RBM Partnership
To End Malaria

Multisectoral Action Guide to End Malaria

RBM Partnership to End Malaria — Multisectoral Action Guide to End Malaria

Credits

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Foreword

In 1993, the World Health Organization's (WHO) Global Strategy for Malaria Control first proposed an explicitly multisectoral and whole-of-government approach, advocating that other sectors, including agriculture, education, energy, the environment, housing, national planning, social development, tourism and transport, all needed to "provide leadership and ensure technical coordination" for the overall malaria response.[1] The recognition that sectors outside of the health sector needed to collaborate and contribute to a comprehensive malaria response and integrated development programme itself led to the creation of the Roll Back Malaria (RBM) Partnership in 1998 by the United Nations Development Programme (UNDP), United Nations Children's Fund, WHO and the World Bank, to support that multisectoral coordination. In 2015, the RBM Partnership and UNDP advanced the theoretical framework for this coordination with the Multisectoral Action Framework for Malaria. However, the integration of the malaria response into the broader development agenda and implementation of the specific actions that could be taken outside of the health sector have remained significant challenges for malaria-endemic countries and for the overall global response.

This *Multisectoral action guide to end malaria* (2021) and its companion, the *Multisectoral action guide to end malaria in Zambia* (2021), were developed to support malaria advocacy outside of the health sector and to specifically detail the types of interventions that could contribute to the malaria response in different settings. The guides contain specific roles suggested for government ministries, departments and agencies as well as for civil society, the private sector and other external financing partners. They also present the current available evidence base for effective actions taken in different sectors to control malaria and suggest opportunities for additional research to learn more about the potential impact of intervention mixtures in different epidemiological and sociopolitical contexts. It is hoped that the guides will inspire more malaria-endemic countries to review their own national multisectoral strategies, and to consider new policies and actions to address malaria outside of the health sector.

In the World Malaria Report 2020, the WHO Director General notes that the remarkable progress that has been made in controlling the disease over the last 20 years has stalled, that the 2020 milestones are unlikely to be met, and that the challenges of the current COVID-19 pandemic pose additional threats to our global malaria strategic objectives. In this context, we believe that this expanded multisectoral approach to malaria is especially timely and relevant. The deployment of existing capital and human resources from other sectors, with explicit consideration of their effects on the transmission of malaria, has the potential to reduce cases and deaths and increase the overall financing available to address malaria.

We are pleased to present this guide in the hope that it inspires specific actions across malaria-endemic countries, and that they will tailor its recommendations to their local needs and contexts. This process will be very important, and the relevant sectors should be involved from the beginning, generating opportunities for consensus, mutual ownership and meaningful engagement. The guides represent the collaboration across the partner organizations that make up the RBM Partnership to End Malaria, which stand ready to work with countries in the adaptation and implementation of the recommendations contained within them. We believe a malaria-free world is possible and requires our collective action.

[1] World Health Organization, *A Global strategy for malaria control* (Geneva, Switzerland, 1993), p. 20.

Acronyms

ALMA – African Leaders Malaria Alliance

BRD – Development bank of Rwanda

CBO – Community-based organization

CSO – Civil society organization

DRC – Democratic Republic of the Congo

EIA - Environmental Impact Assessment

EMC – End Malaria Council

EMF – End Malaria Fund

FAO – Food and Agriculture Organization

FBO – Faith-based organization

GMS – Greater Mekong Subregion

HIA – Health Impact Assessment

HMIS – Health management information system

IDPs – Internally displaced persons

IQ – Intelligence quotient

IRS – Indoor residual spraying

ITN – Insecticide-treated nets

LLIN – Long-lasting insecticidal net

LSM – Larval source management

Lao PDR – Lao People's Democratic Republic

NGO – Non-governmental organization

NMCP – National Malaria Control Programme

NSP – National Strategic Plan

NTDs – Neglected tropical diseases

PMI – U.S President's Malaria Initiative

PPP – Public-private partnership

RAB – Rwanda Agriculture and Animal Resources Development Board

RBM – Roll Back Malaria

SDGs – Sustainable Development Goals

UNDP – United Nations Development Programme

UNICEF – United Nations Children's Fund

UNWTO – World Tourism Organization

VAT – Value-added tax

WASAC – Water and Sanitation Corporation

WASH – Water, sanitation and hygiene

WHO – World Health Organization

WRAIR – Walter Reed Army Institute of Research

Contents

Introduction

As a disease inflicting incredible damage on the youngest, poorest and most vulnerable populations in the world, malaria stands directly in the way of the global ambitions driving all the Sustainable Development Goals (SDGs). Though specifically mentioned in SDG Target 3.3, the goal of eliminating malaria cuts across all 17 SDGs (see appendix A). In turn, malaria elimination would help accelerate progress towards many SDG targets beyond SDG 3.3, with impacts felt across nearly every sector in malaria-endemic communities.

Given that malaria poses a direct threat to human health, it is an obvious target for the health sector. Whether through facility-based or community health workers, or through public or private health-care providers, the health sector plays a pre-eminent role delivering health services designed to diagnose, treat and prevent malaria. However, malaria has significant negative impacts on community health, the consequences of which range far wider than the health sector's traditional reach.

Beyond the 229 million cases and 409,000 deaths caused by malaria each year,[1] the societal costs of the disease are substantial. The direct costs of malaria alone – for example, of illness, treatment and premature death – have been estimated to be at least $12 billion annually.[2] The cost in terms of lost economic growth in malaria-endemic countries is many times more. For example, adults who had repeated childhood malaria infections earn an estimated 50 per cent less than those did not suffer repeat infections.[3] Malaria causes a substantial number of lost workdays and lost school days due to illness, resulting in impaired worker productivity and educational attainment.[4,5] Areas with a risk of malaria are estimated to receive 48 per cent fewer tourists than those without, resulting in approximately $3.5 billion in lost tourist expenditure each year.[6]

Given the far-reaching impacts of malaria on society, all sectors have an important role to play in promoting and protecting community health – and much to be gained by doing so.

What does malaria control have to do with non-health sectors?

Human beings have always known malaria. The malaria parasite's life cycle predates *Homo sapiens* and was part of the environmental context in which our species evolved, even leaving traces in the human genome.[7] Human environments and social behaviours have always affected the dynamics of malaria transmission, but the importance of environmental and social determinants of malaria only became fully clear with the identification of the human *Plasmodium species (P. falciparum, P. vivax, P. malariae, P. ovale and P. knowlesi)* and the discovery of the role that female Anopheles mosquitoes play in transmitting the disease.

Environmental and social change can significantly alter malaria transmission, particularly in the context of development, when the determinants of disease change rapidly. Depending on the setting, these changes can increase or reduce malaria risk, and will sometimes alter the timing of malaria transmission. Managing the environment and influencing social behaviour therefore have considerable potential to reduce – and in some cases even eliminate – malaria cases and deaths.

In many countries, actions being taken outside of the health sector are unwittingly working against the goals of malaria elimination by creating environmental or social changes that increase malaria risk. For example, newly developed rice plantations may harbour malaria mosquitoes even as they increase food production and economic growth.[8,9] New construction,[10] mines and roads leave open pits that fill with rain and subsequently with malaria mosquito larvae,[11,12,13] placing both workers and surrounding communities at increased risk of malaria. Hydroelectric dams can create conditions that increase malaria transmission among people living nearby.[14]

As a consequence, preventing and controlling malaria is not a matter for the health sector alone; other sectors can enhance health sector efforts through measures that address the social, economic and environmental determinants of malaria and are incorporated into the policies, plans and practices within their own sectoral mandate. Many sectors outside of health have the potential to make important contributions to malaria prevention and control – from agricultural and extractive industries to less obvious sectors, such as tourism – while also mitigating or eliminating the harmful impacts of malaria that hinder progress towards their own sectoral goals.

This is what we mean by multisectoral action on malaria: interventions initiated and carried out by sectors other than the health sector that can work in tandem with and enhance the impact of health sector investments, expand the benefits of malaria investments to other sectors, reduce the strain on health systems and economies in malaria-endemic areas, contribute to the sustainability and resilience of health sector efforts and, ultimately, help drive progress towards the control and elimination of malaria.

Multisectoral action on malaria means that all sectors:

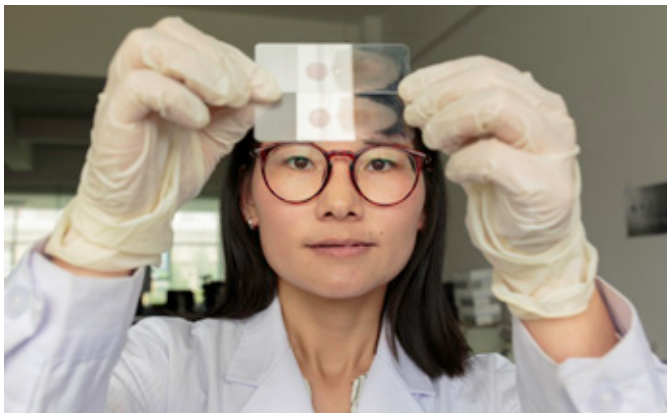
- Recognize the role they play in affecting malaria transmission, either positively or negatively.
- Work with partners in other sectors to identify small- or large-scale opportunities for actions and policy changes within their sector that enhance advancement towards sectoral goals while simultaneously contributing to malaria elimination.
- Implement the identified multisectoral actions alone or in collaboration with cross-sectoral partners.
- Continue to advocate for "malaria-smart" practices and policies within their sector.

What does multisectoral action on malaria look like?

Multisectoral action on malaria does not mean that all sectors should implement or finance health interventions. Nor does it mean that the health sector should finance malaria interventions in other sectors or cede responsibility for disease prevention and control strategies to other sectors. Rather, multisectoral action on malaria seeks to explore options for improved coordination and collaboration, and to identify synergies between actions by different sectors.

Multisectoral action on malaria is related to the concepts of the World Health Organization's Health-In-All-Policies[15] which highlights that policies in other sectors have the potential to improve human health – and to One Health,[16] a collaborative, multisectoral and transdisciplinary approach that recognizes the interconnectedness of human, environmental and veterinary health. This guide specifically focuses on actions on malaria, but some of the interventions that are effective against malaria – particularly those related to environmental health and management – may also be effective against other diseases, particularly water-related or vector-borne diseases.

Young woman using an insecticide treated net in Assam, India. Credit: WHO/A. Loke



A laboratory specialist holds blood smears that she will examine under a microscope for malaria parasites at the Yunnan Institute for Parasitic Diseases, Pu'er Simao, Yunnan, China. Credit: WHO/A. Loke

What are malaria-smart actions, practices and policies?

Malaria-smart interventions proactively identify and effectively address an aspect of malaria surveillance, prevention, diagnosis or treatment through more cost-effective or integrated methods. Any financial, capital or human resources that make a positive difference in the multisectoral response to malaria, while ensuring co-benefits for both non-health sector participants and malaria control (or, at worst, without compromising or undermining other sectors' core objectives) can be categorized as malaria-smart.

As demonstrated by the malaria-smart solutions and practices provided in this guide, it is possible to grow food, build new infrastructure, generate energy and promote tourism – i.e. grow economies and promote sustainable development – without creating conditions in which malaria vectors propagate and subject more people to their deadly bites. Moreover, the reduction in malaria cases and deaths will benefit the other sectors in terms of population health and overall productivity.

The impact of malaria-smart interventions will be context specific, i.e. dependent on a range of physical factors (epidemiology, ecology, climate and geography) and social factors (politics, culture, gender, and economy) of the setting in question.

This guide explores examples of malaria-smart interventions in key sectors and presents case studies that may inform future interventions.

What do we mean by sectors?

The term sector generically refers to a discrete part or subdivision of a larger whole. Within societies, it refers to a group of activities with common social, economic, and political goals or dimensions. When categorized in terms of ownership, sectors are typically organized into three groups: public, private and non-governmental, each of which has distinct objectives and target stakeholders. When categorized by function – as in the sector briefs in this guide – there are many different ways to organize and label sectors. The terms used to refer to the sectors in this guide are common among many malaria-endemic countries and may be adapted to different national or political contexts.

Although we refer to sectors categorized by function, we also consider these sectors by ownership, recognizing that public, private and voluntary organizations play distinct, complementary roles in malaria control. Traditionally, intersectoral action considers the different silos in the public sector from a policy and practice perspective. The private and non-governmental sectors operate within the policy, legal and regulatory frameworks established by the public sector entities. Public sector action is determined by political drivers, while private sector action is determined by the market. The boundaries between public sectors stem from the fact that they are all in competition for limited public resources and are run by stakeholders with discipline-specific vested interests.

How can this guide help me engage in multisectoral action on malaria?

There are many opportunities for actions outside the health sector that have strong potential to support malaria elimination while enhancing the work of the initiating sector. However, these opportunities are often not pursued by the health sector or not considered by key non-health stakeholders due to a lack of awareness that these opportunities exist or an incomplete understanding of the benefits they confer.

This guide is designed to help key health and non-health stakeholders better understand the opportunities, challenges and benefits of multisectoral action on malaria and ultimately aims to:

1. Inspire and inform new, strategic multisectoral engagements initiated from within and outside the health sector.
2. Help stakeholders across sectors identify shared goals and mutual areas of opportunity.
3. Serve as a resource to help advocate for malaria-smart thinking, practices and policies outside the health sector, as well as for the specific commitment, actions, data and deployment of financial and human resources

required for multisectoral engagement to eliminate malaria.

4. Support the creation of a policy framework conducive to multisectoral action to eliminate malaria.
5. Promote multidisciplinary research to generate evidence in support of multisectoral action and to analyse the existing gaps and challenges in addressing malaria in a multisectoral way.

This guide will first provide topics for consideration and guiding principles for conceiving, designing and implementing a national strategic plan for multisectoral action on malaria, including:

- challenges and practical considerations
- key actors, shared goals and priorities, and promising entry points
- impact assessments
- accountability frameworks
- health financing strategies
- policy frameworks

The guiding principles, challenges and areas for consideration outlined in this section are broadly applicable to multisectoral strategic thinking and may be useful to other audiences who are interested in multisectoral strategy development.

A series of sector-specific briefs follow, which provide context for several sectors' connections to malaria transmission and elimination, and the potential impact of multisectoral action on malaria in those spaces. The sectors were selected from among those in which past multisectoral action has been successful, those with known needs or gaps that could be addressed through multisectoral action, and those in which evidence suggests that future success is possible and should therefore be explored further. The sectors discussed in this guide include:

- agriculture
- defence and security
- extractive industries
- humanitarian emergency response
- infrastructure
- primary education
- tourism

Each brief provides a contextual analysis of the specific elements or practices of the sector in question that drive malaria transmission, followed by a list of promising entry points for multisectoral engagement between the sector and the malaria community. This includes multisectoral, malaria-smart interventions that may increase the impact of overall health sector investments, expand the health benefits of investments beyond the sector and contribute

Anopheles *mosquitos in the lab of the KEMRI/CDC research institute outside Kisumu, Kenya. Credit: WHO/S. Torfinn*

to the broader SDGs. The briefs also include specific case studies to exemplify successful past multisectoral efforts or interventions, inform the advocacy objectives of this guide, and inspire future collaboration between non-health sectors and global malaria control.

It should be noted that the interactions between malaria and elements of the different sectors are highly contextual. Each entry point or malaria-smart intervention described in the sector-specific briefs must be considered within the specific setting in which it would be implemented, including the epidemiological, ecological, environmental, geographic, climatic, social, cultural, political and economic factors of the area.

Each brief concludes with additional sector-specific details that may be helpful in designing a strategic plan for multisectoral action, including:

- key actors
- promising entry points
- capacity-building
- resource mobilization and financing
- evidence-building
- accountability

The guide concludes with appendices that provide helpful examples or deeper discussion on the key issues mentioned throughout.

The RBM Partnership to End Malaria, including multilateral organizations such as the United Nations Development Programme, United Nations Children's Fund, the World Health Organization and the World Bank, as well as malaria-endemic country governments, private sector businesses, civil society and other development partners, will work to support greater involvement from sectors outside of health in each of these areas of cooperation. We believe that this begins with ensuring that all sectors first recognize the dynamic interrelations between malaria and various development activities – so that they know that their work can and does make a difference in malaria control.

Advancing from our present world to one that is free of malaria will require global cooperation across a wide range of partners. To end malaria once and for all, there are many lessons to learn from the past. However, there are just as many innovations yet to come and important contributions to be made from all sectors. We hope that this guide supports countries in taking those first steps towards developing a more comprehensive and effective approach to malaria elimination.

[1] World Health Organisation, *World Malaria Report 2020: 20 Years of Global Progress and Challenges* (Geneva, 2020).

[2] Ebrahim Samba, "The malaria burden and Africa", *American Journal of Tropical Medicine and Hygiene*, supplement to vol. 64, No. 1 (January 2001).

[3] Hoyt Bleakley, "Malaria eradication in the Americas: a retrospective analysis of childhood exposure", *American Economic Journal: Applied Economics*, vol. 2, No. 2 (April 2010).

[4] Derek W. Willis and Nick Hamon, "Eliminating malaria by 2040 among agricultural households in Africa: potential impact on health, labor productivity, education and gender equality [version 2; peer review: 2 approved]", *Gates Open Research*, vol. 33 (2018).

[5] Simon Brooker, *Malaria Control in Schools: a Toolkit on Effective Education Sector Responses to Malaria in Africa*, (Washington D.C., World Bank, 2009).

[6] Jaume Rosselló, Maria Santana-Gallego and Waqas Awan, "Infectious disease risk and international tourism demand", *Health Policy and Planning*, vol 32, No. 4 (May 2017).

[7] Dominic P. Kwiatkowski, "How malaria has affected the human genome and what human genetics can teach us about malaria," *American Journal of Human Genetics*, vol 77, No. 2 (August 2005).

[8] Kallista Chan, Kazuki Saito and Jo Lines, "Rice and malaria in Africa: a growing problem", presentation to the 3rd Annual Meeting of the RBM Partnership to End Malaria Multi-Sectoral Working Group, Geneva, 6 February 2020. Available at https://endmalaria.org/sites/default/files/u224/11_Jo%20Lines.pdf

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[10] Steven W. Lindsay and others, "Recommendations for building out mosquito-transmitted diseases in sub-Saharan Africa: the DELIVER mnemonic", *Philosophical Transactions of the Royal Society B*, vol 376, No. 1818 (February 2021).

