys used standard biconical traps deployed at 48 sites (12 per zone) for 72-hour trapping periods in each of the two sampling rounds (February dry season and August wet season). Traps were baited with acetone and cow urine. Tsetse apparent density was expressed as flies per trap per day (FTD). Captured flies were identified to species and sex, and a subsample was dissected for trypanosome midgut and salivary gland infection. Statistical analysis used generalised linear mixed models (GLMM) with binomial error distribution for prevalence data and linear mixed models for PCV, with zone as a fixed effect and herd as a random effect. Odds ratios and 95% confidence intervals were calculated. Significance was set at  $p < 0.05$ .

### Ethical considerations

All animal sampling was approved by the Institutional Animal Ethics Committee of the Nairobi Institute of Tropical Veterinary Medicine (NITVAM-IAEC-2023-042). Blood collection was performed by licensed veterinarians using aseptic technique, and animals were restrained humanely in locally constructed cattle crushes. Herd owners provided verbal informed consent after explanation in the local language (Kikuyu), witnessed by a community animal health worker. All trypanosome-positive animals identified during the survey were offered diminazene aceturate treatment (3.5 mg/kg intramuscular) at no cost, and herd owners were advised on tsetse control options.

### Results

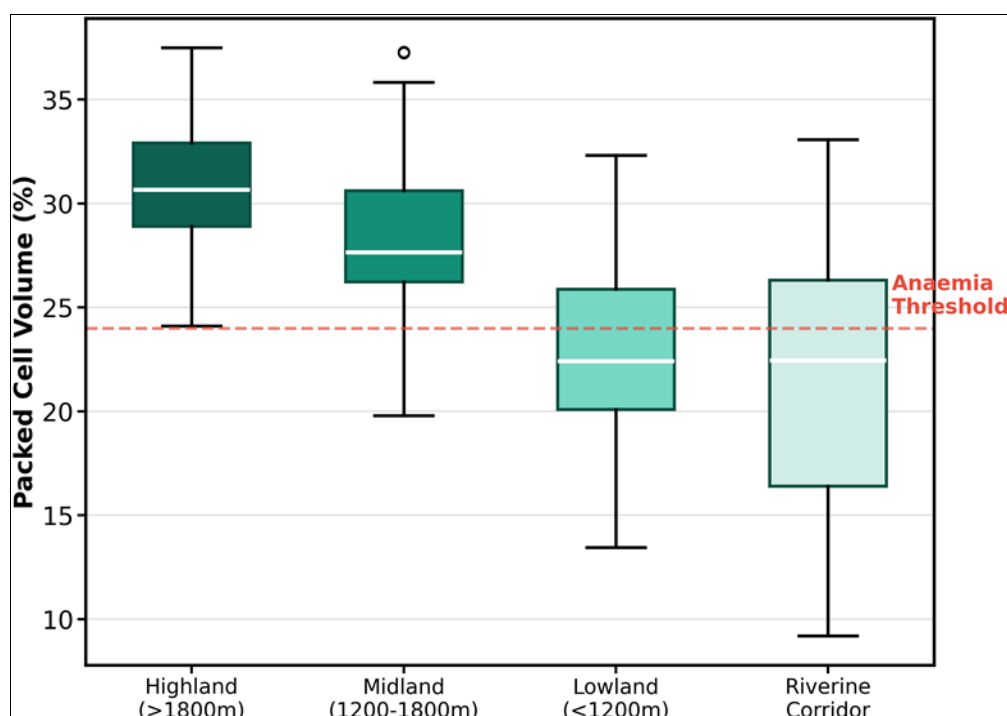


**Fig 1:** Box plot of packed cell volume (PCV, %) in cattle across four ecological zones in central Kenya. The dashed red line indicates the 24% anaemia threshold. Median PCV decreased with altitude, and the riverine corridor showed the widest dispersion and highest proportion of anaemic animals

Overall trypanosomiasis prevalence by PCR was 28.1% (55/196). Buffy coat examination detected only 38 of the 55 PCR-positive animals (sensitivity 69.1%), while thin smear identified 29 (52.7%). The PCR-negative rate was 71.9%,

indicating that the majority of the sampled population was uninfected at the time of sampling, though subclinical carriers below the detection limit of a single blood draw cannot be ruled out.

