

Re-engineering malaria elimination: integrating environmental-health intelligence into malaria control in Africa

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Perspective

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Abstract

Malaria control has expanded rapidly, yet transmission remains entrenched across much of Africa. The next gains may depend not only on adding interventions but on improving how existing information is translated into action. We propose that environmental-health intelligence should become a complementary operational layer of malaria surveillance, linking routine observations of housing and neighbourhood conditions with epidemiological and entomological data. Environmental Health Officers (EHOs), where such functions exist within national or local systems, could collect standardized, georeferenced observations on mosquito entry points, drainage, water-holding structures and other context-specific environmental hazards. Integrated spatially, these data could help malaria programmes identify where environmental investigation or remediation should be prioritized, while housing, planning, water, sanitation and public-works authorities retain responsibility for structural remediation. This is a proposed implementation architecture, not a validated prediction system. Its effectiveness, cost, feasibility and equity would require prospective evaluation. The aim is not to replace insecticide-treated nets, indoor residual spraying, diagnosis, treatment, vaccines or chemoprevention, but to connect malaria intelligence more directly to the environments in which transmission occurs.

Malaria control needs an environmental intelligence layer

Malaria remains one of Africa's greatest public-health challenges. In 2024, the WHO African Region accounted for approximately 94% of global malaria cases and 95% of malaria deaths¹. ITNs, IRS, effective diagnosis and treatment, vaccines and chemoprevention remain indispensable, but substantial transmission persists. The question is therefore not whether existing tools work; it is whether malaria programmes are systematically using information about the physical environments in which those tools must operate.

Malaria transmission is usually described through the interaction of parasite, vector and host. That interaction, however, occurs within houses and neighbourhoods shaped by construction, drainage, water storage, land use and urban development. These conditions can modify mosquito–human contact and, in some settings, the availability of larval habitats. Yet environmental observations are not routinely incorporated into malaria decision-making with the same structure and continuity as clinical and entomological information.

Housing is part of the malaria-control system

Housing should therefore be treated as an intervention environment, not simply as a social determinant. Open eaves, unscreened windows and poorly fitting doors can facilitate mosquito entry, whereas screened openings, closed eaves and ceilings can reduce indoor exposure. Systematic reviews and trials support a protective role for selected house modifications, although effects vary by intervention and outcome^{2–4}. WHO conditionally recommends residential house screening in areas with ongoing malaria transmission, while emphasizing that it complements rather than replaces established vector-control

measures⁵. New and upgraded housing can consequently incorporate context-appropriate vector-resistant features, particularly where they can be maintained at acceptable cost.

Transmission environments are dynamic

Environmental risk also changes over time. Urbanization, construction, rainfall and vector adaptation can alter where mosquitoes breed and how people encounter them. The expansion of *Anopheles stephensi* is an important example: this invasive vector can exploit artificial water containers and urban environments, creating challenges that extend beyond conventional rural malaria-control assumptions. WHO's 2026 elimination strategy emphasizes surveillance, larval-source management, urban planning and multisectoral collaboration⁶. The lesson is not that housing or environmental management can independently control *An. stephensi*, but that malaria programmes need environmental information capable of adapting to changing vector ecology.

At neighbourhood level, poorly functioning drainage, construction depressions, leaking wastewater infrastructure, unsealed soakaways and some water-storage practices may create productive aquatic habitats where epidemiologically relevant. Such features should not automatically be classified as malaria risks: environmental assessment must distinguish suspected hazards from demonstrated or plausible transmission pathways. WHO's operational guidance similarly emphasizes locally adapted, evidence-based larval-source management rather than indiscriminate treatment of all standing water⁷.

From the house to the neighbourhood

This creates an information gap. Clinical surveillance indicates where malaria is occurring; entomological surveillance helps establish which vectors, behaviours and transmission mechanisms are involved. We propose a complementary third layer: structured environmental-health surveillance.

Environmental Health Officers as an environmental-intelligence layer

Environmental Health Officers as an environmental-intelligence layer

In settings where Environmental Health Officers (EHOs) have statutory responsibilities for sanitary inspection, vector control, nuisance identification or related environmental functions, existing field activity could provide a starting point for this layer^{8,9}. The proposal is not to create a new malaria cadre. It is to standardize selected observations already made during environmental inspections and make them usable for malaria intelligence.