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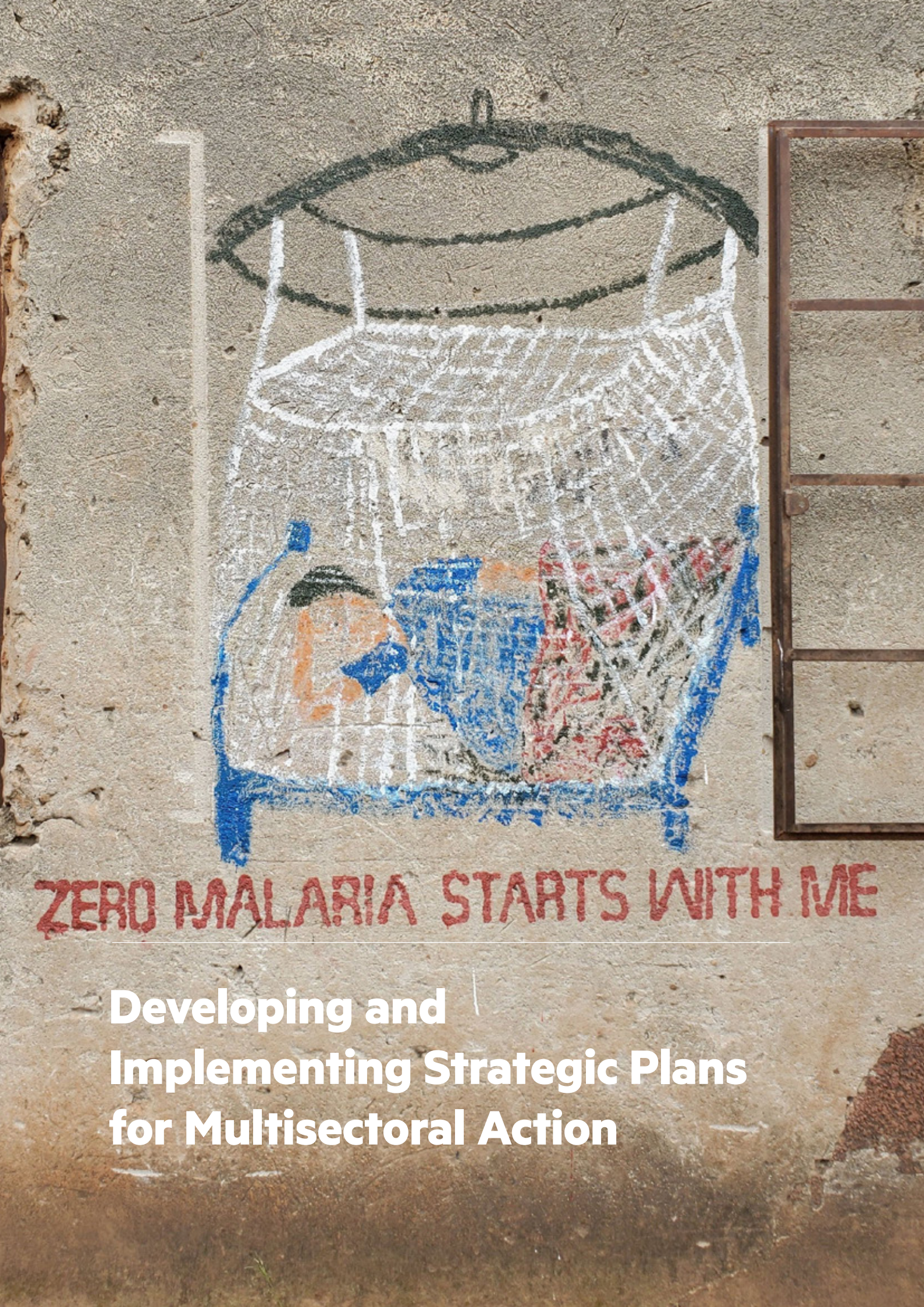
[12] Fiona Mactaggart and others, "Exploring the broader health and well-being outcomes of mining communities in low- and middle-income countries: a systematic review", *Global Public Health*, vol. 13, No. 7 (2018).

[13] Rodrigo Rodriguez-Fernandez and others, "The double burden of disease among mining workers in Papua, Indonesia: at the crossroads between old and new health paradigms", *BMC Public Health*, vol. 16 (2016).

[14] William Jobin, *Dams and Disease: Ecological Design and Health Impacts of Large Dams, Canals and Irrigation Systems* (London, E. & F.N. Spon, 1999); International Water Management Institute, *Dams and Malaria in Africa: Time for Action*, Water Policy Brief Series (Colombo, Sri Lanka, 2018). Also see Solomon Kibret and others, "Malaria around large dams in Africa: effect of environmental and transmission endemicity factors", *Malaria Journal*, vol. 18 (September 2019); Solomon Kibret and others, "Modeling reservoir management for malaria control in Ethiopia", *Scientific Reports*, vol. 9 (December 2019).

[15] World Health Organization, *Health in All Policies: Helsinki Statement. Framework for Country Action* (Geneva, 2014).

[16] Centers for Disease Control and Prevention, *Saving Lives by Taking a One Health Approach: Connecting Human, Animal, and Environmental Health* (2020).



Developing and Implementing Strategic Plans for Multisectoral Action

An important step for malaria programmes that wish to undertake multisectoral engagement is to explicitly develop a national multisectoral strategic plan for malaria that complements the health sector strategy. This step will be critical to define objectives and success criteria, and to access funding for multisectoral initiatives. Several countries already have set out national multisectoral strategic plans for malaria that can serve as a model, for example, Rwanda's Emergency Mitigation Strategy and Uganda's Guidelines for Mainstreaming Malaria in the Multisectoral National and District Plans. Technical assistance from the RBM Partnership to End Malaria can also support the development of a new multisectoral strategy.

The guiding principles for multisectoral strategy development below will be reiterated in the sector-specific briefs, with additional details that are relevant to each sector.

Categories of cooperation and aims for multisectoral strategies:

When engaging with other sectors outside of health, we can consider four broad categories of cooperation for malaria control:

- **Advocacy:** Advocating for malaria control and elimination to be a strategic priority across all sectors and at all levels, i.e. from the national level down to the community level.

- **Action:** Implementing the national strategic plan (NSP) for malaria, including specific interventions by other ministries, departments, agencies and actors outside of the health sector.

- **Resource Mobilisation:** Mobilizing funding and in-kind goods and services to support NSP implementation.

- **Accountability:** Holding the other sectors accountable for delivering on their commitments for advocacy, action and resource mobilization.

Challenges and practical issues to consider when designing a multisectoral strategy:

When it comes to multisectoral action on malaria, strategies alone are insufficient; however, implementing multisectoral initiatives can be challenging in practice. There are a number of common obstacles to successful multisectoral cooperation that should be accounted and planned for when designing a multisectoral strategy. These may include:

- Other sectors resist incorporating malaria-specific objectives because of a lack of political will or because of weak or misaligned incentives.
- Agreed upon activities are unfunded in the national or ministerial budget.
- Coordination across sectors is difficult and bureaucratic because of strong organizational silos.
- Weak project management and accountability mechanisms can impede progress.
- Other sectors may feel a lack of ownership of the initiative, which can limit their enthusiasm for and commitment to a project.
- There is a lack of a solid and compelling evidence to convince other sectors' decision makers of the links between their sectoral actions and malaria incidence and of the mutual benefit of multisectoral action on malaria.

When commencing a multisectoral collaboration, there needs to be a clear understanding from the outset that successful implementation of a multisectoral approach requires investment and substantial advocacy. Maintaining a healthy dose of pragmatism, being prepared to continually invest time and energy into maintaining forward progress – for example, through relationship building – and setting realistic expectations are essential. Efforts may run into challenges if it is assumed that:

- The process for establishing a multisectoral strategy will be quick and easy.
- Other sectors already understand malaria and why control and elimination are strategic priorities.
- Success, excitement and energy will be sustained over the long term without proactive effort to maintain them.

Successful multisectoral approaches often break down institutional silos, decentralize elements of planning and execution, increase transparency and accountability, and build on strong political will and engagement at the highest levels of government, the private sector and in the community.

It is also important to remain focused on the need for agility, here intended to mean "being prepared to evolve as best

practices are identified and challenges arise". There can be a significant gap between the ideal multisectoral strategy sketched out on a whiteboard and the real world. The structure, strategy and function of a particular multisectoral action may vary significantly on day one versus day 1,000. Be prepared for and responsive to the changing realities. In practice, this means that there is no one-size-fits-all approach and instead any approach must account for the country and local contexts.

Identify key actors

Multisectoral approaches involve collaboration among various stakeholder groups, including government ministries, departments and agencies, as well as civil society organizations and private businesses. These stakeholders work within and across sectors or discrete socioeconomic programmes, such as those committed to health and welfare, agriculture, and finance. The purpose of this collaboration is to achieve a joint policy outcome – malaria elimination – to be achieved in a way that does not compromise each of the other sectors' core objectives.

When beginning to design a multisectoral strategy, map the partner landscape and make connections with the key actors in the target sector. Build relationships with actors in other sectors and convince them of the need for and mutual benefits of multisectoral action on malaria, as this will be essential to galvanize practical action and maintain enthusiasm through the activity. Key actors to engage may include:

- national, departmental and municipal government ministries, agencies and service providers
- global, national, departmental and municipal regulatory authorities
- regional, continental and global alliances, partnerships and coordinating mechanisms
- community groups and leadership
- international financing institutions
- multilateral and bilateral technical support agencies
- private businesses
- national, departmental and local health authorities, facilities and service providers
- local and international civil society organizations
- international humanitarian agencies, such as the United Nations Children's Fund and the United Nations High Commissioner for Refugees
- local faith-based organizations, churches and religious leaders.

In the national multisectoral responses to malaria, government ministries, departments and agencies in malaria-endemic countries bear the highest level of responsibility and accountability for promoting malaria-smart interventions. Within the government, the ministry responsible for health plays the pre-eminent role as the source of malaria expertise to guide and inform all other levels, from the Head of State and central government down to the local government authority. Depending on the specific context, a number of other ministries may also play roles in planning and coordinating malaria-smart interventions in different sectors, including prioritizing malaria-affected geographies and populations in other development activities.

However, other elements of the public sector, beyond health ministries, could be key actors in any multisectoral action on malaria. Heads of State play a critical role in multisectoral engagement through their leadership of the public sector and can direct intersectoral cooperation through incentives – often financial – or influence. Other government structures where sectors naturally intersect could serve as fertile breeding grounds for multisectoral collaboration, including national economic planning councils, national environmental protection authorities, and national science and technology councils, which are notably influential in Latin American countries. Further, national institutes for public administration and management, which exist in many countries to train core civil servants, can play a role in building capacity to engage successfully in intersectoral dialogues and decision-making.

Private sector businesses operating within malaria-endemic countries also possess unique capabilities to contribute to the national response. Depending on the context, malaria-smart interventions may be financed by a combination of government and private sector resources. With or without government directives or incentives, businesses can ensure that their capital investments are malaria-smart, contributing to the reduction of malaria mosquito density and better facilitating access for populations to malaria prevention, diagnosis and treatment services and data, without compromising their principal functions.

Through investing in surveillance and impact assessments – including health, environmental and economic impact assessments – as components of their capital investments, businesses such as those in the extractive industry and agricultural operations may create healthier conditions that will directly benefit their own workforce, clients and reputation. Manufacturers of pesticides and vector control

tools also play an essential role by investing in the research, development and manufacturing needed for continuous innovation. National governments and businesses must work together to support the development and scale-up of innovative tools for greater impact.

Civil society also plays an important role, particularly in raising the political profile of malaria and advocating for malaria-smart interventions in multiple sectors. Through campaigns such as Zero Malaria Starts with Me, which originated in Senegal before spreading across Africa and around the world, non-governmental organizations, community-based organizations and faith-based organizations, among others, can advocate for malaria-smart interventions at all levels.[1] Civil society can hold other partners accountable to their commitments and sensitize local communities and households on the direct actions they can take against malaria in all aspects of their lives.

Lastly, many of the sectors described in this guide are supported by their own development partners and donors, who could provide access to new sources of funding, technical support and advocacy for malaria prevention programmes. However, as with many other partners, many multilateral and bilateral donor agencies are also siloed along sectoral lines. This may make it challenging for such donors to provide financial support for a multisectoral action for health without a specific financing mechanism established for that purpose.

Evidence gathering and impact assessment

To be successful, the specific elements of a multisectoral action plan – from the key actors and entry points to ideal regulatory structures and funding mechanisms – must be tailored to specific settings and local contexts, and will need to be planned and implemented in cooperation with key local stakeholders. This requires consideration of variables such as climate, topography, industrial design and operations, and the local epidemiological profile of the population.

Evidence will be key for effectively engaging with stakeholders from any sector and demonstrating mutual benefits and positive impacts of any planned multisectoral projects. A practical approach to leveraging multisectoral resources for malaria involves the use of impact assessments – such as Environmental Impact Assessments (EIA) or Health Impact Assessments (HIA) – in capital development projects. In addition to identifying negative environmental and health impacts, impact assessments are an effective tool to gather evidence on potential health and economic benefits of particular programmes and activities. This information is essential for developing a well-informed multisectoral action plan while opening up clearer avenues for multisectoral investment.

Such assessments may include:

- HIAs: a systematic approach to identify adverse effects and health opportunities of development projects upon which to develop a multisectoral public health management plan. In this way, the environmental and social determinants of health can be managed in the context of development projects.

Young girls using insecticide treated nets in the hostel of a government-run girls high school in Odisha, India. Credit: WHO/A. Loke

- EIAs: a planning and decision-making tool used to identify the environmental, social and economic impacts of a project prior to decision-making. They aim to predict environmental impacts at an early stage of project planning and design, find ways and means to reduce adverse impacts, shape projects to suit the local environment, and present the predictions and options to decision makers.

- Economic Impact Assessments: a systematic approach to estimate the changes in employment, income and levels of business activity that may result from a proposed project or programme.

- Cost-benefit analyses: a way to compare the costs and benefits of an intervention, where both are expressed in monetary units.

- Cost-effectiveness analyses: a way to examine both the costs and health outcomes of one or more interventions by comparing one intervention to another (or to the status quo) by estimating how much it costs to gain a health-outcome unit, for example a life-year gained or a death prevented.

Each assessment gathers specific kinds of information that may or may not be relevant to or useful for developing a comprehensive understanding of specific projects. Different types of impact assessments are often integrated, but it should not be assumed, for example, that an EIA will take health impacts into account, even those related to environmental conditions, or that a HIA will necessarily include a cost-benefit analysis. Before engaging in any project or assessment, consider the type(s) of assessment(s) appropriate for a particular activity, its usefulness for engagement with a particular sector, its feasibility in a specific context (including possible resource constraints) and how multiple assessments may be integrated.

Regulated EIAs are already used by 190 countries to prevent and mitigate potential environmental impacts from industrial development before these new works start. By explicitly requiring projects to identify and address environmental determinants of malaria, development projects in these other sectors would be in a position to contribute additional resources to tackle malaria.[2,3]

While HIAs are widely used on a voluntary basis in high-income countries, there remains a great deal of potential to further develop this mechanism and expand its use in lower-income, malaria-endemic settings to mobilize additional resources for malaria. For the Greater Mekong Subregion, the Asian Development Bank set up a Regional Malaria and Other Communicable Disease Threats Trust in December 2013, which strengthened the practice of HIAs while financing multisectoral projects to eliminate malaria.[4] Six universities offered HIA certificate courses targeting 262 future practitioners, and 696 government and non-governmental organization staff were trained on HIAs. The project, which was completed in June 2018, supported increases in domestic funding for malaria, from $90 million in 2013 to more than $300 million in 2018 across the Greater Mekong Subregion countries. The first Asian Development Bank health bond also made available $124 million in loan financing for the countries.

Identify shared goals and priorities to determine promising entry points

Prior to engaging each sector, it is essential to identify the target sector's priorities, incentives and the types of activities it could feasibly perform. This preparation is essential for aligning the needs of the overall NSP for malaria with those of the sector.

While the public health sector may measure success in cases and lives saved, the private sector is likely to measure success in return on invested capital, revenues and costs. Assuming that a sector will be intrinsically motivated by the same priorities as the national malaria programme can lead to failure, whereas adopting the metrics and objectives of the target sector will enhance efforts to advocate for prioritization of malaria.

When seen through the lens of shared priorities and goals, information gathered through impact assessments, gap analyses or any other research can help identify the most promising entry points for multisectoral engagement. However, regardless of how much planning, strategizing and research is done, a list of possible entry points or activities contained in a multisectoral strategy is not definitive.

Successful multisectoral approaches nurture collaboration by inviting the other sectors to define how they will commit to supporting the NSP and to suggest what the malaria programme can do to support them in return. Not only does this promote ownership and accountability for each sector, but each sector is uniquely aware of its capabilities, resources and assets that could be applied.

Capacity-building

Once activities have been identified, assess current capacity for their implementation and identify capacity-building efforts that will be required across sectors to fill gaps. Bilateral and multilateral agencies can further contribute through HIA/EIA capacity development for national and local governments.

Accountability

It is essential to incorporate accountability measures from the start to ensure that partners keep to their commitments. Elements to be incorporated into a multisectoral strategic plan include:

- **Standards and guidance:** Work across sectors to provide standard guidance for practices, interventions and systems that reduce malaria burden and transmission, as well as any adverse health, economic or environmental impacts.

- **Monitoring and evaluation:** Develop a monitoring and evaluation framework to assess progress towards shared goals and objectives identified in the multisectoral action plan, and integrate it into existing malaria monitoring and evaluation structures.

- **Accountability mechanisms:** Establish frameworks and structures to promote accountability among partners across sectors, and integrate them into existing local and national regulatory frameworks.

Health Financing Strategies

Domestic resource mobilization will be essential to support multisectoral action on malaria. In addition to securing high-level, domestic political commitment, countries are advised to develop a national health financing strategy to realize their malaria goals.[5]

While this guide considers how to finance malaria control efforts, it is important to keep in mind that a sound health financing strategy holistically considers a country's health needs and services. Financing malaria services should not be considered in isolation of overall health system requirements and reforms. Neither should funding streams be earmarked or ring-fenced for malaria-specific services in ways that may undermine the comprehensive delivery of an essential, integrated-service package to deliver universal health coverage. However, as this guide emphasizes, malaria control services do not only come from the health sector. For this reason, a comprehensive malaria financing strategy should also consider the broader multisectoral environment and be aligned with a national health financing strategy.

As described by the World Health Organization, a health financing strategy:

- diagnoses the current performance of the health system
- takes a comprehensive view of the entire population and all aspects of the health system
- identifies and prioritizes country-specific objectives over a defined time period
- includes an evaluation strategy for accountability and course-correction.

Women and children waiting at a health centre, Central African Republic. Credit: UNICEF/ P. Holtz

The strategy should evaluate and identify potential reforms across all health financing policies and arrangements, including:

- revenue sources and contribution mechanisms
- pooled funds
- service procurement
- policies on benefit design, rationing and the basis for entitlement
- governance of all these functions and policies.

To consider the broader multisectoral environment, a comprehensive financing strategy should:

- Identify policies, interventions and resources in sectors outside of health that have the potential to improve malaria prevention, diagnosis, treatment and surveillance.
- Analyse and prioritize those policies, interventions and resources, paying attention to:
  - Their impact on other development objectives: Will a malaria focus undermine or strengthen the primary goals of the sector?
  - Cost-effectiveness: Will the impact be substantial and justify the additional cost?
- Set national objectives over a defined time period that can be evaluated.

Health sector financing strategies are necessarily led and coordinated by the ministries responsible for health and finance; however, financing strategies to achieve multisectoral malaria goals may be achieved in a number of different ways depending on the country context. In different countries, multisectoral agendas – such as those to address HIV and AIDS or nutrition – are led and coordinated by offices of the president, vice-president or prime minister, or by ministries responsible for local government coordination. Multisectoral coordination and financing strategies for malaria should be adapted based on lessons learned from these other similar initiatives. This may involve repurposing existing structures or designing mechanisms to specifically address multisectoral financing for malaria.