**Table 1:** Trypanosomiasis Prevalence and Tsetse Density across Ecological Zones

| Zone                 | n   | PCR Prev. (%) | BCT Prev. (%) | Tsetse FTD | Anaemia (%) |
|----------------------|-----|---------------|---------------|------------|-------------|
| Highland (>1800m)    | 45  | 8.9           | 4.4           | 0.3        | 11.1        |
| Midland (1200-1800m) | 52  | 21.2          | 13.5          | 2.1        | 26.9        |
| Lowland (<1200m)     | 61  | 39.3          | 27.9          | 4.7        | 47.5        |
| Riverine corridor    | 38  | 50.0          | 34.2          | 7.8        | 63.2        |
| Overall              | 196 | 28.1          | 19.4          | 3.7        | 34.2        |

PCR = polymerase chain reaction; BCT = buffy coat technique; FTD = flies per trap per day. Anaemia defined as PCV < 24%. Prevalence increased significantly with decreasing altitude (GLMM trend  $p < 0.001$ )

**Table 2:** Trypanosome Species Identified by ITS1-PCR across Ecological Zones

| Zone     | T. cong. | T. vivax | T. brucei | Mixed | Total Pos.         | Dominant Sp.  |
|----------|----------|----------|-----------|-------|--------------------|---------------|
| Highland | 3        | 1        | 0         | 0     | 4                  | T. congolense |
| Midland  | 8        | 4        | 1         | 0     | 11                 | T. congolense |
| Lowland  | 14       | 11       | 5         | 4     | 24                 | T. congolense |
| Riverine | 9        | 8        | 4         | 4     | 19                 | T. congolense |
| Total    | 34       | 24       | 10        | 8     | 55 (98 detections) | —             |

T. cong. = Trypanosoma congolense; totals exceed individual species counts because some animals harboured mixed infections. Species totals reflect PCR-based identification.

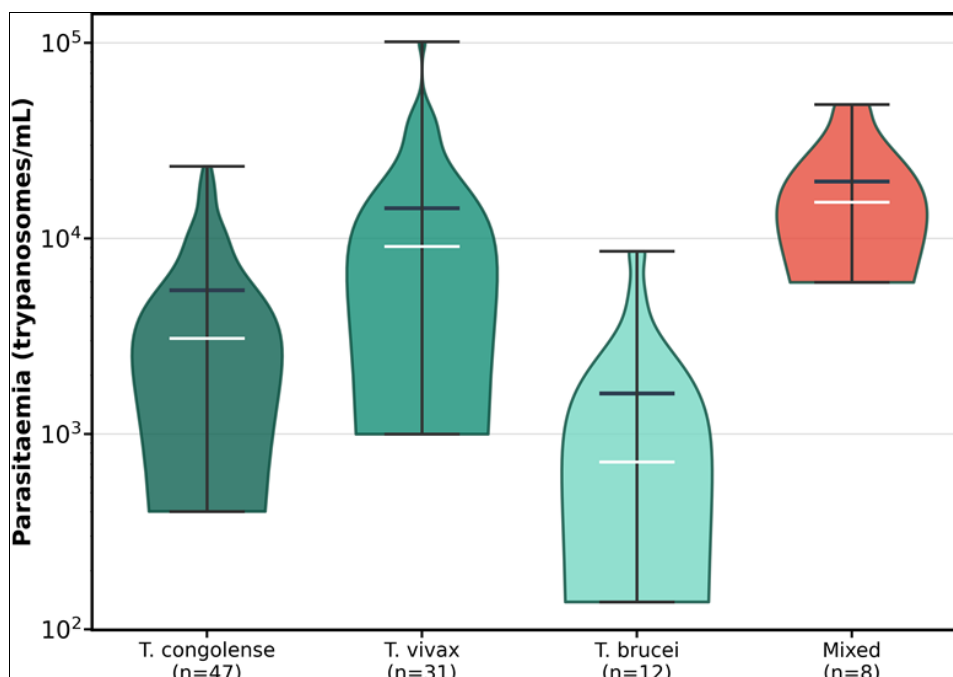


**Fig 2:** Violin plot showing the distribution of parasitaemia (trypanosomes per mL of blood, log scale) by Trypanosoma species in PCR-positive cattle. Mixed infections showed the highest median parasitaemia, while T. brucei infections had the widest dispersion