A malaria-relevant environmental record could capture, according to local epidemiology and legal scope, features such as housing entry points, drainage condition, water-holding structures, construction-related habitats and other environmental observations. Each record could be georeferenced and linked, subject to appropriate data governance, with epidemiological and entomological information. The objective

would be to identify spatially concordant areas where environmental investigation or intervention merits priority—not to infer causality from an environmental feature alone.

Operationally, the proposed cycle is: map risk; inspect; identify and classify hazards; record and georeference; integrate with malaria intelligence; target appropriate action; verify implementation; monitor outcomes; and feed learning back into the next surveillance cycle (Fig. 1). EHOs would contribute environmental intelligence and field verification; malaria programmes would retain responsibility for malaria surveillance and programme decisions; entomologists would provide vector expertise; and housing, planning, water, sanitation and public-works authorities would lead remediation within their mandates.

This distinction matters. The framework is an implementation hypothesis, not an established continent-wide system and not a validated malaria-prediction model. Research should determine whether adding environmental-health data improves spatial targeting, intervention uptake, environmental remediation, transmission outcomes or cost-effectiveness compared with existing surveillance alone.

From information to action

From information to action

The value of an environmental layer is realized only if information leads to feasible action. Where a priority location is identified, the appropriate response might be house screening or repair, drainage improvement, removal or management of productive larval habitats, correction of water-storage practices, targeted larval-source management, or referral to another authority. The response should be selected according to local vector ecology and evidence, rather than treating every environmental hazard as requiring the same intervention.

Affordability is central. A 2026 economic evaluation in Uganda estimated mean societal costs of approximately US\$116 per house for screening and US\$50 for eave tubes, while poorer households were often unable or unwilling to pay the full cost¹⁰. Environmental intelligence could therefore help target scarce resources, but targeting must not become a mechanism for shifting the cost of public-health protection onto households least able to pay. Financing mechanisms such as targeted subsidies, vector-resistant features in publicly supported housing and incremental upgrading warrant evaluation alongside epidemiological effectiveness, durability and equity.

The institutional problem is equally important. Many physical determinants of malaria lie outside malaria programmes: housing authorities regulate construction; planning agencies shape land use; water and sanitation agencies influence drainage and water infrastructure; public works departments manage roads and drainage; and local authorities may enforce environmental standards. The sector measuring malaria risk may therefore not control the environment producing that risk.

Re-engineering malaria control

Rather than establishing a parallel bureaucracy, countries could test mechanisms that connect existing environmental-health inspection with malaria intelligence. Standardized digital forms, geolocation, interoperable data systems, staff training and clear referral pathways would be required. Inspection timing could be adapted to local transmission and rainfall patterns. Critically, the workflow should be supportive rather than punitive: inspect, identify, record, support and verify—not simply inspect, identify and penalize. Where hazards reflect infrastructure deficits or household poverty, environmental-health intelligence should help mobilize remediation rather than generate unaffordable sanctions.

Re-engineering malaria control

The proposal is ultimately about architecture, not replacement. WHO's current malaria guidance continues to emphasize high-impact interventions including diagnosis and treatment, ITNs, IRS, vaccines and chemoprevention, with prioritization informed by local epidemiology, feasibility, equity and resource constraints¹¹. Environmental-health intelligence would sit alongside these tools rather than compete with them.

A more integrated malaria-control system would therefore assign complementary functions: clinical surveillance shows where disease is detected; entomological surveillance characterizes vectors and transmission behaviour; environmental-health surveillance describes modifiable physical conditions; and cross-sector institutions act on those conditions. The resulting cycle—observe, integrate, locate, target, verify, learn and adapt—could make environmental determinants visible within routine malaria decision-making.

Declarations

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Author Contribution

James Godspower conceived the Perspective, conducted the literature review and conceptual analysis, developed the framework, prepared the figure, wrote and revised the manuscript.