Policy frameworks for multisectoral action on malaria

Before beginning any activities, it is imperative to formulate a conducive policy framework, legal framework and regulatory framework for multisectoral action on malaria; without such frameworks, it will be difficult, if not impossible, to sustain multisectoral efforts over time. The health sector itself is not well placed to advocate for policies promoting multisectoral action; such policies should be formulated at a higher, over-arching level.

Heads of State can issue decrees to impose intersectoral action, but this may be less sustainable in countries where there is regular turnover of politicians in office. Some government institutions may be appropriate for the task – for example, in most countries, ministries of economic development oversee the development process and approve large-scale infrastructure, energy and other sectoral projects, often requiring HIAs or EIAs. Similarly, environmental protection agencies can ensure that health issues are properly addressed, and will have a vested interest in ensuring that health protection and promotion is environmentally sound. Many countries – especially those in Latin America – have national science and technology councils that can stimulate such multidisciplinary, collaborative research. As mentioned earlier, civil service training institutes for management and administration further provide an opportunity to create awareness and develop skills in intersectoral negotiation, including for public health issues. Thus, policy formulation can create the framework for multisectoral action by practitioners, promote the strengthening of the evidence base and expand the human resource base needed to maintain intersectoral action.

Lastly, regulatory action can bring the efforts to a local level, which is critical given the highly contextual nature of most multisectoral interventions. Regulation should particularly ensure safeguards in agricultural practices, building design, water management and engineering practice.

[1] For more details, see https://ZeroMalaria.Africa (accessed on 9 March 2021).

[2] Julia Nowacki, *The Integration of Health into Environmental Assessments: With a Special Focus on Strategic Environmental Assessment* (Copenhagen, World Health Organization Regional Office for Europe, 2018).

[3] Patrick Harris, Francesca Viliani and Jeff Spickett, "Assessing health impacts within environmental impact assessments: an opportunity for public health globally which must not remain missed", *International Journal of Environmental Research and Public Health*, vol. 12, No. 1 (January 2015).

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[5] Joseph Kutzin and others, *Developing a National Health Financing Strategy: a Reference Guide* (Geneva, World Health Organization, 2017).

[6] For more details see https://alma2030.org/wp-content/uploads/2020/02/EMC-Background-min.pdf and https://endmalaria.org/news/president-kenyatta-new-chair-african-leaders-malaria-alliance-alma-outlines-his-priorities (accessed on 10 March 2021).

National End Malaria Councils and End Malaria Funds as Levers for multisectoral action

Without a senior-level malaria champion to drive advocacy for multisectoral action, national malaria programmes may lack the stature to fully implement a multisectoral framework once it has been put in place. To overcome this, several countries are establishing End Malaria Councils (EMCs) and/or End Malaria Funds (EMFs) to help implement multisectoral action. To differentiate between the two components of this approach, which may be implemented separately or together, **EMCs** focus on convening the high-level national influencers who can promote the financing of multisectoral initiatives against malaria, while **EMFs** are mechanisms for mobilizing, managing and distributing additional financial resources for health sector or multisectoral initiatives against malaria.

EMCs convene senior leaders across the government, private sector and civil society to drive advocacy, action, resource mobilization and accountability. EMCs are country-led, country-owned approaches to developing multisectoral public-private partnerships and serve as a platform to solve resource gaps and operational bottlenecks identified by the national malaria programme. By engaging the various sectors through the senior-level champions on the EMC, the national malaria programme can more easily mainstream the objectives of the national strategic plan.

The process for establishing an EMC requires four steps:

- **Diagnostic:** Detailed evaluation of the operational and resource gaps under the national strategic plan and need for advocacy, action, resource mobilization and accountability.
- **Design:** Development of a proposed structure and concept note describing the council.
- **Implementation:** Sensitization of EMC members across sectors on the importance of malaria and establishment of the EMC.
- **Execution:** Sector-by-sector engagement to identify the unique capabilities and resources available and make commitments for advocacy, action and resource mobilization; ongoing follow up and mutual accountability for meeting commitments.

Once malaria has been established as a priority, the EMC works with health and other sectors to jointly create commitments for further advocacy, action and resource mobilization. The EMC can present the initial list of activities from the multisectoral framework for consideration by the sector. By collaborating and co-creating the commitments, the EMC can ensure that commitments will support the NSP while also not overlooking innovative ways of working. Once commitments have been made, the EMC promotes mutual accountability through its members by monitoring and reporting on the fulfilment of each sector's commitments.

This approach has already been taken up by countries including Eswatini, Mozambique and Zambia, and has been endorsed by Kenyan President Uhuru Kenyatta, the current chair of the African Leaders Malaria Alliance, who is targeting the establishment of at least 15 new EMCs and EMFs during his two-year term as chair.[6]

Agriculture

Agriculture is an important contributor to gross domestic product and represents a substantial portion of the workforce in many malaria-endemic countries. The most malaria-affected regions – notably South Asia and sub-Saharan Africa – are also the most reliant on agriculture. In many settings, agricultural practices can increase malaria transmission, risking lost farmer workdays and agricultural productivity due to illness. Multisectoral action and collaboration between key actors in agriculture and malaria control is needed to mitigate the impacts of agriculture on malaria transmission, while improving farmers' quality of life and increasing agricultural productivity.

The intersection of malaria and agriculture

Demand for food is increasing worldwide, propelled by a growing population and increasing per capita incomes. To meet this demand, the Food and Agriculture Organization estimates that by 2050, the world will need to produce almost 50 per cent more food, animal feed and biofuel than it did in 2012.[1] A great deal of this increased production will be needed in some of the countries with the highest burden of malaria, such as the Democratic Republic of the Congo, India and Nigeria.

Where malaria is present, it can pose a significant risk to farmers' productivity. One analysis estimates that approximately 261 million cases of malaria would be prevented among agricultural households in sub-Saharan Africa between 2018 and 2030 if current plans to eradicate malaria by 2040 are successful; this would decrease the number of lost workdays among agricultural households by up to 1.95 billion workdays over that time period.[2]

Malaria significantly impacts revenue earned from agriculture through its effects on family labour, hired labour and agricultural investment. Beyond the health-care costs associated with malaria illness, the disease can disrupt farmers in their work during critical planting, weeding and harvesting times, forcing farmers to choose to either incur additional cost by substituting family labour with hired labour or to accept a reduction in labour force and land productivity.[3,4] Farmers who are impacted by malaria may be unable to sufficiently feed themselves and their families, compounding their suffering from the disease with malnutrition and impoverishment due to lower crop yields – which in turn place the household at even greater malaria risk. The same conditions can also disrupt commercial farming through outbreaks among the workforce.

While malaria burden has a notable negative impact on agricultural productivity and the quality of life of farmers and field workers, the expansion of agricultural land use and intensification of agricultural production – for example, by introducing irrigation and water impoundments – can in turn exacerbate the spread of malaria across ecologically diverse settings.[5,6,7] The impact of agricultural practices

Relevant Sustainable Development Goals

and production systems on malaria risk and vector populations is highly contextual, with the exact same practices either increasing, decreasing or having no effect on malaria risk in different epidemiological, ecological, climatic and environmental contexts. However, some ways in which agricultural production can increase malaria transmission include

Water storage: Agriculture – including irrigation, livestock and aquaculture – is responsible for the largest percentage of global water withdrawals, at 69 per cent.[8] Many open water storage facilities – including reservoirs, ponds and tanks – can serve as ideal breeding sites for malaria mosquitoes, bringing malaria vectors closer to human habitations and people.[9] Such water storage systems across a range of scales – from water harvesting ponds and wells for single households to large surface dams for large-scale irrigation or hydropower production[10,11] – have been shown to increase malaria transmission in many settings, sometimes even those that already have moderate or high levels of malaria transmission. Irrigation schemes have even been observed to alter malaria transmission patterns from seasonal to year-round.[12] This is not confined to rural areas; market gardening often found in urban and peri-urban areas can also increase malaria vector habitats.[13]

A range of factors determine the suitability of stored water as mosquito breeding habitats, including water depth, soil, temperature, presence of vegetation, predators and chemical composition. Whether or not vector propagation in stored water actually leads to increased malaria transmission further depends on a number of additional variables related to local climate, agroecosystem, epidemiology, and human interventions and behaviour.[9]

Deforestation and changes in land use: Agriculture is estimated to drive approximately 80 per cent of deforestation worldwide. Low-income countries are particularly affected, with tropical and subtropical regions having lost 7 million hectares of forest and added 6 million

GF, John Rae, Cambodia, Thailand Border Migrant farmers

hectares of agricultural land per year between 2000 and 2010.[14] Deforestation and land clearance can lead to changes in the ecosystem that can encourage malaria mosquito proliferation, including shifts in temperature, sunlight, humidity and vegetation.[15] However, it should be noted that in some settings, deforestation leads to conditions that are inhospitable to the local malaria vector species and the opposite effect is observed.[16]

Use of agrochemicals: Use of agrochemicals can have environmental and ecological impacts that affect local malaria transmission. Agricultural pesticide use can help drive resistance to insecticides that are important for public health – such as those applied to insecticide-treated nets – with the same or a similar mode-of-action.[17],[18] Additionally, the use of fertilizer and manure on agricultural lands may affect water quality downstream. Such ecological changes could create conditions that increase malaria vector populations, for example, by reducing predator populations while leaving mosquito larvae less affected.

Animal husbandry: In some situations, the close proximity of livestock to humans can increase malaria risk by potentially providing malaria-infected mosquitoes with additional blood-sources and aquatic habitats.[19] Nomadic pastoralists, such as the Fulani in West Africa, who undergo extensive migration in search of pasture have been shown to be at higher risk of malaria, as their nomadic living conditions in close contact with livestock frequently increase malaria risk, while also precluding access to protective measures such as insecticide-treated nets and other health services.[20] In settings where the malaria vectors are highly zoophilic, the strategic location of livestock between vector breeding sites and human settlements can help reduce malaria transmission (for example, Anopheles arabiensis in the Mwea-Tebere rice irrigation schemes in Kenya),[21] supporting the idea that well-studied zooprophylaxis could be an efficient tactic to manage malaria and other mosquito-borne diseases in similar contexts. The opposite has also been shown, with implications for malaria transmission; for example, in Guyana, malaria increased after the mechanization of agriculture, as replacing livestock with tractors forced the zoophilic malaria vector to take blood meals from humans.[22]

Aquaculture: The rearing, breeding and harvesting of fish, shellfish and other aquatic organisms has been associated with malaria increases in some settings. For example, in the Brazilian Amazon, fish farming in deforested and abandoned areas has led to increased malaria due to the adaptation of the Anopheles darlingi malaria mosquito to fishponds, despite predation by juvenile fish.[23]

Opportunities for action

Given the heavily interconnected relationship between malaria and agriculture, many opportunities exist for multisectoral action to substantially benefit both malaria control and agricultural production in malaria-endemic countries.

Due to the highly contextual nature of many of the interactions between malaria transmission and agricultural practices, a comprehensive multisectoral response must be tailored to specific country and local contexts to be effective, considering variables such as the local malaria epidemiology, ecology, climate, topography, water supply, crops, customs and agricultural practices in different parts of the country. Any recommended changes in agricultural practices will also need to be made in collaboration with communities and other stakeholders.

Entry points and actions for mainstreaming malaria-smart practices in agriculture include:

- **Research and evidence building:** Form collaborations between academia, private agricultural industry and government ministries related to health and agriculture to gather evidence on the contributions of common agricultural practices to malaria transmission in specific settings.

- **Introducing malaria-smart changes to standard agricultural practices:** Assess potential impacts and support the introduction and scale-up of changes to agricultural practices, production methods and policies that mitigate or minimize the impact of agricultural production on malaria. Such practices may include:

- Irrigation practices that reduce standing water
- Use of intermittent or alternating wet-dry irrigation[24]
- Improved and regularly maintained drainage canals, free of debris and flowing well.
- Adequate shoreline management around lakes and reservoirs by zoning and adequate coverage, such as vegetation or pebbles.
- For small-scale water storage, storage of water in field-level structures rather than household ponds, as fields are usually further from habitations than malaria mosquitoes can fly.[9]
- Where feasible, use of covered tanks or storage in groundwater rather than open water storage, as these are less associated with water-related diseases, such as malaria. Groundwater storage may not be possible in some areas, depending on local geology, soils and slope.
- Increased larval source management, including deployment of chemical or microbial larvicides where appropriate.
- Planting improved and malaria-smart crop varieties – for example, those that require less water – while being conscious of possible side-effects, such as the impact of maize pollen on mosquito larval size.
- Where zoophilic mosquito species are key malaria vectors, treatment of livestock with insecticide or endectocide[25], and strategic placement of livestock between breeding sites and houses.
- Building on experience with integrated pest management and expanding to integrated vector management of malaria mosquitoes (as demonstrated in the case study below on farmer field schools).
- Use of agricultural extension services to distribute bednets and insecticide kits and to provide community education on reapplying insecticide to bednets and on evidence-based agricultural practices in support of malaria control.
- Offering malaria preventative tools and health services to temporary labourers, with particular attention to providing diagnosis and treatment for those from malarious areas.
- Promotion and support of the wide-scale roll-out of malaria-smart environmental and vector management practices that are appropriate for the specific country context, including epidemiological, ecological and environmental factors.

- **Community education and support:** In addition to addressing agricultural practices, it is important to focus on the material conditions of agricultural workers, their financial support and living conditions, access to health services and malaria prevention tools, and continuing education. Such community support improves quality of life, while providing the health and physical well-being required to run a productive farm. Improved education and socioeconomic status are also linked to reduced malaria risk.

Taking action

The first step towards multisectoral action in any space is to develop a strategy for multisectoral action that is aligned with the national strategic plan for malaria and that considers the broader multisectoral environment in a specific country and regional setting, including key actors; promising entry points; sectoral goals and priorities; financing; and health, environmental and economic impacts of multisectoral action in this space. For more details on developing a comprehensive national strategy for multisectoral action, see page [X].

The specific elements of a successful multisectoral action plan for malaria and agriculture – from the key actors and entry points to ideal regulatory structures and funding mechanisms – will vary greatly depending on the specific political, epidemiological, ecological, economic and cultural context of the country or region and the current geopolitical situation. However, many important topics for consideration and steps in the process of strategizing effective multisectoral engagement between the agriculture and malaria communities remain largely consistent across settings:

Key actors: Map the agricultural landscape and make connections with the key country or regional actors in agriculture. Build relationships with actors in other sectors and convince them of the need for and mutual benefits of multisectoral action on malaria, as this will be essential to galvanize practical action. Key actors to engage in agriculture may include:

- government ministries or departments related to agriculture, animal industry and fisheries
- national agricultural and veterinary research centres
- the Consultative Group on International Agricultural Research partners and Consortium members
- civil society organizations, associations and groups related to agriculture, which may include associations and groups related to the agricultural industry – such as those specific to particular crops or markets, e.g. cotton, coffee, dairy, agritourism or agricultural cooperatives – or philanthropic organizations working to achieve development goals related to food security, poverty alleviation and sustainable agriculture
- existing regulatory authorities
- local focal points of international organizations related to agriculture and food security – for example, the Food and Agriculture Organization.

It is also important to work with affected communities, identifying existing capacity in local and displaced communities, whose members may have important skills, influence and cultural understanding not available in the international humanitarian community.

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Entry points: Identify promising entry points for integrating malaria interventions and malaria-smart thinking into standard agricultural practices, systems and planning, including those detailed in the previous section.

Capacity-building: Assess current capacity for rapid implementation of malaria-smart agricultural practices and policies and identify capacity-building efforts that will be required across sectors to fill gaps.

Resource mobilization and financing: Additional resources will likely be required to support proposed multisectoral activities and programmes. To assist with resource mobilization, proposed plans to implement malaria-smart agricultural practices and policies should be costed, funding gaps should be identified and potential multisectoral funding and advocacy targets should be evaluated. The ways in which these needs could be met by integrating them into existing malaria and health financing strategies should be assessed, as well as opportunities to mobilize previously untapped resources from domestic and – where appropriate – global sources.

Evidence – especially that demonstrating mutual benefit for all participants in multisectoral engagement – will be essential for mobilizing efforts from within the agricultural sector. Impact assessments are an effective tool to gather evidence to develop a well-informed multisectoral action plan while opening up clearer avenues for multisectoral investment in malaria. Before implementing a new policy or programme to integrate malaria-smart thinking into agricultural practices and systems, conduct a series of impact assessments whose combined results help strategize ways to maximize the benefits of interventions while preventing or mitigating any unintended negative effects on public health, agricultural productivity, local ecology or the environment. Such assessments may include Health Impact Assessments, Environmental Impact Assessments, and cost-benefit analyses. Use of participatory approaches – including Participatory Health Impact Assessments – can help identify user preferences and gain deeper insight into potential impacts of specific programmes or risk factors.[9]

For more information on impact assessments, see page [X], and for more details on financing multisectoral action for malaria, see page [X].

Case study:
farmer field schools

Malaria control can be effectively integrated into a complementary intervention in rural development for agricultural pest management known as “farmer field schools”. These schools employ a “learning by doing” approach to building farmers’ expertise and can be adapted to address a variety of environmental management issues. During the crop cycle, farmers meet weekly to make field observations and discuss crop pests, beneficial organisms, plants, soil and environmental conditions. The farmers are encouraged to design experiments (for example, “What if instead of spraying, we drain the water to control plant hoppers in rice?”), which are evaluated the following week. Farmer field schools have been shown to drastically reduce the use of agropesticides, empower farmers to innovate, and to produce economic benefits for the community.

In malarious areas, the integrated pest management curriculum has been amended to include malaria ecology and control, and to involve farmers and others in malaria control in their environment through integrated pest and vector management. Farmer field schools can reduce malaria in four ways: (1) reduced pesticide use reduces selection pressure on malaria mosquitoes; (2) increased awareness and understanding of malaria increases personal protection and treatment-seeking behaviour; (3) increased profits from agriculture can be invested in improved housing, nutrition and treatment access; and (4) environmental management reduces mosquito breeding and thus malaria transmission.

The best example of this approach comes from Sri Lanka, where the curriculum has been adapted for the wetland rice ecosystem.[1] Farmers are encouraged to identify mosquito aquatic habitats by sampling with dippers; to study the mosquito life cycle by rearing young larvae in water jars covered with mesh; and to develop a better understanding of disease vector activity by sampling and identifying adults of the three main mosquito genera from different habitats at different times. Farmers also assess the effects of agricultural methods for suppressing mosquito breeding (e.g. alternate wet–dry irrigation of field plots, land levelling at planting) and draw maps of the village environment – including water bodies, crops, houses, etc. – to facilitate planning of coordinated environmental management..

Accountability:

- **Standards and guidance:** Work across sectors to provide standard guidance for the introduction, scale-up and maintenance of practices and production systems that reduce malaria burden and transmission, while supporting a productive agricultural industry.
- **Monitoring and evaluation:** Develop a monitoring and evaluation framework to assess progress towards shared goals and objectives identified in the multisectoral action plan, and integrate it into existing malaria monitoring and evaluation structures.
- **Accountability mechanisms:** Establish frameworks and structures to promote accountability among partners across sectors, and integrate them into existing local and national regulatory frameworks.

Effective collaboration between the malaria community and key agricultural stakeholders will be essential for malaria elimination and improving the health and productivity of farmers in malaria-endemic regions. While the specific challenges and required interventions depend on the context, specific and effective actions can be taken that will simultaneously reduce malaria and improve agricultural production.