**Table 3:** Risk Factors for Trypanosomiasis: Multivariable Logistic Regression

| Variable             | n        | Pos. (%)     | OR    | 95% CI     | p-value |
|----------------------|----------|--------------|-------|------------|---------|
| Riverine vs Highland | 38 vs 45 | 50.0 vs 8.9  | 10.27 | 3.14-33.56 | <0.001  |
| Lowland vs Highland  | 61 vs 45 | 39.3 vs 8.9  | 6.52  | 2.12-20.07 | 0.001   |
| Midland vs Highland  | 52 vs 45 | 21.2 vs 8.9  | 2.74  | 0.78-9.63  | 0.117   |
| Wet vs Dry season    | —        | 33.7 vs 22.4 | 1.76  | 1.02-3.04  | 0.042   |
| Age >5 yr vs ≤5 yr   | —        | 34.1 vs 22.8 | 1.72  | 0.96-3.08  | 0.068   |
| Zebu vs Exotic cross | —        | 24.3 vs 33.8 | 0.63  | 0.35-1.14  | 0.127   |

OR = odds ratio; CI = confidence interval. Reference category for zone = Highland. Models adjusted for herd (random effect), breed, age, and season

### Comprehensive interpretation

The data reveal a clear altitudinal gradient in trypanosomiasis prevalence that mirrors the gradient in tsetse density. The

detection of tsetse flies albeit at low density (0.3 FTD) and PCR-confirmed trypanosome infections (8.9%) in the highland zone above 1,800 m is the most notable finding, as

this zone had no documented tsetse presence before 2020. The haematological impact follows the same gradient: mean PCV fell from 31.2% in highland cattle to 21.1% in riverine animals, and the proportion of anaemic cattle rose from 11.1% to 63.2%. *T. congolense* was the dominant species in all zones, consistent with its known association with *Glossina pallidipes* and *G. morsitans*, the two species captured in the survey area.

### Discussion

The main findings confirm that bovine trypanosomosis prevalence and tsetse density follow a strong altitudinal gradient in central Kenya, and that tsetse flies and trypanosome infections are now detectable in highland areas above 1,800 m that were previously tsetse-free. These results align with climate model predictions by Moore and colleagues, who projected a 300-metre upslope shift in the tsetse belt for every 1°C increase in mean temperature [6]. The 0.8-1.2°C warming recorded in the central Kenyan highlands since 1990 falls squarely within the range expected to push *Glossina* into the 1,800-2,000 m band [4, 5].

Where our data extend the existing literature is in documenting the haematological and production consequences of this range expansion in a naïve cattle population. Highland cattle predominantly dairy crosses with no prior tsetse exposure and no acquired trypanotolerance showed PCV values in the normal range when uninfected but dropped sharply in the four positive animals, suggesting that initial infections in immunologically naïve herds may be clinically more severe than in endemically exposed lowland populations [10]. This has important implications for highland dairy farmers, who may not recognise trypanosomosis as a differential diagnosis for chronic weight loss and reduced milk yield in their herds. The predominance of *T. congolense* (85.5% of positive cases) is consistent with the known tsetse species composition in central Kenya, where *Glossina pallidipes* is the primary vector. *T. vivax*, which can also be transmitted mechanically by biting flies, was present in all zones including the highland, suggesting that mechanical transmission may supplement cyclical transmission in newly colonised areas [11]. This dual transmission pathway complicates control strategies because tsetse-targeted interventions alone may not eliminate *T. vivax* circulation. From a policy perspective, these findings argue for immediate inclusion of the highland zone in national trypanosomosis surveillance programmes and for proactive deployment of insecticide-treated targets along the tsetse expansion front. Community-based tsetse control using pour-on insecticides applied to cattle an approach that has proven cost-effective in Uganda and Tanzania could be adapted for the Kenyan highland context [12, 13]. Veterinary extension services should also raise awareness among highland farmers about trypanosomosis clinical signs and the availability of diminazene aceturate treatment.

### Limitations

This research has several constraints. The cross-sectional design captures prevalence at a single time point and cannot track seasonal or year-to-year trends in tsetse colonization. The sample size of 196 cattle, distributed across four zones, limits statistical power for breed- and age-specific analyses. Buffy coat and thin smear sensitivity were predictably low (69% and 53%), reinforcing the importance of PCR but also indicating that some low-level infections may have been missed even by molecular methods. Tsetse trapping was

conducted at only 12 sites per zone, and the low FTD in the highland zone (0.3) is based on a small absolute number of captures, making density estimates imprecise. Finally, historical tsetse records for the highland zone are sparse, and it is possible that low-density tsetse populations existed undetected before 2020 rather than representing a genuinely new colonisation event.

### Safety considerations

All field personnel were trained in safe handling of trypanosome-infected blood samples, which pose a theoretical zoonotic risk through *T. brucei rhodesiense* (not identified in this survey but endemic in some Kenyan regions). Latex gloves, sharps containers, and closed-system blood collection were used throughout. Tsetse trapping sites were marked and local communities notified to prevent accidental contact. Diminazene aceturate treatment was administered only by licensed veterinarians, and animals were observed for 30 minutes post-injection for adverse reactions, of which none occurred.