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Figures

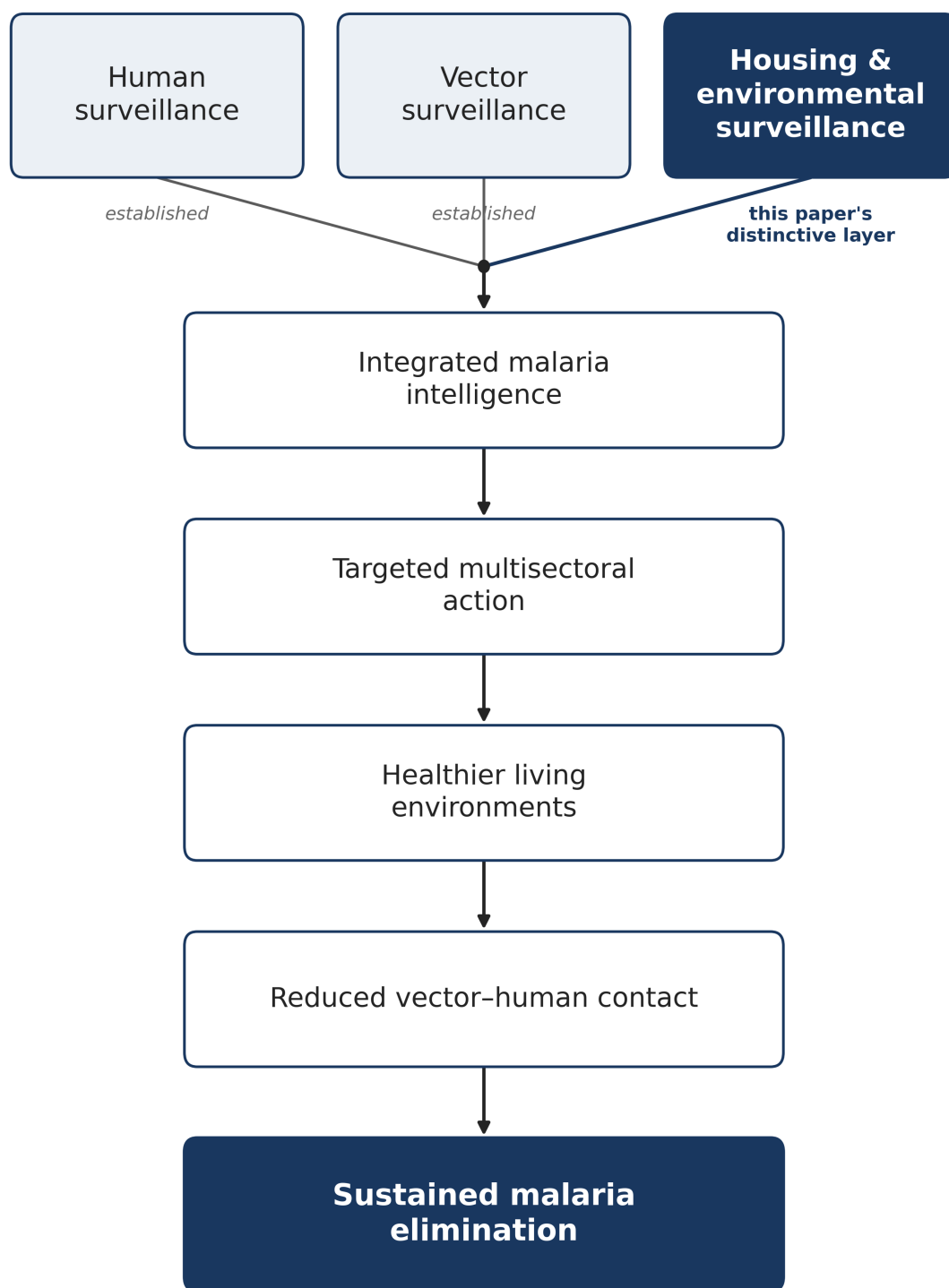


Figure 1

Proposed integration of housing and environmental-health surveillance into malaria intelligence.

Clinical and entomological surveillance are established components of malaria control; environmental-health surveillance is proposed as a complementary third information layer. The cycle is intended to support targeted, multisectoral action while retaining established malaria interventions.