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Defence and security

Malaria has had an impact on military and defence since their invention. Military populations are often at higher risk of contracting malaria, particularly when naïve individuals are deployed to malaria-endemic areas domestically or abroad and risk bringing the disease home with them when they return.[1] Likewise, these populations can also spread malaria to new areas. Militaries often play an important role in a country's preparation and response to global health security threats, like malaria. Given the dangers malaria poses to global health security and military personnel, as well as the extensive resources, political capital and labour available to the military, multisectoral collaboration between the health and defence sectors provides significant opportunities for mutual benefit.

The intersection of malaria, defence and security

Malaria has long played a role in military history, with military leaders having used their experience of malarious areas and transmission seasons to strategize and plan their campaigns.[2] Particularly following the First and Second World War, military agencies rose to the forefront of research on malaria prevention, diagnosis and treatment, leading the development of new tools – notably the compounds dichlorodiphenyltrichloroethane (DDT) and chloroquine – that inspired the World Health Organization's Global Eradication Programme of the 1950s and 1960s.[3]

In addition to sponsoring a great deal of the subsequent research into malaria prevention, diagnosis and treatment, the U.S. Department of Defense's Walter Reed Army Institute of Research (WRAIR) has continued to play a leading global role, including support for the first malaria vaccine (RTS,S), currently undergoing clinical trials in Ghana, Kenya and Malawi. Likewise, the Chinese military, through its secret "Project 523" supported development of research which led to the Nobel prize-winning discoveries on the antimalarial properties of artemisinin medicines.[4]

National defence and security forces in malaria-endemic countries also contribute to national responses to infectious diseases such as malaria. As mentioned above, military populations may be especially at risk, and can play a role in spreading malaria to new areas. It is therefore a top priority for the defence sector to ensure that military personnel have access to prevention, diagnosis and treatment services that will protect their health and maintain their productivity while serving in areas with high malaria transmission. Controlling malaria among the military can also benefit the general population: military designated health facilities often serve nearby civilian populations, as well as military personnel and their families. These facilities may also implement vector control measures in the community which protect both soldiers and civilians.

Other defence and security workers may also face heightened malaria risk. Many of them work outdoors at night during peak times of malaria transmission without

Relevant Sustainable Development Goals

chemical prophylaxis or personal protective equipment such as topical repellents and insecticide-treated clothing. This increases the risk not only to themselves but also to their communities as they may bring malaria into their homes. Measures to address these occupational hazards may be broadly applicable for military personnel as well as for private security guards.

The political economy of militaries: Militaries have the potential to provide additional funding and labour for malaria control. Typically designated in national budgets as a top priority, military agencies and departments may have more financial flexibility than other sectors to contribute towards the national multisectoral strategic plan for malaria, especially when the case can be made that reducing malaria increases productivity. Four of the highest malaria burden countries spend more than 2 per cent of their gross domestic product on the military (the global average is 2.14 per cent); several also have substantial numbers of armed forces personnel who could be engaged in malaria control.

In addition to making the case for mobilizing new resources from the defence sector for the national malaria response, there is also argument in favour of developing multi-country defence and security partnerships that feature malaria elimination objectives.

Defence and security partnerships: From their experience of controlling malaria during wartime, national defence ministries and agencies have an intrinsic motivation to protect their armed forces against this disease. However, there have also been some successes in the development of defence and security partnerships between countries and their militaries. The U.S. Department of Defense has convened East and West African malaria task forces with selected countries to address areas of collaboration.[5] In addition, funds from the U.S. President's Malaria Initiative have supported both malaria research and international cooperation involving the US military. Some recent examples have included work in Cameroon and Uganda with the U.S. Navy Entomology Center of Excellence on malaria research and vector control, and WRAIR also recently training 48 Nigerian scientists in eight States to implement and supervise quality assurance procedures for malaria diagnostics in their laboratories.[6] The People's Republic of China has also dispatched peacekeeping forces, including medical detachments, that have supported public health efforts such as those against Ebola and malaria.[7] As part of a broader agenda for global health security, the Government of Australia has also promoted defence cooperation among regional partners that incorporates malaria elimination objectives (described in the case study below).

Global health security: COVID-19 has served as a reminder of how interconnected the world is. Strong health systems, cross-border collaboration, sustained political will and financial commitments to public health are all needed to manage threats to global health, whether long established – like malaria – or new – like the COVID-19 pandemic. Investments in malaria can simultaneously build resilient health systems and protect the world from current and emerging disease threats.

Health emergencies and pandemics, such as COVID-19, can put malaria services at risk. Overwhelmed health systems, reductions in health-seeking behaviour, illnesses among front-line workers and procurement disruptions compromise malaria service delivery and access. Interruption of malaria services can increase the number of malaria deaths and cases. Preparedness and other global health security capacities reduce the risk of health emergencies and enable continued gains for malaria eradication. Preventing malaria is an important strategy for reducing the strain on health systems. The capacity and infrastructure requirements for achieving and sustaining malaria elimination are the same as those needed for strengthening global health security, including robust and responsive surveillance and reporting systems, a multisectoral approach, cross-border networks to facilitate communication and collaboration, and a well-trained workforce. Malaria investments are working to ensure all people have access to quality health care by increasing the capacity of health workers, strengthening supply chain management systems, building real-time surveillance and data management infrastructure, improving laboratories, and reinforcing monitoring and evaluation.

Global health security is more than pandemic preparedness. It includes protection from biological weapons, the spread of antimicrobial resistance or "superbugs", and the epidemics the world is already facing like malaria, HIV and AIDS, and tuberculosis. Malaria is as mobile as its human hosts, travelling easily, rapidly and often undetected between endemic and non-endemic places. This is especially concerning for drug-resistant malaria. Given current unprecedented mobility, a global commitment to malaria eradication is the only tenable approach to protect the more than 100 countries that have eliminated malaria from the threat of resurgence and the spread of drug and insecticide resistance.

Case study:
Military-civilian cooperation in the Greater Mekong Subregion

Countries in the Greater Mekong Subregion (GMS), which include Cambodia, the People's Republic of China, Lao People's Democratic Republic (Lao PDR), Myanmar, Thailand and Viet Nam, have made great progress towards the regional goal of malaria elimination by 2030. As malaria cases have receded from small towns and villages into more remote areas and border regions – including many sites with military encampments – military-civilian cooperation has become even more important for reaching the final stages of malaria elimination. With anecdotal data suggesting that as many as 5–10 per cent of malaria cases in the GMS may be attributed to military personnel, defence and health ministries in the subregion have agreed to form a partnership to control malaria. This partnership has involved high-level advocacy among senior officials, information-sharing between military agencies for improved regional surveillance and response, and identification of new areas for capacity-building.

Particularly with the unique challenge of drug-resistant malaria strains in the subregion, there is a common focus to unite regional partners under a common banner and platform for joint action. If military and security forces are ignored in this operation, they might serve as reservoirs of new infections and jeopardize attainment of the regional elimination target of 2030. However, with joint action, this sector has the potential to finish the job of eliminating malaria in the region once and for all.

Credit: World Health Organization, Nat Sumon

Opportunities for action

strategic plans for malaria, from the direct participation of the armed forces – including military, prisons and police – to the engagement of the private security workforce. These actions can range from workplace protection and the expansion of health services within the sector to specific actions that deploy defence and security personnel to expand the reach of malaria services, including surveillance, prevention, diagnosis and treatment. Some specific entry points to multisectoral engagement between the defence and security sectors and malaria control include:

- **Malaria health services for military and security personnel, including:**
  - improving the quality of and expanding service for health facilities serving military, police, and prison populations
  - screening and treatment of peacekeeping forces to prevent the spread of malaria, for example to prevent the introduction of artemisinin-resistant malaria into Africa[8]
  - expanding personal protective measures for outdoor guards in malarious regions, including potential consideration of prophylaxis, topical repellents and insecticide-treated clothing
- **Mainstreaming malaria-smart practices in military engineering corps projects, including:**
  - employing environmental management to address vector breeding sites around military infrastructure, buildings and encampments
  - incorporating or retrofitting mosquito-resistant designs into military infrastructure (for details, see the "Infrastructure" section beginning on page [X])
- **Integrate disease surveillance in military operations in malaria-endemic areas,** particularly in remote areas and at border stations[9]
- **Implementing and enhancing information-sharing and cooperation with regional military partners**, as exemplified in the GMS case study
- **Leverage multisectoral approaches to malaria to propel a whole of government approach for emerging disease threats**.

A coordinated and whole-of-government approach is essential for both successful malaria elimination and outbreak response. Ensuring that leadership from all ministries focuses on efforts to drive down malaria and other outbreaks provides the political will and resources necessary to protect health in the face of emerging disease threats.

Uganda/Malaria Smart Schools images. © SOLOMON TUMWESIGYE/NOTHING BUT NETS

Taking action

The first step towards multisectoral action in any space is to develop a strategy for multisectoral action that is aligned with the national strategic plan for malaria and that considers the broader multisectoral environment in a specific country and regional setting, including key actors; promising entry points; sectoral goals and priorities; financing; and health, environmental and economic impacts of multisectoral action in this space. For more details on developing a comprehensive national strategy for multisectoral action, see page [X].

The specific elements of a successful multisectoral action plan for malaria with coordination between defence and security actors and the malaria community – from the key actors and entry points to ideal regulatory structures and funding mechanisms – will vary greatly depending on the specific political, epidemiological, ecological, economic and cultural context of the country or region and the current geopolitical situation. However, many important topics for consideration and steps in the process of strategizing effective multisectoral engagement between key partners to mitigate the impacts of malaria on emergency situations remain largely consistent across settings:

Key actors: Map the partner landscape and make connections with the key country or regional actors. Build relationships with actors in other sectors and convince them of the need for and mutual benefits of multisectoral action on malaria, as this will be essential to galvanize practical action.

Key actors to engage in defence and security may include:

- national defence ministries and branches of the military
- military research and development institutions and funding agencies
- local, municipal and departmental defence and security personnel, such as private security, prisons and police staff
- regional, continental and intercontinental military-security alliances.

Entry points: Identify promising entry points for integrating malaria interventions and malaria-smart thinking into standard operating procedures for the defence and security sector in malaria-endemic areas, including those detailed in the previous section.

Capacity-building: Assess current capacity for rapid implementation of malaria control measures among military and security personnel and for integration of malaria-smart practices and policies into standard operating procedures and programmes. Identify capacity-building efforts that will be required across sectors to fill gaps.

"It's a household war – chase malaria to zero"

As part of Uganda's national malaria control campaign, the armed forces (military, prisons, and police) have been trained in the use of the national health management information system and e-health data-collection tools which include reporting on the management of malaria cases, as well as the stock status and consumption levels of malaria test kits and antimalarial medicines.

Resource mobilization and financing: Additional resources will likely be required to support proposed multisectoral activities and programmes. To assist with resource mobilization, proposed plans to integrate malaria prevention and control into emergency responses should be costed, funding gaps should be identified and potential multisectoral funding and advocacy targets should be evaluated. The ways in which these needs could be met by integrating them into existing malaria and health financing strategies should be assessed, as well as opportunities to mobilize previously untapped resources from domestic and – where appropriate – global sources.

Evidence – especially that demonstrating mutual benefit for all participants in multisectoral engagement – will be essential for building political will and mobilizing resources from within the defence and security sector. Impact assessments are an effective tool to gather evidence to develop a well-informed multisectoral action plan while opening up clearer avenues for multisectoral investment in malaria. Such assessments may include Health Impact Assessments and cost-benefit analyses. For more information on impact assessments, see page [X] , and for more details on financing multisectoral action on malaria, see page [X] .

Accountability:

- **Standards and guidance:** Work across sectors to provide standard guidance for practices, interventions and systems that reduce malaria burden and transmission among security and defence personnel and the communities they serve, while supporting a robust and healthy defence sector.

- **Monitoring and evaluation:** Develop a monitoring and evaluation framework to assess progress towards shared goals and objectives identified in the multisectoral action plan, and integrate it into existing malaria monitoring and evaluation structures.

- **Mechanisms for accountability:** Establish frameworks and structures to promote accountability among partners across sectors, and integrate them into existing local and national regulatory frameworks.

Multisectoral collaboration between malaria control actors and the defence and security sector has a long and successful history. Through continued partnership and planning across sectors, key actors in the defence and security sectors can take specific and targeted actions to simultaneously prevent malaria outbreaks and ensure national and regional security.

[1] For examples, see Phoutnalong Vilay and others, "Malaria prevalence, knowledge, perception, preventive and treatment behavior among military in Champasak and Attapeu provinces, Lao PDR: a mixed methods study", Tropical Medicine and Health, vol. 47, No. 11 (2019); Sylvia Egbom and Sidney Obidimma Nzeako, "Malaria parasitaemia amongst military personnel households in a military formation in Port Harcourt, Nigeria," *International Journal of Scientific Research in Environmental Sciences*, vol. 5, No. 1 (2017), pp. 10–16; Jaymin C. Patel and others, "Genetic evidence of importation of drug-resistant *Plasmodium falciparum* to Guatemala from the Democratic Republic of Congo", *Emerging Infectious Diseases*, vol. 20, No. 6 (2014), pp. 932–940.

[2] For a survey of military campaigns shaped by malaria, see Timothy C. Winegard, *The Mosquito: A Human History of Our Deadliest Predator* (New York, Dutton, 2019).

[3] For examples from the First World War, see Bernard J. Brabin, "Malaria's contribution to World War One – the unexpected adversary," *Malaria Journal*, vol. 13, No. 497 (2014). For examples from the Second World War, see Karen M. Masterson, *The Malaria Project: The U.S. Government's Secret Mission to Find a Malaria Cure* (New York, Penguin Books, 2014). For more information on the World Health Organization's Global Malaria Eradication Programme, see Randall M. Packard, "'No other logical choice': global malaria eradication and the politics of international health in the post-war era", *Parassitologia*, vol. 40, No. 1–2 (1998), pp. 217–229.

[4] Zongru Guo, "Artemisinin anti-malarial drugs in China," *Acta Pharmaceutica Sinica B*, vol. 6, No. 2 (2016), pp. 115–124.

[5] See Jeffrey T. McCollum and others, "Strengthening malaria prevention and control: Integrating West African militaries' malaria control efforts. The inaugural meeting of the West African malaria task force, April 24–26, 2013, Accra, Ghana", *Military Medicine*, vol. 180, No. 1 (January 2015), pp.7–11.

[6] U.S. President's Malaria Initiative, *U.S. President's Malaria Initiative, 13th Annual Report to Congress, May 2019* (Washington, D.C., U.S. Agency for International Development, 2019), p. 4.

[7] Shu Chen and others, "Chinese medical teams in Africa: a flagship program facing formidable challenges," *Journal of Global Health*, vol. 9, No.1 (2019).

[8] Stan Houston and Adam Houston, "Screening and treating UN peacekeepers to prevent the introduction of artemisinin-resistant malaria into Africa," *PLoS Medicine*, vol. 12, No. 5 (May 2015).

[9] See Jessica E. Manning and others, "Fighting the good fight: the role of militaries in malaria elimination in Southeast Asia,", *Trends in Parasitology*, vol. 30, No. 12 (November 2014), pp. 571–581.

Extractive industries and energy production

Extractive industries – such as oil, gas and mineral extraction and gem mining – and energy production play a pivotal role in the global economy and substantially contribute to the overall economic output of many malaria-endemic countries in Africa, Asia and the Americas.[1] However, industrial processes of extraction like drilling, pumping, quarrying and mining also have socio-environmental impacts that can create favourable conditions for the proliferation of malaria vectors and increase malaria transmission. Given that an increase in the malaria burden would be detrimental to the health and productivity of the extractive industry workforce and surrounding communities, there is an especially strong case for multisectoral engagement in malaria-endemic countries that are highly reliant on these industries.

The intersection of malaria, extractive industries and energy production

Hydroelectric dams provide between 20 and nearly 100 per cent of electricity production in highly malaria-endemic countries in sub-Saharan Africa.[2] Likewise, of the world's top 20 mining-dependent countries[3], 4 are among the top 10 countries with the highest malaria burden[4]. Together, these 16 countries accounted for more than 61.5 million malaria cases and 120,000 deaths in 2018.

Deforestation, environmental degradation and increased population mobility associated with extractive projects can also increase the incidence of malaria in a region. In a modelling study from 2015, researchers conservatively estimated that 1.1 million malaria cases were attributable to large hydroelectric dams in sub-Saharan Africa, with 47 per cent of the burden among communities living within 5 km of the dams' reservoirs.[5]

Extractive industries have the potential to impact malaria transmission in several different ways depending on a range of factors, including the climate and topography of a location, the design and implementation of the extractive operations, and the epidemiological profile of the surrounding populations.

Extractive industries and malaria vector management: Certain aspects of the process of extraction can create a favourable environment for the proliferation of malaria-infected mosquitoes. For example, rainwater in mining trenches and pits and hydroelectric dams designed with gently sloping draw-down areas both create pools of stagnant water or shallow puddles that are optimal breeding sites for malaria-infected mosquitoes. Large-scale industrial operations have the management capacity and resources to mitigate this risk by eliminating existing mosquito breeding sites, rehabilitating sites after operations are completed and designing new sites to minimize or eliminate potential mosquito breeding sites.

Relevant Sustainable Development Goals

Extractive industries and workforce: The extractive workforce is highly mobile, with many workers living away from their families in remote camps that have limited infrastructure and access to emergency and specialized health care and treatment services. Workers in these industries face several occupational health risks, including non-communicable and infectious diseases such as malaria. These risk factors are compounding, producing a high prevalence of multimorbidity and posing a threat to the workers' health and the health systems that serve them.[6] A highly mobile workforce carrying malaria parasites can also spread and/or reintroduce the disease to other communities, including those in which their families reside.[7,8] While some companies do provide health services for their employees, these services must be continuously improved to reduce and eliminate malaria.[9]

Extractive industries and malaria-endemic communities: Extractive sector operations in malaria-endemic countries typically take place in locations surrounded by poor communities that are highly vulnerable to contracting malaria. The environmental impacts of these operations pose an additional health risk to nearby communities, including communities living downstream of hydroelectric dams. While some companies enter into public-private partnerships to extend health services to communities impacted by their work, better design, management, monitoring and evaluation of these partnerships and sector operations will be crucial for addressing health and development for these populations.[10]

Artisanal and illegal extractive operations: Artisanal and illegal extractive operations are far more likely to promote increased malaria vector breeding and transmission, in part because they lack the capacity and resources to mitigate malaria risk available to larger, formal companies. Threats from security forces may further limit workers' ability to access health services in these settings.[11, 12]

Malaria Burden in the World's Top 20 Most Mining-Dependent Countries:

Mining Contribution Index Rank[13]	Country	Estimated Annual Malaria Cases[14]	Estimated Annual Malaria Deaths[15]
1	Democratic Republic of Congo	26,888,424	44,615
2	Burkina Faso	7,875,575	12,725
3	Mali	7,378,847	11,848
4	Papua New Guinea	1,587,573	3,124
5	Eritrea	99,716	196
6	Namibia	51,898	132
7	Mauritania	173,555	1,397
8	Suriname	29	0
9	Peru	58,455	4
10	Liberia	1,742,079	2,006
11	Botswana	879	2
12	Chile	0	0
13	Zambia	2,719,036	7,519
14	Guyana	34,565	43
15	Sierra Leone	2,451,110	6,564
16	Mongolia	0	0
17	Australia	0	0
18	Guinea	3,524,261	8,203
19	Tanzania	6,997,809	21,550
20	Kyrgyzstan	0	0

Colour Legend: High burden in red, medium burden in orange, very low burden in yellow, malaria-free in green

Opportunities for action

Given the socio-environmental impacts of energy production and oil, gas and mineral extraction practices, and the resulting potential for increased malaria transmission, there are many opportunities for multisectoral action to substantially benefit both malaria control efforts and the economic output of malaria-endemic, mining-dependent countries.