### Conclusion

In the context of a 0.8-1.2°C warming trend over three decades, tsetse flies and bovine trypanosomosis have been detected in the central Kenyan highlands above 1,800 m a zone previously considered free of both. Prevalence reached 8.9% by PCR in the highland zone and climbed to 50.0% in the riverine corridor, with *T. congolense* as the dominant species throughout. The haematological impact was severe in low-altitude cattle, with over 60% falling below the anaemia threshold. For livestock health authorities, these data support expanding trypanosomosis surveillance into highland areas, deploying community-based tsetse control along the expansion front, and educating highland farmers about a disease that is no longer confined to the lowlands. Long-term monitoring that links meteorological data, tsetse population dynamics, and livestock infection rates will be essential to forecast future range shifts and target interventions before endemic transmission becomes established at higher altitudes.

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#### Contributions not qualifying for authorship

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### References

- Desquesnes M, Dargantes A, Lai DH, Lun ZR, Holzmüller P, Jittapalapong S. Trypanosoma evansi and surra: a review and perspectives on transmission, epidemiology and control, impact, and zoonotic aspects. Biomed Res Int. 2013; 2013:321237.

2. Shaw AP, Cecchi G, Wint GR, Mattioli RC, and Robinson TP. Mapping the economic benefits to livestock keepers from intervening against bovine trypanosomosis in Eastern Africa. *Prev Vet Med.* 2014; 113(2):197-210.
3. Leak SG. *Tsetse Biology and Ecology: Their Role in the Epidemiology and Control of Trypanosomosis.* Wallingford: CABI Publishing; 1999.
4. Githeko AK, Ndegwa W. Predicting malaria epidemics in the Kenyan highlands using climate data: a tool for decision makers. *Glob Change Hum Health.* 2001; 2(1):54-63.
5. Ogutu JO, Piepho HP, Dublin HT, Bhola N, Reid RS. Rainfall influences on ungulate population abundance in the Mara-Serengeti ecosystem. *J Anim Ecol.* 2008; 77(4):814-829.
6. Moore S, Shrestha S, and Tomlinson KW, Vuong H. Predicting the effect of climate change on African trypanosomiasis: integrating epidemiology with parasite and vector biology. *J R Soc Interface.* 2012; 9(70):817-830.
7. Muhanguzi D, Picozzi K, Hatari J, Waiswa C, Welburn SC. Bovine trypanosomosis in newly tsetse-colonised areas of Uganda. *Vet Parasitol.* 2014; 199(1-2):44-48.
8. Dayo GK, Bengaly Z, Messad S, Sidibé I, Cene B, Cuny G, *et al.* Prevalence and incidence of bovine trypanosomosis in an agro-pastoral area of southwestern Burkina Faso. *Res Vet Sci.* 2010; 88(3):470-477.
9. Njeru ZK, Constantine CC, Guya S, Crowther J, Kiragu JM, Thompson RCA, *et al.* The use of ITS1 rDNA PCR in detecting pathogenic African trypanosomes. *Parasitol Res.* 2005; 95(3):186-192.
10. Murray M, Dexter TM. Anaemia in bovine African trypanosomiasis: a review. *Acta Trop.* 1988; 45(4):389-432.
11. Desquesnes M, Dia ML. Mechanical transmission of *Trypanosoma vivax* in cattle by the African tabanid *Atylotus fuscipes*. *Vet Parasitol.* 2004; 119(1):9-19.
12. Muhanguzi D, Okello WO, Kabasa JD, Waiswa C, Welburn SC, Shaw AP. Cost analysis of options for management of African animal trypanosomiasis using interventions targeted at cattle in Tororo District, south-eastern Uganda. *Parasit Vectors.* 2015; 8:387.
13. Hargrove JW, Ouifki R, Kajunguri D, Vale GA, Torr SJ. Modeling the control of trypanosomiasis using trypanocides or insecticide-treated livestock. *PLoS Negl Trop Dis.* 2012; 6(5):e1615.
14. Cecchi G, Mattioli RC, Slingenbergh J, De La Rocque S. Land cover and tsetse fly distributions in sub-Saharan Africa. *Med Vet Entomol.* 2008; 22(4):364-373.
15. Van den Bossche P. Some general aspects of the distribution and epidemiology of bovine trypanosomosis in southern Africa. *Int J Parasitol.* 2001; 31(5-6):592-598.

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