Entry points and actions for mainstreaming malaria-smart practices in extractive industries include:

- **Monitoring and surveillance:** Involve national and local government authorities, surrounding communities and private sector stakeholders in continuous or expanded monitoring of malaria trends and encourage reporting of malaria cases among the workforce and surrounding communities. Promote sharing of epidemiological data with local health authorities – including the National Malaria Programme – to inform the health sector decision-making process.

- **Environmental impact and regulation:** Introduce malaria risk assessments into standard licensing regulations, including requiring that Health and Environmental Impact Assessments investigate the potential impacts of an extractive operation on malaria transmission and that practices and interventions to prevent and mitigate malaria are introduced or scaled up at extractive sites.[16]

- **Malaria-smart design and management of extractive sites:** Promote, mainstream and support malaria-smart design and management of extractive sites in malaria-endemic areas. Such efforts should include developing environmental and surface water management strategies for vector control and an integrated approach to larval source management, both informed by Health and Environmental Impact Assessments. Malaria-smart practices to consider include:

  - designing mosquito-resistant shelters and buildings on sites and in the surrounding communities
  - removing unused infrastructure that could serve as mosquito breeding sites
  - reducing standing water by installing proper drainage systems
  - using chemical or microbial larvicides, where appropriate
  - controlling vegetation around roads, camps, storage facilities and reservoirs or other bodies of water, as appropriate.

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- **Community and worker health:** Promote access to malaria health services for the workforce and surrounding communities through public-private partnerships between the health sector and extractive companies. This includes:
  - conducting behaviour change education and malaria awareness-raising campaigns
  - distributing bednets and insecticide kits
  - providing malaria prophylaxis for workers from non-endemic areas
  - providing regular malaria screening and treatment for workers entering and leaving camps that can also be deployed to surrounding communities based on the level of need.

- **Improved dam design:**[17] Because of the role that dams play in providing consistent sources of water for hydropower, domestic use, livestock watering and irrigation, it may be difficult to keep populations from settling too close to dam reservoirs that are potential sources of malaria infection.[18] However, the following steps can be taken to mitigate any negative impacts of dams on malaria transmission:
  - Create buffer zones between settlements and dams to put as much physical distance as possible between humans and vector breeding sites.
  - Conduct appropriate shoreline management along reservoirs to manage mosquito breeding sites.
  - Design dam reservoirs to minimize their suitability for malaria vectors. The slope of the draw-down area – the area of which can change daily, weekly, monthly, seasonally and even between years – appears to be the most important design factor related to malaria prevalence; the steeper the slope, the lower the chance that shallow puddles will form, providing breeding habitats for malaria mosquitoes. Unfortunately, this does not apply to dams that have already been built – once a site has been selected, the slope cannot be changed. While shallow slopes provide longer shorelines and more potential breeding habitats, fast draw-down rates can reduce the number of mosquitoes even in shallow reservoirs. Reservoirs are often important sources of water for livestock, whose hoofprints create puddles that may be ideal mosquito breeding sites. Separate and appealing animal watering points should be created to prevent these potential breeding sites.
  - Where feasible, implement modes of operation at dam reservoirs that reduce malaria vector habitats, for example, a combination of rapid draw down and fluctuation of water levels to reduce stagnant water pools.

Taking action

The first step towards multisectoral action in any space is to develop a strategy for multisectoral action that is aligned with the national strategic plan for malaria and that considers the broader multisectoral environment in a specific country setting, including key actors; promising entry points; sectoral goals and priorities; financing; and health, environmental and economic impacts of multisectoral action in this space. For more details on developing a comprehensive national strategy for multisectoral action, see page [X].

In order to be successful, the specific elements of a multisectoral action plan in this space – from the key entry points to ideal regulatory structures and funding mechanisms – must be tailored to specific extractive settings and local contexts and will need to be planned and implemented in collaboration with key local stakeholders. This requires taking into consideration variables such as the climate, topography, industrial design and operations, and the local epidemiological profile of the population.[19]

Despite these important context-specific considerations, many steps in the process of strategizing effective multisectoral engagement between key partners remain largely consistent across settings:

Key actors: Map the partner landscape and make connections with the key country or regional actors in the extractive industries. Build relationships with actors in other sectors and convince them of the need for and mutual benefits of multisectoral action on malaria, as this will be essential to galvanize practical action and achieve an efficient response.

Case study:
Hydropower in Brazil

Since 1980, Brazilian environmental regulations have recognized that extractive activities have an environmental impact and can contribute to an increase in malaria incidence. Environmental assessments were first introduced in 2001, alongside proposals for multisectoral approaches to reduce the malaria transmission risks posed by rural projects. Companies that operate in malaria-endemic parts of the Amazon jungle are now mandated by law to set aside funds to help mitigate malaria transmission.

In Brazil, cross-sectoral regulations jointly developed by the Ministries of Health, Environment, and Mines and Energy and the National Foundation for Indigenous Peoples mitigate the direct and indirect health impacts of infrastructure projects on malaria-endemic regions. Companies need to conduct assessments focused on malaria and its determinants, recommend potential mitigating actions, and allocate funding for malaria control before they can obtain environmental licensing to operate in an area.

Most importantly, municipal action plans for malaria receive funding for vector control; procurement and installation of bednets; diagnosis; active case detection; health education and microscopy training. These funds also support the construction of health care facilities and transportation to referral facilities for malaria treatment.

Santo Antônio and Jirau hydroelectric dams: In 2008, construction of the Santo Antônio and Jirau hydroelectric dams began in and around Porto Velho, a municipality in the Amazon which has the second highest malaria burden in Brazil. Despite the presence of competent vectors, environmental degradation providing conditions favourable for malaria transmission, and considerable population growth, malaria incidence in Porto Velho has decreased: the number of cases fell from 34,865 in 2006 to 3,600 cases in 2015.

The companies involved in this hydroelectric dam project were required by environmental licensing regulations to provide support for malaria control. Equipment, educational materials, malaria rapid diagnostic tests, bednets, and health services with a total value of over $21 million were provided to the State and municipal health secretariats to enhance existing programmes designed to reduce malaria transmission. In addition to implementing interventions for malaria diagnosis, treatment and vector control, the health programmes also created a space for engaging with local communities to involve them in finding solutions.

Jirau hydroelectric dam, Porto Velho - Rondônia, Brazil. Photo Credit: PAHO.

Key actors to engage in these areas may include:

- government authorities, including ministries and regulatory agencies related to health, the environment, infrastructure, mining and energy
- private industry stakeholders, including mining, oil, gas and hydroelectric companies
- local and international non-governmental organizations (NGOs) related to health and workers' rights and safety
- local and international trade organizations and associations, such as the International Council on Mining and Metals and the International Hydropower Association.

Public-private partnerships between mining companies and governments to provide health services and malaria vector control have the potential to expand the capacity of national public systems, increase domestic resource mobilization, and attract additional external investment. The case of the AngloGold Ashanti public-private partnership is an excellent example of this approach.[20]

The health sector can also work with environmental regulatory agencies to minimize possible negative impacts that extractive operations can have on the health of the local environment and populations. The case of hydropower regulation in Brazil detailed in the case study on page [X] provides an example of successful implementation of such a strategy.[21,22]

It is also important to work with affected communities, identifying existing capacity in local and displaced communities, whose members may have important skills, influence and cultural understanding not available in the international humanitarian community.

Entry points: Identify promising entry points for integrating malaria interventions and malaria-smart thinking into standard extractive industry practices, management, and site design, including those detailed in the previous section.

Capacity-building: Assess current capacity for rapid implementation of malaria control measures in the emergency response and for integration of malaria-smart practices and policies into emergency response plans. Identify capacity-building efforts that will be required across sectors to fill gaps.

Resource mobilization and financing: Additional resources will likely be required to support proposed multisectoral activities and programmes. To assist with resource mobilization, proposed plans to integrate malaria prevention and control into extractive industry practices should be costed, the economic impact should be assessed, public-sector or NGO funding gaps should be identified, and potential multisectoral funding and advocacy targets should be evaluated. The ways in which these needs could be met by integrating them into existing malaria and health financing strategies should be assessed, as well as

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opportunities to mobilize previously untapped resources from domestic and global sources.

Evidence will be key to effectively engaging with extractive industry stakeholders, particularly private companies who could be impactful participants in public-private partnerships in this area. In addition to identifying negative environmental and health impacts, impact assessments are an effective method of gathering evidence on the potential health and economic benefits of particular programmes and activities. This information is essential to develop a well-informed multisectoral action plan, while opening up clearer avenues for multisectoral investment. Such assessments may include Health Impact Assessments, Environmental Impact Assessments, Economic Impact Assessments and cost-benefit analyses. For more information on impact assessments, see page [X], and for more details on financing multisectoral action for malaria, see page [X].

Accountability:

- **Standards and guidance:** Work across sectors to provide standard guidance for practices, interventions and systems that reduce malaria burden and transmission and environmental impacts, while maintaining robust extractive and hydropower industries.

- **Monitoring and evaluation:** Develop a monitoring and evaluation framework to assess progress towards shared goals and objectives identified in the multisectoral action plan, and integrate it into existing malaria monitoring and evaluation structures.

- **Mechanisms for accountability:** Establish frameworks and structures to promote accountability among partners across sectors, and integrate them into existing local and national regulatory frameworks.

The successful implementation of multisectoral frameworks that promote the active engagement of the extractive sector can make a difference in limiting the spread of malaria, bringing significant benefits to malaria-endemic communities and supporting a productive extractive industry.

Case study: AngloGold Ashanti

In 2006, AngloGold Ashanti – a private gold mining company – began supporting a malaria control project to address the high prevalence of the disease in the vicinity of the Obuasi gold mine in Ghana. The work focused on delivering core malaria interventions, including distributing insecticide-treated nets, carrying out indoor residual spraying, community case detection and education campaigns, and providing prophylaxis, personal protective equipment and clothing. Since this work began, the number of malaria cases observed at the district hospital each month has fallen dramatically, from over 7,000 to less than 400.

Since 2011, this public-private partnership between the Government and AngloGold Ashanti has received additional funding from external sources, including from the Global Fund to Fight AIDS, Tuberculosis and Malaria in its capacity as a Principal Recipient, the funds from which cover Obuasi and 12 other districts in the Upper West and Upper East regions of Ghana. AngloGold Ashanti has also started working with the mining community in Geita, Tanzania, partnering with the Government and other NGOs to create community-based malaria initiatives that support the national malaria strategy.

Indoor residual spraying in Obuasi, Ghana

Suriname Gold mining images, copyright PAHO_WHO Photo by Sonia Mey Schmidt

[1] Magnus Ericsson and Olof Löf, "Mining's contribution to national economies between 1996 and 2016," *Mineral Economics*, vol. 32 (June 2019), pp. 223–50.

[2] See https://data.worldbank.org/

[3] Magnus Ericsson and Olof Löf, "Mining's contribution to national economies between 1996 and 2016," Mineral Economics, vol. 32 (June 2019), pp. 223–50.

[4] World Health Organization, *World Malaria Report 2020: 20 Years of Global Progress and Challenges* (Geneva, Switzerland, 2020).

[5] Solomon Kibret and others, "Malaria impact of large dams in sub-Saharan Africa: Maps, estimates, and predictions", *Malaria Journal*, vol. 14, No. 339 (September 2015). See also Jennifer Keiser and others, "Effect of irrigation and lage dams on the burden of malaria on a global and regional scale", *American Journal of Tropical Medicine and Hygiene*, vol. 72, No. 4, pp. 392–406.

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Humanitarian emergency response

Emergencies such as violent conflict and natural disasters can trigger malaria epidemics by exacerbating conditions that increase the risk of disease transmission, such as displacement, strained health systems and supply chains, or increased malaria vector populations. Delivery of essential malaria services such as prevention, diagnostic testing and treatment can be challenging in emergency settings, further hindering malaria control efforts. Multisectoral action is essential to help countries and communities prevent, prepare for and respond to malaria outbreaks in emergency settings.

The intersection of malaria, humanitarian emergencies and forced displacement

Humanitarian emergencies can result from violent conflict, natural disasters, famine, epidemics or mass migration, and often result in prolonged internal or external displacement.[1] In 2019, the United Nations High Commissioner for Refugees (UNHCR) reported a total of 79.5 million forcibly displaced persons worldwide as a result of persecution, conflict, violence or human rights violations. Malaria remains a leading cause of morbidity and mortality among those forcibly displaced from their homes.[2] In 2019, the five countries that accounted for nearly half of all malaria cases worldwide – the Democratic Republic of the Congo, India, Mozambique, Nigeria and Uganda – were also home to more than 14.5 million of the world's persons of concern to UNHCR.

Malaria poses unique risks to people experiencing prolonged or acute displacement. High levels of mobility, displacement to malaria-endemic areas and poor living conditions can contribute to increased risk of exposure and decreased access to health services in humanitarian emergencies.[3] Travel may take refugees – including those with little or no immunity – through or to areas of higher malaria endemicity than their place of origin, and almost two-thirds of refugees, internally displaced persons (IDPs), asylum seekers, returnees and other persons affected by humanitarian emergencies live in malaria-endemic regions. Refugee and IDP camps are often built on marginal lands in conditions

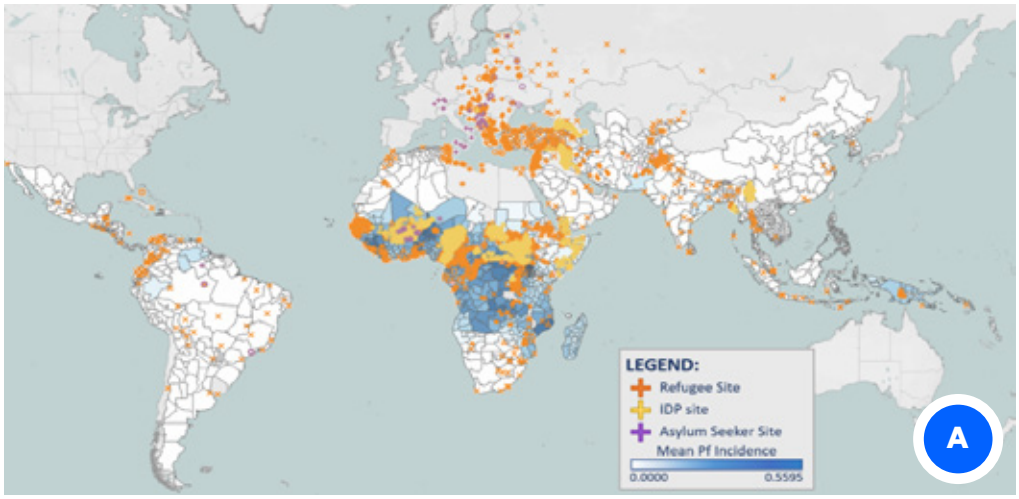
A village malaria worker is testing a young child for malaria in Battambang Province, Cambodia. Credit: WHO/ V. Sokhin

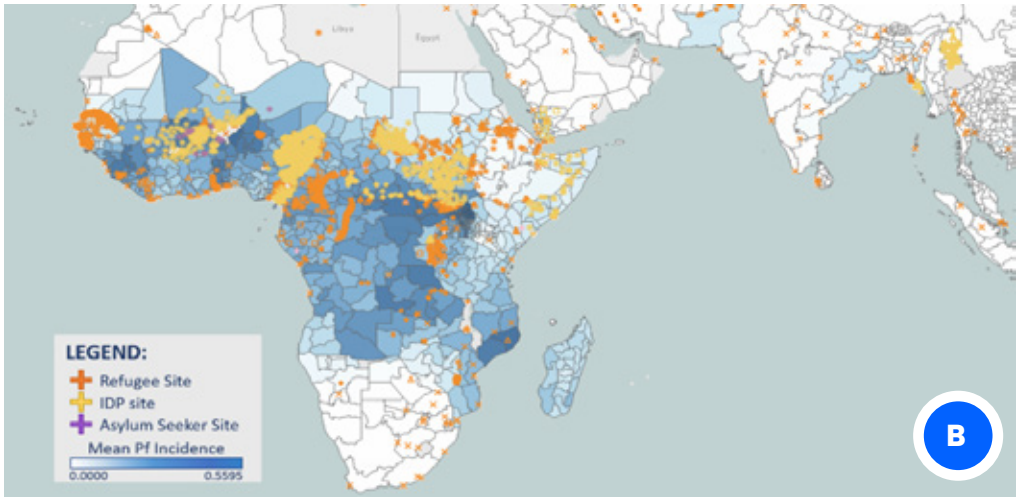
Relevant Sustainable Development Goals

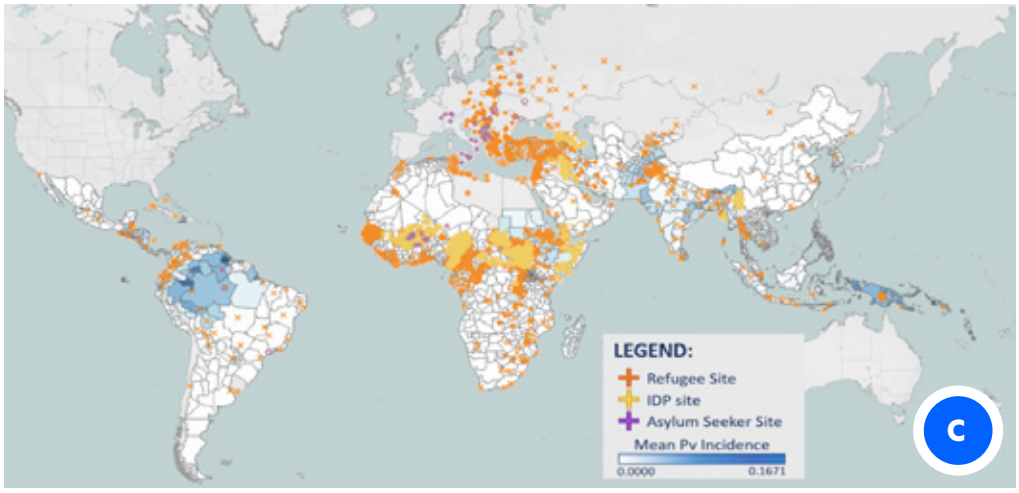
ripe for becoming breeding sites for malaria vectors. Displaced populations and temporary shelters may not be equipped with the vector-control tools displaced persons would normally use to prevent malaria when at home in their places of origin.

This reduced access to vector-control equipment may increase their exposure to mosquito bites. Disruption of essential health services due to disasters or conflict also interferes with effective malaria case management.

In addition to causing substantial population displacement at a global level, natural disasters often exacerbate risk factors for malaria infection. Heavy rainfall and flooding are extreme weather events that are most commonly associated with malaria outbreaks in malaria-endemic areas. Standing water







Overlap between UNHCR locations of persons of concern and:

A. Plasmodium falciparum globally
B. Plasmodium falciparum in Sub-Saharan Africa
C. Plasmodium vivax globally

Maps: United Nations Foundation

Data: Malaria incidence data (2017 estimates), Weiss et al. 2019, The Lancet; UNHCR sites, gis.UNHCR.org (last updated July 2020).

caused by heavy rainfall and receding flood water create ideal breeding sites for mosquitoes, and increased relative humidity may significantly extend the lifespan of adult mosquitoes.

Combined with overcrowded conditions and temporary shelters introduced for temporary or prolonged displacement, this increase in the malaria vector population can increase bite frequencies and promote a surge in malaria transmission. Depending on geographic and climatic conditions, the lag time between flooding and the onset of a malaria outbreak is usually around four to eight weeks.

Opportunities for action

Multisectoral action is required for effective malaria coordination during emergencies. As malaria control is also the responsibility of sectors beyond the health sector, cross-sector collaboration and communication is essential to assess which partners are involved in the ongoing response, agree upon the mechanism and scope for coordination and joint planning, gather evidence for a more targeted and efficient response, and determine which activities may already be under way.

Entry points and actions for multisectoral collaboration and coordination to help countries and communities prevent, prepare for and respond to malaria outbreaks in emergency settings include:

- **Ensuring emergency response plans include rapid implementation of malaria control measures for displaced populations and surrounding communities**, particularly vector-control and personal protective equipment such as bednets.

- **Considering overlap of the phases of a disaster, displacement, local malaria transmission patterns and incidence hotspots to guide resource allocation and achieve a more efficient response.** This includes collaboration between partners before and during emergencies to collect key information on the context, such as:
  - the local environment, including the geographical characteristics, water, agriculture, rainfall and temperature
  - the population, including demography, numbers, settlement patterns and duration of displacement
  - the local malaria epidemiology, including disease prevalence, vectors and breeding sites, and at-risk communities or areas
  - any potential security and access issues
  - the resources and logistics, including human resources, health facilities, malaria-treatment and vector-control commodities, and local import practices.

- **Coordinating surveillance systems:** Coordinate with the government, first responders, academia and the environmental, health and private sectors to integrate malaria surveillance systems and extreme weather early warning systems in order to streamline data-driven emergency planning and response for malaria.

- **Ensuring malaria is fully integrated into humanitarian planning and appeals**, such as flash and consolidated appeals.

- **Working with global health advocates and potential funding sources** such as multilateral banks and international financing organizations to secure new or reprogrammed funds for the emergency response.

- **Integrating malaria-smart practices into new or existing settlements:** If there is a choice when selecting a site where displaced populations are to be settled, the government, humanitarian organizations, and the vector control and civil engineering communities can work together to identify sites with the least potential for malaria transmission and to build malaria-smart practices into the sites and materials used to build shelters.

- **Leveraging the education and private sectors to assist with behaviour change communication:** during the post-acute stabilization phase and during chronic emergencies or prolonged displacement to promote positive health outcomes based on established theoretical models of behaviour change.

Case study:
Preventing malaria during an acute emergency – Cyclone Idai

Shortly after Cyclone Idai made landfall in March 2019 in central Mozambique, extensive flooding of rivers displaced entire communities. Twenty-nine camps were set up to provide aid and temporary shelter for the 1.8 million people impacted by the disaster. With 93 local health centres totally or partially destroyed, fears arose of an impending large malaria outbreak, and an urgent call was made for malaria prevention interventions. Multisectoral cooperation between humanitarian organizations, NGOs, government agencies and the private sector were key to a successful malaria response during this emergency. Humanitarian organizations and NGOs played an essential role in coordinating efforts and aligning partner activities to avoid redundancy and ensure more complete and integrated coverage of emergency services, including malaria prevention interventions. Initially, coordination of emergency relief partners with the National Malaria Control Programme (NMCP) was a challenge due to a delayed recognition that malaria posed a serious threat and the initial lack of an assistance group to take the lead in coordinating the response.

The involvement of NGOs such as Goodbye Malaria and PATH was critical to supporting the NMCP team, leading efforts on the ground, delivering goods and services, setting up temporary shelters and coordinating between partners. A malaria task force was created to identify gaps, secure funding and focus interventions. Efforts were made to ensure the WHO Cluster System recognized the importance of vector control in this emergency and to highlight the specific needs of the vector control response effort. Drone mapping of rehabilitation areas was used for indoor residual spraying planning, and spraying was carried out in the four most affected districts.

Coordination with other programmes within the health sector enabled better coverage of malaria prevention interventions. In some areas, net distribution was paired with a cholera vaccine campaign, and in others, long-lasting insecticidal nets were distributed simultaneously with food supplies. The distributions worked well where they were implemented.

Source: Goodbye Malaria

Aftermath of Cyclone Idai, Mozambique, 15–16 March 2019. Credit: Denis Onyodi: e International Federation of Red Cross and Red Crescent Societies/German Red Cross/ Climate Centre.

Taking action

The first step towards multisectoral action in any space is to develop a strategy for multisectoral action that is aligned with the national strategic plan for malaria and that considers the broader multisectoral environment in a specific country setting, including key actors; promising entry points; sectoral goals and priorities; financing; and health, environmental and economic impacts of multisectoral action in this space. For more details on developing a comprehensive national strategy for multisectoral action, see page [X].

The specific elements of a successful multisectoral action plan for malaria during emergency situations – from the key actors and entry points to ideal regulatory structures and funding mechanisms – will vary greatly depending on the specific emergency situation and the political, epidemiological, ecological, economic and cultural context of the country or countries in which it occurs. However, many important topics for consideration and steps in the process of strategizing effective multisectoral engagement between key partners to mitigate the impacts of malaria on emergency situations remain largely consistent across settings:

Key actors: Map the partner landscape and make connections with the key country or regional actors in the emergency response. Build relationships with actors in other sectors and convince them of the need for and mutual benefits of multisectoral action on malaria, as this will be essential to galvanize practical action and achieve an efficient response.

Operational partnerships between sectors are essential in emergency situations. Key actors to engage in these areas may include:

- international humanitarian organizations like United Nations Children's Fund (UNICEF) and UNHCR
- national and local government agencies, particularly those related to water, public health, sanitation, shelter, environment and social protection/community services
- local and international civil society organizations
- existing health facilities and national staff, which play an important role in any response and – with international support —are often best placed to deliver emergency health care
- local non-governmental organizations (NGOs), faith-based organizations and community groups, particularly after the acute phase of the emergency[4]

It is also important to work with affected communities, identifying existing capacity in local and displaced communities, whose members may have important skills, influence and cultural understanding not available in the international humanitarian community.

Entry points: Identify promising entry points for integrating malaria interventions and malaria-smart thinking into standard emergency response practices, systems and planning, including those detailed in the previous section.

Capacity-building: Assess current capacity for rapid implementation of malaria control measures in the emergency response and for integration of malaria-smart practices and policies into emergency response plans. Identify capacity-building efforts that will be required across sectors to fill gaps.

Resource mobilization and financing: Additional resources will likely be required to support proposed multisectoral activities and programmes. To assist with resource mobilization, proposed plans to integrate malaria prevention and control into emergency responses should be costed, funding gaps should be identified and potential multisectoral funding and advocacy targets should be evaluated. The ways in which these needs could be met by integrating them into existing malaria and health financing strategies should be assessed, as well as opportunities to mobilize previously untapped resources from domestic and global sources.

Evidence will be essential for emergency response planning and appeals. Impact assessments are an effective tool to gather evidence to develop a well-informed multisectoral action plan while opening up clearer avenues for multisectoral investment in malaria. Such assessments may include Health Impact Assessments and cost-benefit analyses. For more information on impact assessments, see page [X], and for more details on financing multisectoral action for malaria, see page [X] .

Accountability:

- **Standards and guidance:** Work across sectors to provide standard guidance for practices, interventions and systems that reduce malaria burden and transmission while supporting a rapid and efficient emergency response.
- **Monitoring and evaluation:** Develop a monitoring and evaluation framework to assess progress towards shared goals and objectives identified in the multisectoral action plan, and integrate it into existing malaria monitoring and evaluation structures..
- **Accountability mechanisms:** Establish frameworks and structures to promote accountability among partners across sectors, and integrate them into existing local and national regulatory frameworks.

Effective multisectoral action and coordination is at the heart of a rapid and impactful emergency response. Through continued partnership and planning across sectors, key actors in an emergency response can take specific and targeted actions to simultaneously prevent malaria outbreaks following emergencies and enhance emergency response efforts by leveraging existing systems put in place for malaria control.

A health care provider and IOM volunteer is conducting malaria rapid tests at Kwai Camp in Mon State, where migrant workers live and work on a rubber plantation, Myanmar. Credit: WHO/ V. Sokhin

[1] United Nations High Commissioner for Refugees, "Coordination in complex emergencies", 1 September 2001.

[2] World Health Organization, *Malaria control in Humanitarian Emergencies – An inter-agency Field Handbook, Second edition* (Geneva, Switzerland, 2013). Available at https://www.who.int/malaria/publications/atoz/9789241548656/en/.

[3] United Nations High Commissioner for Refugees, *Global Trends: Forced Displacement in 2019* (Copenhagen, Denmark, Statistics and Demographics Section, 2019).

[4] World Health Organization, "Epidemics and emergencies", 6 December 2018. Available at https://www.who.int/malaria/areas/epidemics_emergencies/en/.

Infrastructure

Achieving the Sustainable Development Goals and eradicating extreme poverty will require substantial new investment, policy reform and innovation in providing access to improved infrastructure. In a number of contexts, construction of or access to infrastructure such as housing, water, sanitation, roads and electrification can be linked to additional risks or benefits with regards to malaria transmission.[1] With an understanding of these links, the health sector has the opportunity to engage in multisectoral collaboration to carry out activities that can promote health in multiple ways – including by reducing malaria transmission – while improving quality of life and creating economic value for businesses and communities.

The Intersection of malaria and infrastructure

Housing: In sub-Saharan Africa, up to 90 percent of malaria transmission occurs inside the home at night.[2] In many homes, a combination of open eave spaces, thatched roofs and a lack of ceiling, window and door screens creates an environment in which malaria mosquitoes can easily enter people's homes and bite the occupants. Fortunately, there is good evidence that more modern housing provides better protection against malaria than traditional housing – researchers have found that residents of modern homes were 47 percent less likely to be infected by malaria and experienced 45–65 percent fewer malaria cases than those living in traditional homes.[3]

Although access to improved housing and modern building construction has increased in countries where malaria is endemic, there is still a long way to go. In 2015, an estimated 403 million people in Africa were living in houses constructed with natural or unfinished materials, including adobe walls and thatched roofs.[4]

The population of malaria-endemic countries is expected to double in the next 30 years, and the demand for housing will rise alongside it. This presents a golden opportunity to provide millions of people with access to homes that protect them from malaria by mainstreaming malaria-smart practices in housing construction.

Environmental management and modification: Environmental management is the modification or manipulation of the environment to reduce malaria transmission by rendering it less suitable for local vector mosquitoes. Such approaches require an understanding of the ecology of these species and the conditions that enable man-made structures and sites to unwittingly create ideal malaria vector breeding habitats – for example, during construction projects, builders often create concrete basins or dig brick pits, both of which can become malaria mosquito habitats.[5] One such environmental management approach to combat malaria is larval source management, which works to prevent Anopheles mosquitoes from breeding through actions aimed at destroying suitable habitats, such as drainage, flushing, influencing flow rates, shading, and de-weeding, depending on the location and the mosquito species.

Relevant Sustainable Development Goals

The impact of certain behaviours, practices and artificial habitats on malaria risk depends on the setting and the mosquito species involved. For example, *Anopheles stephensi* – a malaria mosquito species typically found in South Asia and the Persian Gulf – favours wells and water storage tanks in India[6] but has recently been found to lay its eggs in tyres, plastic containers, wells and ponds in the Horn of Africa.[7]

Water and sanitation infrastructure: Hydraulic infrastructure and water management practices can influence human health in many ways. Access to clean, safe water and improved sanitation facilities can reduce the risk of malaria infection.[8,9] An analysis of 49 nationally representative surveys in 23 sub-Saharan African countries found that water and sanitation conditions were important risk factors for malaria infection in children under five years old, even after adjusting for their age, gender, housing quality, mother's highest level of education and use of either long-lasting insecticidal nets or indoor residual spraying. Improvements in sanitation are linked to reduced malaria risk, even among children of a higher socioeconomic status.[10]

However, such infrastructure can also create habitats for disease vectors, such as the Anopheles mosquitoes that transmit malaria, and evidence suggests that different types of water sources have different implications for malaria risk. For example, piped water systems can reduce malaria mosquito breeding sites and therefore possibly malaria, whereas reliance on water from unprotected wells can increase the risk of malaria. There is also evidence that the structure and functioning of particular water and sanitation facilities or equipment – including different types of water pumps, drains, pipes, and storage containers – can create different risk profiles for malaria transmission.[11]

Water management decisions have huge potential to provide health benefits to communities, and vulnerable groups in particular. Public health and water resources are governed separately, so a focus is needed on multisectoral approaches supported by evidence from multidisciplinary research.[12]

Case study: Khartoum Malaria-Free Initiative

In the 1980s and 1990s, malaria was the main reason for outpatient attendance, hospital admission and death in Khartoum, Sudan. The Khartoum Malaria-Free Initiative was a multisectoral response to this challenge, which included efforts in the building construction sector to address malaria mosquito breeding throughout the state. Over 500 support workers, known as "mosquito men", reported on the contribution of different breeding sites to guide efforts across sectors.

After the initiative was launched, the total number of malaria deaths decreased by almost 75 percent, from 1,070 in 1999 to 274 in 2004, and parasite prevalence decreased from 0.78 percent in 1995 to 0.04 percent in 2008. Malaria prevention focused on control of the primary malaria mosquito in the city, An. arabiensis, which lays its eggs in irrigation canals, pools created from broken water pipes, concrete water basins and storage tanks. The expansion of agricultural production and new construction sites were helping to create mosquito habitats all over Khartoum.

The initiative received strong political support from both state and federal authorities, as well as close collaboration between the State government, the Federal Ministry of Health, and other ministries, including those for education, public works and agriculture. The involvement of other sectors helped to keep costs low; the total annual cost of the programme, which targeted a total of 2 million people in urban areas, 3 million in peri-urban areas and 0.6 million in rural areas, was US$ 600,000 or approximately US$ 0.10 per person protected per year.[20]

Electricity access and production: Historically, the provision of a durable electric power supply has been associated with malaria elimination, such as in the Tennessee River Valley after World War II, on the island of Mauritius in 1990, and along the Amu Darya river in Turkmenistan in 2009.[13] While access to electricity is growing, there are still an estimated 840 million people around the world without it; a large proportion of those people are found on the African continent, where an estimated 600 million people – or two-thirds of the population – are without electricity.[14] Like malaria, a lack of access to electricity is associated with poverty. Electricity access among rural populations, who also bear the majority of malaria morbidity and mortality, is approximately 22 percent, compared with 78 percent for urban populations.

There is some evidence that access to electricity in high-burden malaria settings may be associated with a lower risk of malaria infection and increased access to diagnosis and treatment services.[15] However, the relationship between access to electricity and malaria is complex, as are the changes that access to and the use of electricity can have on both human and mosquito behaviour.[16] Access to electricity can promote behaviours and economic growth that are typically associated with improved health outcomes; for example, staying inside during peak mosquito-biting hours thanks to the availability of indoor electric lighting, greater usage of bednets usage during warmer weather due to the use of electric fans, longer health facility operating hours, better access to e-health tools, and greater access to malaria social behaviour change communication messages via mass media. However, it can also lead to behaviours that put people at greater risk of malaria infection or poor disease outcomes – for example, outdoor lighting may promote outdoor public events during peak biting hours. Despite the fact that electric fans may increase the use of bednets by making them more comfortable during warmer months, in some communities, improved housing with electricity has been associated with reduced bednet use.

While there is no one-size-fits-all scenario for the impact of access to electricity on malaria transmission, both access to electricity and malaria elimination are important development objectives that can help to raise populations out of poverty and that should be considered together as part of a joint multisectoral development strategy.

Opportunities for action

Malaria transmission is highly interconnected with the design, construction and management of and access to infrastructure in malaria-endemic areas, and a wide range of stakeholders are involved in this issue. This creates many opportunities for multisectoral action to reduce the malaria risk while supporting sustainable development and increased access to improved infrastructure.

Entry points to multisectoral action for malaria-smart infrastructure include:

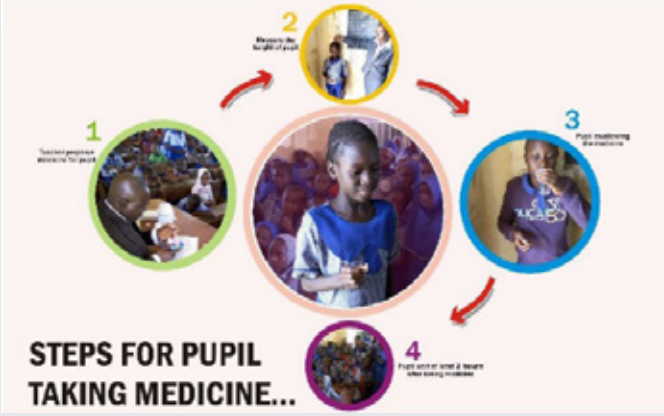
- **Research and evidence-building:** Collaborations between academia, the private sector and relevant government ministries could be formed to gather evidence on the contribution of infrastructure gaps, shortcomings, design, maintenance and management to malaria transmission. The data and insights gained may then be used to inform policies, mitigate the health and environmental impacts of planned or existing infrastructure, and design and target programmes for areas where they will have the greatest impact. Areas for research and evidence-building could include:
  - Assessing community-level, context-specific opportunities, risks, and health and environmental impacts before construction projects are begun or new or improved infrastructure, such as access to electricity or improved sanitation facilities, is implemented
  - Mapping malaria risk around water and sanitation features such as water access points, water storage and transportation infrastructure, and improved toilets and sanitation facilities
  - Identifying the types of water and sanitation technologies, strategies and policies that would best mitigate malaria transmission in different geographical and epidemiological contexts
  - Ensuring that entomological and epidemiological surveillance is a key component of health impact assessments and their implementation in large-scale infrastructure projects

Case Study:
Malaria/NTD/WASH co-implementation in Nigeria

In addition to having the world's highest number of people affected by malaria and neglected tropical diseases (NTDs), Nigeria faces major gaps in its water and sanitation sector, with only an estimated 26.5 percent of the population using improved drinking water sources and sanitation facilities.[1] Although significant investment in new water and sanitation infrastructure will be required to overcome these obstacles, there are also opportunities to better educate the population and prevent disease using integrated approaches.

Recognizing the role that water, sanitation and hygiene (WASH) education and practices can play in preventing malaria and other NTDs, and the savings that can be made by integrating these programmes together, a co-implementation intervention was designed and piloted at nine schools in the states of Ebonyi, Cross River and Jigawa, in a cooperative venture with the Government of Nigeria and the Malaria Consortium. In this pilot, teachers from each school were identified and trained on the mass administration of medicines, the distribution of insecticide-treated nets, and the assessment of WASH activities in schools, including the availability of drinking water, toilets and tools for practising good hygiene.

This work demonstrated the feasibility of greater intersectoral collaboration and opportunities for the malaria, NTD and WASH programmes to pool resources, integrate training, and harmonize tools for increased coverage and greater cost-effectiveness.



Standard Operating Procedure materials (top); Teachers administering treatment to pupils (centre); Pupils receiving long-lasting insecticidal nets (bottom). Credit: Malaria Consortium

- **Prioritizing areas with high malaria transmission for infrastructure development and improvement:** While electrification, sanitation and housing improvements alone may not drive a reduction in malaria transmission, there is, nevertheless, a clear rationale for considering malaria as a criterion for prioritizing areas for electricity access. Malaria prevalence runs alongside poverty and underdevelopment, rural environments, poor housing, lack of access to electricity, low levels of improved water and sanitation facilities, and reduced access to trained health care workers. Malaria prevalence can serve as a proxy for communities in need of investments in development for the effective identification of areas where new infrastructure would have significant health benefits for some of the most vulnerable populations.

- **Promoting widespread availability of malaria-smart housing:** In settings where the home is a major site of malaria transmission, multisectoral action that supports the widespread availability of malaria-smart housing and protects against the potential negative impacts of construction is essential to reducing malaria transmission within the community. Such activities may include:

  - Mainstreaming malaria-smart principles into housing standards, such that mosquito-resistant design features are regularly incorporated into newly built houses or retrofitted into existing ones. These principles are summarized by the **DELIVER** mnemonic:[17]
    - **DOORS: Doors** should be screened, self-closing and without surrounding gaps
    - **EAVES: Eaves,** the space between the wall and roof, should be closed or screened
    - **LIFTED:** Houses should be **lifted** above the ground
    - **ITN: Insecticide-treated nets** should be used when sleeping in houses at night
    - **VENTILATED:** Houses should be **ventilated**, with at least two large-screened windows to facilitate airflow
    - **ENVIRONMENTAL MANAGEMENT: Environmental management** should be conducted regularly inside and around the home
    - **ROOF: Roofs** should be solid, rather than thatched
  - Passing and enforcing legislation to ensure that malaria-smart principles are incorporated into standard practice, for example:
    - Modifying building codes for new private housing and social housing schemes to include malaria-smart standards
    - Integrating good design practices into Environmental Management Plans based on Environmental Impact Assessments for new construction projects
    - Engaging land registry authorities to address the security of land tenders and promote building and property improvements
    - Mandating that construction sites have an environmental protection officer to control malaria vectors, including reducing vector breeding sites[18]
  - Creating financial mechanisms or incentives that facilitate the widespread construction of and access to malaria-protective housing, such as:
    - Providing subsidies or financial incentives for including mosquito-resistant design features in retrofitting and new construction projects
    - Financial saving and borrowing schemes that support the building of new malaria-smart homes and incremental self-build housing improvements
    - Improving access to mortgages and longer-term financing for developers to promote

Closing Eave Gaps in the Gambia. Credit: Steve Lindsay

mosquito-resistant designs in retrofitting and new building construction projects

- Supporting civil society and behaviour change communication agents to promote mosquito-resistant housing design in affected communities

- **Environmental management, including:**
  - Designing and improving new water sources and toilets with effective drainage and mosquito-proof storage for vector control
  - Ensuring larval source management of community water points, through national and local government authorities and community structures[19]
  - Monitoring water storage and sanitation facilities to identify malaria mosquito habitats
  - Inspecting malaria mosquito habitats in commercial activities – for example dams, mines, brickmaking pits and road construction sites
  - Identifying and removing unused concrete water storage containers and wells
  - Ensuring adequate shoreline management around lakes, reservoirs and other bodies of water

Taking Action

The first step towards multisectoral action in any space is to develop a strategy for multisectoral action that is aligned with the national strategic plan for malaria and that considers the broader multisectoral environment in a specific country and regional setting, including key actors; promising entry points; sectoral goals and priorities; financing; and health, environmental and economic impacts of multisectoral action in this space. For more details on developing a comprehensive national strategy for multisectoral action, see page [X].

The specific elements of a successful multisectoral action plan for malaria coordination during emergency situations – from the key actors and entry points to ideal regulatory structures and funding mechanisms – will vary greatly depending on the specific emergency situation and the political, epidemiological, ecological, economic and cultural context of the country or countries in which it occurs. However, many important topics for consideration and steps in the process of strategizing effective multisectoral engagement between key partners to mitigate the impacts of malaria on emergency situations remain largely consistent across settings:

Key actors: Map the partner landscape and make connections with the key country or regional infrastructure stakeholders. While there are clear benefits to multisectoral collaboration for malaria in this space for all stakeholders, in practice, implementation is often limited by institutional, political and financial barriers. In order to galvanize practical action, relationships must be built with key actors across government ministries and agencies, civil society, academia and private businesses operating in the sector, including:

- **National and local government ministries related to:**
  - Urban planning and housing
  - Water and sanitation
  - Public utilities
  - Power and energy
  - Infrastructure

- **Housing:**
  - Local manufacturers and retailers of housing materials
  - Community associations and civil society organizations
  - Architects and landscape designers
  - Structural and civil engineers
  - Municipal planning authorities
  - Builders and contractors

- **Water and sanitation:**
  - Water and sanitation regulatory authorities, including municipal water authorities and irrigation authorities
  - Private sector stakeholders, such as water supply and transportation companies, water storage and irrigation suppliers, and water well equipment suppliers.
  - Sanitation service providers, such as wastewater treatment companies, municipal waste collection

companies, and industrial waste collection companies

- **Electrification:**
  - Public utilities
  - Civil service oversight bodies
  - Regulatory agencies
  - Private-sector power producers

- **Civil society organizations** related to infrastructure access and governance, including those dedicated to safe housing, WASH and electricity

It is also important to work with affected communities, identifying existing capacity in local and displaced communities, whose members may have important skills, influence and cultural understanding that is not available in the international humanitarian community.

Entry points: dentify promising entry points for integrating malaria interventions and malaria-smart thinking into standard infrastructure design, construction, maintenance and planning, including those detailed in the previous section.

Capacity-building: Assess current capacity for integration of malaria-smart practices and policies into standard infrastructure planning and maintenance activities. Identify capacity-building efforts that will be required across sectors to fill gaps.

Resource mobilization and financing: Additional resources will likely be required to support proposed multisectoral activities and programmes. To assist with resource mobilization, proposed plans to construct, improve or retrofit malaria-smart infrastructure should be costed, funding gaps should be identified and potential multisectoral funding and advocacy targets should be evaluated. The ways in which these needs could be met by integrating them into existing malaria and health financing strategies should be assessed, as well as opportunities to mobilize previously untapped resources from domestic and global sources.

Evidence will be essential for mobilizing any funds required to ensure malaria-smart infrastructure. More systematic planning with increased availability of dedicated health impact tools and interdisciplinary and multisectoral collaboration help to prevent the negative impacts of building or improving infrastructure while enhancing the health benefits of increased access to clean water, safe housing and electricity. Impact assessments are an effective tool to gather evidence to develop a well-informed multisectoral action plan while opening up clearer avenues for multisectoral investment in malaria. Such assessments may include Health Impact Assessments, Environmental Impact Assessments, Economic Impact Assessments and cost-benefit analyses. For more information on impact assessments, see page [X], for more details on financing multisectoral action for malaria, see page [X].

Health inspector shows an area map with the mosquito-prone areas to a resident of Estreda, during a routine house-to-house malaria control visit, Costa Rica. Credit: WHO/ J. Ruiz Cicera

Accountability:

- **Standards and guidance:** Work across sectors to provide standard guidance for practices, interventions and systems that reduce malaria burden and transmission, while increasing access to improved infrastructure.

- **Monitoring and evaluation:** Develop a monitoring and evaluation framework to assess progress towards shared goals and objectives identified in the multisectoral action plan, and integrate it into existing malaria monitoring and evaluation structures.

- **Mechanisms for accountability:** Establish frameworks and structures to promote accountability among partners across sectors, and integrate them into existing local and national regulatory frameworks.

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Primary education

Education is a key element in socioeconomic development for improving quality of life. There is a link between low malaria prevalence and school attendance: malaria is a notable determinant of poor educational outcomes globally,[1] whereas high levels of school attendance may improve malaria control efforts in areas where school-based programmes have been implemented.[2] Multisectoral collaboration between education systems and the community provides an opportunity not only to augment malaria control efforts, but also improve school enrolment and attendance levels, educational performance, and intellectual development in school-age children.

The intersection of malaria and primary education

Evidence suggests that school-age children represent an underappreciated reservoir of malaria infection, with studies showing high malaria prevalence and risk of asymptomatic infection and predicting that in some settings this age group may be responsible for most human-to-mosquito Plasmodium falciparum transmission.[3]

Concerns are also being raised that recent success in reducing malaria transmission in previously highly endemic areas, and an emphasis on malaria prevention in children under five, may create a situation where immunity to malaria is acquired later in life, resulting in more cases of both uncomplicated and severe malaria in school-age children than seen in the past.[4]

Impacts of malaria on health and educational outcomes in school-aged children: Malaria is associated with poor health and education outcomes in school-age children, including increased school absenteeism and impaired intellectual development. In some high transmission areas, malaria has been reported to be responsible for 30 to 50 percent of all missed school days; in 2000, an estimated 4–10 million school days were lost due to malaria in Kenya alone.[5] In some settings, malaria infections were a predictor of children's educational performance, even after controlling for parents' education, monthly family income and house type. In one study, school-aged children who had experienced more than five malaria episodes scored about 15 per cent worse in grade-specific language and mathematics tests than children who had experienced less than three.[6]

Children who have experienced at least one malaria episode are also at increased risk of impaired intellectual development and neurological problems. Cerebral malaria – a relatively rare but deadly manifestation of malaria that primarily impacts young children – can cause long-term impairment of cognition, speech, language and/or motor skills, and has been associated with intelligence quotient impairment and an increased risk of behavioural disorders.[7] Repeated episodes of uncomplicated malaria have been associated with impaired attention and cognitive function in

Relevant Sustainable Development Goals

Case study:
Ghana – engaging children as health messengers

Schoolchildren have the potential to be effective health messengers for malaria control. A study conducted between 2007 and 2008 in the Dangme-East district of the Greater Accra region of Ghana explored the impact of school-based malaria education intervention on schoolchildren and community adults. Trained schoolteachers designed participatory health education activities and led schoolchildren to disseminate messages related to malaria control to their communities. In the community where the educational intervention had been implemented, the misperception that malaria has multiple causes was significantly improved among both children and community adults. Insecticide-treated bednet usage by adults more than doubled, and parasite prevalence in school-age children decreased from 30.9 per cent to 10.3 per cent. This study suggests that participatory health education can have a positive impact not only on children attending the school where an educational intervention takes place, but also on community adults through the educational messages shared by the children.

Source : Ayi et al, Malaria Journal 2010

GF_John Rae_Cambodia_malaria awareness session for villagers (18)

school-age children, and several studies have even identified an association between asymptomatic malaria and worsened cognitive performance in school-age children.[8] In some settings, malaria interventions among school-age children improved these poor outcomes, resulting in a higher level of sustained attention and educational achievement.[9]

Despite the evidence of a high burden of malaria in school-age children and the observed impact of malaria on their health and educational attainment, this age group is less likely than other age groups to be prioritized for routine malaria control interventions. Further, school-age children are the least likely group to sleep under a bednet, seek treatment for malaria, or receive care from a formal health care provider – a 2009 analysis of household surveys in 18 African countries found that between 38 and 42 per cent of school-age children had not slept under an insecticide-treated net the previous night; similar results have been seen in more recent studies in Cameroon, Kenya and Uganda.[10]

School-based diagnosis and treatment: Prompt and effective treatment of malaria can be enhanced by provision of treatment at school. In the past, training teachers to provide presumptive treatment was shown to be both feasible and to reduce school absenteeism and malaria deaths.[11] However, presumptive treatment is no longer the standard for malaria case management – current World Health Organization policy recommends that suspected malaria cases are tested and that only patients with confirmed cases receive antimalarial treatment.[12] To enable continued school-based malaria case management in light of these changes, the malaria community is exploring the potential of training teachers to diagnose and treat their students.

Recent studies have investigated the feasibility of training schoolteachers in a variety of malaria interventions, including rapid diagnostic test use, administration of malaria treatment, and planning and conducting participatory malaria education activities. Teachers have been found to be able to successfully administer the interventions, following training, and the quality of their performance is retained even after several months. These programmes are generally viewed as important and valuable by both teachers and implementers and are being willingly taken up by communities.[13]

Results on the health and educational impacts of these interventions, however, are contradictory. A community-based research programme in Uganda investigating the impact on school absenteeism of school-based RDT testing and malaria treatment found significant improvement in school absenteeism when school-based malaria case management interventions were applied, including a reduction in the mean duration of absence from school from 6.5 days to 0.59 days.[14] In contrast, a cluster-randomized controlled trial conducted in Malawi assessing the impact of school-based malaria case management via a first-aid kit called the Learner Treatment Kit (LTK) found no overall impact of the LTK on school absenteeism, health or education outcomes.[15] Despite this, the trial demonstrated that the LTK programme was in high demand and well-perceived, and the particularly high uptake of this programme among school-age girls indicates a potential opportunity to integrate the LTK programme with other school-based health interventions aimed at girls, such as sexual and reproductive health education programmes.

There are many possible reasons for differences in the results of such trials, including differences in transmission setting, study power, the complicated nature of absenteeism and measuring educational outcomes, and altered treatment-seeking behaviour or other unconscious biases resulting from participating in such a study. Regardless of the cause of the discrepancy, the breadth of evidence that school-based treatment can improve educational and health outcomes indicates a clear need for future research to better understand the impacts of school-based malaria case management in different settings and explore ways it could be implemented safely and effectively to supplement ongoing community and facility-based delivery of essential malaria services.

School-based participatory health education: Schools can play a vital role in ensuring that their pupils understand the dangers of malaria and learn ways to effectively fight it in their communities. Educational interventions can help children develop the attitudes, knowledge and skills necessary to allow them to protect their health and that of their communities.[16] Some malaria programmes have sought to use school-based health education to engage students in key malaria preventative actions at school and home, while encouraging them to become health messengers to their families and broader communities.

These programmes teach children about malaria, sensitize them to the dangers of the disease, and give them the skills needed to encourage malaria-smart practices in their communities. This includes teaching them about the disease itself, such as how it spreads, how it is treated, and ways to prevent its transmission. It helps them

take malaria preventative actions in their homes and communities, for example by eliminating vector breeding sites and encouraging younger family members to sleep under bednets. It also empowers them to serve as health messengers in their communities and to be stewards of their community's health. This includes building their confidence to share accurate malaria messages in their homes, encourage family members to seek immediate care if they notice malaria symptoms, ensure they take their full course of treatment, and help care for sick family members.

Such programmes have the potential to improve malaria knowledge and attitudes in communities, reducing misconceptions about malaria among children and adults alike and increasing uptake of malaria preventative measures across the community.

Vector control at educational institutions: Vector control at educational institutions may be important not only as a measure to protect schoolchildren, but also as part of a wider community-based integrated vector management strategy.

Educational buildings can be targeted in indoor residual spraying (IRS) campaigns to increase community coverage and reduce the overall vector population in the area. Schools can also play an important role in supporting IRS programmes by disseminating messages on the need, purpose, method and timing of community-wide spraying. Eliminating vector breeding sites at schools through larviciding, introducing predators that feed on mosquito larvae, and ensuring malaria-smart school infrastructure and school-based water, sanitation and hygiene programmes, including latrines, kitchens and water taps, may also contribute to malaria prevention. However, more studies are needed to clearly demonstrate the malaria-specific health impacts of such interventions.

Boarding schools are particularly important targets for vector control measures to protect school-age children from malaria. IRS spraying of boarding schools is important to achieve community-wide IRS coverage and protect school-age children while sleeping. Installing window and door screens in dormitories, ensuring bednet usage among students, and encouraging students to prevent bites through use of repellent or wearing long-sleeved shirts and trousers can all help protect students at boarding schools from malaria infection.

Uganda/Malaria Smart Schools images. © SOLOMON TUMWESIGYE/NOTHING BUT NETS

Opportunities for action

In many endemic countries, there are geographical and financial barriers that prevent school-age children from obtaining rapid access to diagnosis and treatment of malaria. Several areas have been proposed where multisectoral collaboration between the malaria community and the education sector could help overcome these barriers, improving access to early malaria diagnosis and treatment for this important population and enhancing broader malaria control efforts. Entry points to such multisectoral collaboration and coordination include:

- **Research and evidence-building:** Support operational research to inform global policymakers and funders on the burden of malaria in school-age children and to ensure appropriate interactions between educational and health providers at national and local levels. Key research questions to be addressed may include:
  - determining how best to raise awareness of the importance of malaria in school-age children
  - determining how to improve the use of established malaria control measures such as ITNs in this age group
  - clarifying the impact of school-based interventions such as vector control and teacher-administered rapid diagnostic tests in decreasing malaria transmission and improving educational outcomes in specific epidemiological settings
  - understanding the role of asymptomatic malaria infection in school-age children in malaria transmission, and identifying circumstances under which treating asymptomatic school-age children is appropriate.

- **School-based participatory health education:** Collaboration between educators, the malaria community, and social and behaviour change communication experts to improve the malaria-relevant content of school curricula to equip school-age children with the understanding needed to serve as health messengers and improve malaria knowledge and attitudes in their community.

- **Programme integration:** Working across sectors to determine ways to integrate school-based malaria interventions with other school-based programmes, such as water, sanitation and hygiene or sexual and reproductive health programmes, as well as with ongoing malaria control efforts, such as routine community and healthcare facility-based malaria diagnosis and treatment.

Taking action

The first step towards multisectoral action in any space is to develop a strategy for multisectoral action that is aligned with the national strategic plan for malaria and that considers the broader multisectoral environment in a specific country setting, including key actors; promising entry points; sectoral goals and priorities; financing; and health, environmental and economic impacts of multisectoral action in this space. For more details on developing a comprehensive national strategy for multisectoral action, see page [X].

The specific elements of a successful multisectoral action plan for malaria during emergency situations – from the key actors and entry points to ideal regulatory structures and funding mechanisms – will vary greatly depending on the specific emergency situation and the political, epidemiological, ecological, economic and cultural context of the country or countries in which it occurs. However, many important topics for consideration and steps in the process of strategizing effective multisectoral engagement between key partners to mitigate the impacts of malaria on emergency situations remain largely consistent across settings:

Key actors: Map the partner landscape and make connections with the key country or regional actors in the emergency response. Build relationships with actors in other sectors and convince them of the need for and mutual benefits of multisectoral action on malaria, as this will be essential to galvanize practical action and achieve an efficient response.

Operational partnerships between sectors are essential in emergency situations. Key actors to engage in these areas may include:

- national and local government agencies, particularly those related to education and social protection/ community services
- local and international civil society organizations
- existing health facilities and national staff
- local non-governmental organizations, faith-based organizations and community groups
- local religious and cultural leaders.

It is also important to identify existing capacity in affected local and displaced communities, and work with these communities whose members may have important skills, influence and cultural understanding not available in the international humanitarian community.

Entry points: Identify promising entry points for integrating malaria interventions and malaria-smart thinking into schools, including those detailed in the previous section.

Capacity-building: Assess current capacity for integration of malaria-smart practices and policies into local educational practice and implementation of malaria control measures at educational institutions. Identify capacity-building efforts that will be required across sectors to fill gaps.

Resource mobilization and financing: Additional resources will likely be required to support proposed multisectoral activities and programmes. To assist with resource mobilization, proposed plans to integrate malaria prevention and control into education should be costed, funding gaps should be identified, and potential multisectoral funding and advocacy targets should be evaluated. The ways in which these needs could be met by integrating them into existing malaria and health financing strategies should be assessed, as well as opportunities to mobilize previously untapped resources from domestic and global sources.

Evidence will be essential to mobilize resources to integrate malaria programming into educational institutions and practices. Impact assessments are an effective tool to gather evidence to develop a well-informed multisectoral action plan while opening up clearer avenues for multisectoral investment in malaria. Such assessments may include Health Impact Assessments and cost-benefit analyses. For more information on impact assessments, see page [X].

See page [X] for more details on financing multisectoral action for malaria.

Accountability:

- **Standards and guidance:** Work across sectors to provide standard guidance for practices, interventions and systems that reduce the malaria burden and transmission while improving educational outcomes and attainment.

- **Monitoring and evaluation:** Develop a monitoring and evaluation framework to assess progress towards shared goals and objectives identified in the multisectoral action plan, and integrate it into existing malaria monitoring and evaluation structures.

- **Mechanisms for accountability:** Establish frameworks and structures to promote accountability among partners across sectors, and integrate them into existing local and national regulatory frameworks.

Evidence exists that school-age children are a critical but underappreciated target population for the global fight against malaria. However, more studies are required to determine the effectiveness of school-based malaria interventions, and the optimal methods of delivery – including the frequency, timing, and most effective interventions to apply – under different transmission settings and conditions. Multisectoral collaboration between the health and education sectors will be vital to efforts to ensure equitable access to essential malaria services and to improve educational attainment and performance in school-age children in malaria-endemic regions.

Uganda/Malaria Smart Schools images.
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Tourism

Up to the end of 2019, more than 1.4 billion international tourists travelled annually, generating export earnings of more than $1.7 trillion, and accounting for over 10 per cent of world Gross Domestic Product.[1] Malaria contributes significantly to the global burden of travel-related diseases, depressing tourism in endemic areas and creating lost potential revenue. Working together, the tourism and health sectors can implement malaria-smart practices and policies that protect the health of industry workers, tourists and local communities, while generating greater demand for tourism in malaria-endemic areas.

The intersection of malaria and tourism

Malaria is the travel-related disease that has the greatest impact on tourism.[2] The disease poses a significant threat to the health of travellers – especially children and those travelling from non-malaria endemic regions – and is among the most common diagnoses for those who fall ill while traveling.[3]

In the African region, which bears over 93 per cent of the global malaria burden, there remains substantial, untapped potential for increases in the tourism sector.[4] While sub-Saharan Africa's travel and tourism market remains small in absolute terms, the region still has more than the global average rate of growth in terms of tourist arrivals and receipts. Moreover, the region continues to take positive steps to improve its competitive position in the tourism market, taking advantage of its substantial natural resources to attract visitors. However, malaria poses a threat to such growth.

Countries with a risk of malaria receive 48 per cent fewer inbound tourists compared to those that are malaria-free. This can have a significant impact on revenue generated by the tourism industry in malaria-endemic areas, as a 1 per cent increase in tourist arrivals produces an increase in tourist expenditures of 0.69 per cent. Estimates indicate that malaria eradication is associated with an increase of 6.2 million additional tourists visiting malaria-endemic regions and a corresponding $3.5 billion increase in tourist expenditures per year.[5] The negative impact of malaria on the tourism industry in endemic regions can be seen in the case of Rwanda in 2017: the greatest decline in travel and tourism competitiveness rankings between 2017 and 2018 – a drop from being ranked 118th to 140th globally – occurred in Rwanda, driven primarily by a spike in malaria.[6]

In the current context of the COVID-19 pandemic, the tourism sector has taken a profound hit and faces an uncertain future even as countries actively consider how to reopen their tourism industries. With increased attention to the health risks associated with travel, the potential threat of contracting other infectious diseases, such as malaria, poses an additional barrier to attracting tourist arrivals and revenues.

Relevant Sustainable Development Goals

Opportunities for action

The tourism sector has several unique capabilities which can support malaria programmes. Entry points to engagement between the tourism sector and the fight against malaria include:

- **Employee, community and tourist health** – Ensure comprehensive malaria services are provided at hotel resorts and in surrounding communities. This includes ensuring that tourists, resort employees and surrounding communities have adequate access to malaria commodities such as insecticide-treated bednets, as well as educating tourists and tourist communities about malaria risks and prevention.

- **Malaria-smart design and management of tourist sites** – Promote, mainstream and support malaria-smart design and management of tourist sites in malaria-endemic areas. Such efforts could include the development of environmental and surface water management strategies for vector control and an integrated approach to larval source management, both informed by health and environmental impact assessments. Malaria-smart practices to consider include:

  - mosquito-resistant design for structures and administrative buildings at tourist sites and in the surrounding community. This includes incorporating malaria-smart features into new structures and retrofitting old ones with improved malaria-protective elements.
  - reduction of standing water through proper drainage systems near lodging sites and in surrounding communities
  - use of chemical or microbial larvicides to eliminate mosquito breeding sites, where appropriate
  - adequate shoreline management around reservoirs, water features and other bodies of water, including appropriate coverage with vegetation or pebbles

- **Malaria-free marketing**

  - Promote "malaria-free" branding in the tourist industry, working with the national tourism ministry, travel book publishers, online travel websites, and businesses in the tourist transportation, accommodation and attraction industries. For example:
    - from Madikwe Safari Lodge: "Safaris are often associated with a risk of contracting malaria, but you needn't worry about that here. Madikwe is situated in a region of South Africa that is not inhabited by the Anopheles mosquito, responsible for transmitting this disease. The reserve is therefore classified malaria-free."[7]
    - from Go2africa: "Malaria is present throughout much of Africa and may [many] of our travel destinations fall inside that range.... [T]o remove the threat entirely we have identified malaria-free destinations for both safaris and beach holidays.[8]
  - Tourism trade groups can work with national malaria control programmes to certify, recognize, and reward those destinations and communities that are malaria-free.
  - Leaders in the tourist industry can participate in their national "Zero Malaria Starts with Me"

Global tourism statistics

1,407 million international tourist arrivals occur annually:

- 348 million in Asia-Pacific
- 216 million in the Americas
- 68 million in Africa

$1,712 billion export revenues derive from international tourism:

- $483 billion in Asia-Pacific
- $338 billion in the Americas
- $47 billion in Africa

Tourism is 7% of total exports globally:

- 6% in Asia-Pacific
- 9% in the Americas
- 9% in Africa

Source: United Nations World Tourism Organization. Global and Regional Tourism Performance 2019.

campaign and in national multisectoral bodies such as national End Malaria Councils.

- **Fundraising, donations and domestic resource mobilization**
  - Engage tourism businesses through corporate social responsibility programmes, financing projects from a percentage of profits, earmarked donations or voluntary customer contributions.
  - Organize fundraising campaigns or events, or support such events with donated in-kind contributions as incentives or prizes.
  - Donate used vehicles, equipment, or other assets that can either be used by malaria programmes or sold to raise money for malaria.
  - Provide air/ground transportation of commodities and programme staff within the country.
  - Donate advertising to promote malaria messaging.
  - Donate use of facilities to store malaria commodities for community-level distribution.
  - Use tax proceeds to support tourism-related malaria programmes (see box: Taxes, tourism and malaria financing).

Taking action

The first step towards multisectoral action in any space is to develop a strategy that is aligned with the national malaria strategic plan and considers the broader multisectoral environment in a specific country setting, including key actors. The strategy should also indicate promising entry points; sectoral goals and priorities; financing; and health, environmental and economic impacts of multisectoral action. For more details on developing a comprehensive national strategy for multisectoral action, page [X].

The specific elements of a successful multisectoral action plan for tourism – from the key actors and entry points to ideal regulatory structures and funding mechanisms – will vary greatly depending on the specific political, epidemiological, ecological, economic and cultural context of the country or countries in which it occurs. However, many important topics for consideration and for elaborating effective multisectoral engagement between key partners to mitigate the impacts of malaria on the tourism industry in endemic areas remain consistent across settings:

Taxes, tourism and malaria financing

Countries can mobilize resources for malaria through tax proceeds. For example:

- Ghana levies a 2.5 per cent value-added tax to finance the national health insurance fund. It should be noted that value-added tax can be difficult to reliably collect, is not tailored specifically to tourism, and does not cover duty-free shopping popular in international transit hubs. Additionally, international visitors can reclaim their value-added tax.

- Many countries – such as Botswana, Kenya, South Africa and Zambia – impose occupancy or tourism levies to mobilize resources. Funds are typically invested in promoting tourism. The TOMSA tourism levy, for example, funds South Africa's tourism marketing budget.[1] There is significant industry opposition, especially in competitive markets – for example, at Victoria Falls, where the fact that Zambia hotels face high taxes, but Zimbabwe hotels do not, may affect visitors' decisions on where to stay.visitor's decision on where to stay.

- *Victoria Falls – Zimbabwe, Zambia. Credit: Pius Mahimbi*

Key actors: Map the partner landscape and make connections with the key country or regional actors in the tourism industry. Build relationships with actors in other sectors and convince them of the need for and mutual

benefits of multisectoral action against malaria, as this will be essential to galvanize practical action and an efficient response.

With an understanding of the relationship between the tourism sector and the fight against malaria, government health leaders can advocate for direct engagement by ministries, departments, and agencies supporting tourism, including tourism boards and private sector associations. Government and non-state actors can also engage with businesses and civil society organizations with explicit financial interests in the tourism sector to promote and finance malaria-smart interventions. Through improved policies to support the tourist economy and effective public-private partnerships, new businesses can be brought effectively into the fight against malaria.

Key actors in the tourism sector may include:

- Government ministries and regulatory authorities related to tourism and travel at national and state/ departmental levels
- Local authorities and agencies related to tourism, such as tourism boards and associations
- Tourist Transportation
  - airlines
  - cruise lines
  - bus companies
  - car rental agencies
  - international and national tour operators
- Tourist Accommodation
  - regional hotel chains
  - boutique hotels
  - hostels
  - camp sites
- Tourist attractions
  - restaurants
  - gift shops
  - swimming and dive shops
  - camping and hunting suppliers
  - national parks and wildlife reserves

It is also important to work with affected communities to identify existing capacity in local and displaced communities, whose members may have important skills, influence and cultural understanding not available in the international humanitarian community.

Entry points: Identify promising entry points for integrating malaria interventions and malaria-smart thinking into standard tourism industry practices, including those detailed in the previous section.

Capacity-building: Assess current capacity for integration of malaria-smart practices and policies into the tourism industry, including implementation of malaria control measures at tourist sites and lodgings. Identify capacity-building efforts required across sectors to fill gaps.

Resource mobilization and financing: Additional resources will likely be required to support proposed multisectoral activities and programmes. To assist with resource mobilization, proposed plans to integrate malaria prevention and control into emergency responses should be costed, funding gaps should be identified, and potential multisectoral funding and advocacy targets should be evaluated. The ways these needs could be met through integration into existing malaria and health financing strategies should be assessed, as should opportunities to mobilize previously untapped resources from domestic and global sources.

Evidence will be essential for multisectoral engagement and resource mobilization to integrate malaria-smart practices into the tourism industry. Impact assessments are an effective tool to gather evidence to develop a well-informed multisectoral action plan while opening clearer avenues for multisectoral investment in malaria. Such assessments may include health, environmental and economic impact assessments, as well as cost-benefit analyses. For more information on impact assessments, see page [X].

See page [X] for more details on financing multisectoral action for malaria.

Case study:

The Sumba Foundation, tourism and malaria in Indonesia

The Sumba Foundation was established in 2001 by Claude Graves – owner of the Nihiwatu Resort Hotel on the island of Sumba in eastern Indonesia – and philanthropist Sean Downs to alleviate poverty in the local community and catalyse support from the hotel and its guests. Initial foundation projects focused on water and education, and the first Sumba Foundation malaria clinic was opened in 2004 with four nurses. By 2007, the foundation operated four clinics with 14 nurses and one medical doctor, followed by a microscopy training centre to support diagnostics for malaria and other infectious diseases in 2010. Today these clinics see around 20,000 patients a year, of which around 4,000 are malaria cases. Screening to detect malaria in villages reaches another 10,000 people a year. The hotel also benefits from this work, having won more than 10 international awards for responsible tourism and cultivating long-term relationships with hotel guests.

Closing Eave Gaps in the Gambia. Credit: Steve Lindsay

Accountability:

- **Standards and guidance:** Work across sectors to provide standard guidance for practices, interventions and systems that reduce the malaria burden and transmission while supporting a robust tourism industry.
- **Monitoring and evaluation:** Develop a monitoring and evaluation framework to assess progress towards shared goals and objectives identified in the multisectoral action plan, and integrate the framework into existing malaria monitoring and evaluation structures.
- **Mechanisms for accountability:** Establish frameworks and structures to promote accountability among partners across sectors, and integrate them into existing local and national regulatory frameworks.

The successful implementation of multisectoral frameworks that promote the active engagement of the tourism sector in the fight against malaria can make a difference in limiting the spread of malaria, improving the health of communities and adding to the value and attractiveness of local tourist attractions.

[1] Lauren Uppink Calderwood and Maksim Soshkin, *The Travel & Tourism Competitiveness Report 2019: Travel and Tourism at a Tipping Point* (Geneva, Switzerland, World Economic Forum, 2019).

[2] Jaume Rosselló, Maria Santana-Gallego and Waqas Awan, "Infectious disease risk and international tourism demand", *Health Policy and Planning*, vol. 32, No.4 (May 2017), pp. 538–548.

[3] See Lin H. Chen and others, "Business travel-associated illness: a GeoSentinel analysis", Journal of Travel Medicine, vol. 25, No. 1 (January 2018), pp. 1–18; Kristina M. Angelo and others, "Malaria after international travel: a GeoSentinel analysis, 2003–2016", *Malaria Journal*, vol. 16, No. 293 (2017).

[4] For global malaria morbidity statistics, see World Health Organization, *World Malaria Report 2019* (Geneva, Switzerland, 2019).

[5] Jaume Rosselló, Maria Santana-Gallego and Waqas Awan, "Infectious disease risk and international tourism demand", *Health Policy and Planning*, vol. 32, No.4 (May 2017), pp. 538–548. .

[6] Lauren Uppink Calderwood and Maksim Soshkin, *The Travel & Tourism Competitiveness Report 2019: Travel and Tourism at a Tipping Point* (Geneva, Switzerland, World Economic Forum, 2019), p. 55.

[7] Madikwe Safari Lodge, "What you need to know" (n.d.). Available at www.madikwesafarilodge.co.za/travel-tips-useful-information/what-you-need-to-know/ (accessed on 10 March 2021).

[8] Go2Africa, "Malaria-free safari destinations", (n.d). Available at www.go2africa.com/holiday-types/malaria-free-safari/where-to-go (accessed on 8 March 2021).

Appendix A:
Addressing malaria across all 17 Sustainable Development Goals

The global 2030 Agenda for Sustainable Development identifies 17 Sustainable Development Goals (SDGs), addressing both critical threats to our survival and tremendous opportunities for humanity to thrive. The SDGs are driven by the values of leaving no one behind and raising the standard of living for all populations. Reducing the burden of malaria will also pay broader social dividends by reducing the number of productive life-years lost to illness and death among the workforce and freeing up national health systems to better address other health priorities. Evidence suggests that, for industries with the same level of labour intensity, economic growth is slower in malaria-endemic countries and that individuals affected by persistent childhood malaria infections receive 50 per cent lower income as adults.[1] As a disease of poverty that perpetuates poverty, malaria has a pernicious effect across the SDGs.

Improvements across the different development sectors can reduce malaria cases and deaths, just as success in reducing malaria contributes to the broader strategy of achieving economic growth, environmental sustainability, and social inclusion by the year 2030.[2] Heads of state across the Americas, Asia Pacific and Africa have called for malaria elimination by 2030; the World Health Organization Global Technical Strategy targets 90 per cent reductions in malaria cases and deaths and total elimination in at least 35 countries, from the 2015 baseline.[3] This guide identifies the synergies between the Global Technical Strategy for Malaria and other SDG strategic objectives, with specific recommended actions.

The following table lists the 17 SDGs and some of the specific ways in which malaria elimination contributes to achieving these goals, or these goals themselves promote the elimination of malaria. In addition to providing some suggestions for concrete actions, the table illustrates the mutually reinforcing relationship between controlling and eliminating malaria and promoting sustainable development. Malaria impedes socioeconomic development, and improved development provides resilience against malaria. The actions listed in the following table take account of this dynamic. In this guide we refer to them as “malaria-smart”.

Malaria in All SDGs

Reducing malaria prioritises the poorest, lowers health care and out-of-pocket costs, and increases household incomes. Anti-poverty measures in turn provide resilience to malaria-affected populations.

Growing more food while preventing mosquito proliferation through agriculture improves nutrition, food security, and nourishes populations, especially children, who can better resist all infections. Incorporating contextualized environmental management into agricultural practices will reduce the malaria burden of rural communities

Universal health coverage can provide equitable access to prevention, diagnosis and treatment, including vector control. Less malaria means more resources for other health interventions.

Reducing malaria improves school attendance. Better education also leads to greater use of preventive measures and access to health services. Attention to health issues in academic and professional curricula of other sectors can support malaria elimination.

Reducing malaria will free women and girls from an undue burden of caring for sick family members and will also reduce illness and death among pregnant women.

Better sanitation and water management decreases mosquito breeding sites around homes and improves water quality for better health and hygiene.

Access to energy for cooking, lighting, and fans may reduce exposure to malaria vectors and improve mosquito net use. Clever operation of hydropower dams can reduce mosquito breeding.

Reducing malaria creates a healthier, more productive workforce, especially among the poorest and most vulnerable. Economically stronger communities will have more resources to spend on preventive and curative measures

Investing in Research, Development, and local production to develop new tools will accelerate malaria elimination and promote economic growth.

Reducing malaria improves the health of the poorest, reducing health expenditures, including out of pocket payments, and increasing productivity.

Improved community planning, management, and better housing reduces malaria transmission.

Promoting the consumption and production of quality assured malaria products protects against the threats of drug and pesticide resistance.

Global warming and extreme weather events can increase the spread of malaria.

Safe disposal of insecticides, proper use of mosquito nets, and a greater emphasis on environmental management measures will prevent contamination of contamination of coasts, seas and oceans.

Responsible insecticide management helps to eliminate malaria while protecting biodiversity, preventing the emergence of resistance, and keeping mosquito predators alive. Proper management of surface and groundwater will reduce mosquito breeding.

Reducing malaria-exacerbated poverty supports institutions to help vulnerable populations.

Mobilising partners across all sectors to address all aspects of malaria prevention, diagnosis, treatment, and surveillance will accelerate the progress to end malaria.

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