



## CASE STUDY: CLIMATE INFORMATION SERVICES FOR HEALTH SYSTEMS STRENGTHENING Climate-Informed Early Warning and Response Systems for Malaria in Ethiopia USAID Climate Adaptation Support Activity

### CASE OVERVIEW

Climate change and its impacts pose significant risks for malaria control and elimination programs. There are inextricable links between weather, climate, the environment and malaria, with threats that are growing. For instance, some models show that by 2030, increased temperatures may put up to 61 million additional people at risk for endemic malaria transmission and another 48 million additional people at risk for seasonal transmission.<sup>1</sup>

In Ethiopia, where cases have surged in part due to climate factors, more than 52% of the population was estimated to be at risk of infection in 2023.<sup>3</sup> Early warning systems that leverage Climate Information Services (CIS) can help reduce this national malaria burden. Additionally, targeted and concentrated surveillance can create an opportunity to control outbreaks as they happen while also reducing the risk of novel outbreaks. The Ethiopian Public Health Institute (EPHI) and its Public Health Emergency Management (PHEM) Center are collaborating with diverse partners in new ways to continuously improve climate-informed national early warning and response systems for malaria, as well as other climate-sensitive diseases.

The U.S. President's Malaria Initiative (PMI), which is led by the United States Agency for International Development (USAID) and implemented together with the Centers for Disease Control and Prevention (CDC), has heavily invested in malaria control and surveillance in Ethiopia and is supporting these efforts. Based on a pilot conducted by a

### Case Study by the Numbers

Ethiopia ranks as **one of the most climatically and topographically diverse countries in the world**, making it especially vulnerable to climate impacts.

Between 2021 and 2022, **the incidence of malaria increased by 32% (to 5.1 million cases) in Ethiopia.**<sup>2</sup>

Malaria is prevalent in **nearly 70% of the country**, with an estimated **52% of Ethiopians (or 55 million) at risk of infection.**<sup>3</sup>

**34-40 million people living in the highlands of East Africa, where malaria is currently not present, will be at risk by the 2030s.**<sup>6</sup>

The **United States has invested \$445 million** since 2007 to combat malaria in Ethiopia, a priority PMI focus country. An estimated **\$725,000 is needed annually** to implement a national malaria early warning system using EPIDEMIA, **a fraction of what is spent each year** on malaria control and elimination in Ethiopia.

research team at the University of Oklahoma, EPHI has rolled out an innovative malaria early warning tool tailored to public health staff and community health workers at the national and regional levels.

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The Epidemic Prognosis Incorporating Disease and Environmental Monitoring for Integrated Assessment (EPIDEMIA) tool integrates malaria surveillance and climate data to generate forecasts and produce malaria early warning reports with up to 8-12 weeks lead time. Piloted first in the Amhara region of northern Ethiopia and later in Oromia, the state surrounding the capital- Addis Ababa, EPIDEMIA is now being scaled to the national level. The development of a roadmap to assess and support pathways for national scale-up was supported by PMI and USAID.

The implementation of the EPIDEMIA malaria early warning system has required a range of resources, including national leadership, committed partner support, sustained financing, and dedicated training for public health practitioners operating in a context of high turnover. Continued

## BACKGROUND

Malaria is a serious disease that caused an estimated 608,000 deaths globally in 2022. It is a major public health threat in Ethiopia, especially for children under five.<sup>2</sup> Because of Ethiopia's high climatic and topographic diversity, the western lowland areas, which experience higher rainfall and warmer temperatures, are particularly prone to malaria due to higher rainfall and warmer temperatures. Regions marked by higher altitudes – such as the capital, Addis Ababa, and others – typically experience a lower risk of malaria transmission.

Climate change is expanding the geographical distribution of malaria prevalence and is increasing transmission conditions in Ethiopia.<sup>9</sup> Transmissions are highly seasonal – peaking between September and December after the main rainy season – and are largely influenced by rainfall and temperature, with high temperatures supporting both the mosquito vector and the malaria parasite.<sup>9,10</sup> Additionally, the climatic phenomenon El Niño is associated with more rain and higher temperatures in the region, which has in turn been linked to higher malaria rates.

Indeed, despite remarkable advancements in reducing Ethiopia's national burden of malaria over the last two decades, cases have recently increased. Between 2021 and 2022, the country experienced an increase of approximately 1.3 million cases.<sup>3</sup> Various factors contributed to this surge in cases – including armed conflict, COVID-19-related

investments have also been made in data harmonization and the integration of climate and malaria surveillance information with the goal of scaling the tool to the national level.

The EPIDEMIA tool demonstrates how CIS, when driven by demand from the health community, can support surveillance and response capabilities by providing accurate, timely, and actionable forecasts for climate-sensitive diseases. The tool has also enabled broader health system strengthening by fostering cross-sectoral collaboration, resource optimization, and improved pinpointing and support for populations affected by climate variability and climate change. With this example, it is clear, that similar CIS tailored for other vector-borne diseases can be useful for addressing a range of diseases in Ethiopia and beyond

disruptions to malaria programs, an increase in insecticide resistance among vectors, the emergence of a new invasive mosquito species, and climatic influences.<sup>7</sup> The 2023/2024 El Niño event has additionally contributed to the increasing trend in cases.<sup>9</sup>

The Ministry of Health's Ethiopia National Malaria Elimination Program (NMEP) envisions a malaria-free country by 2030. To achieve this goal, systematic efforts and surveillance are urgently needed to better predict and respond to the (climate-driven) spread of malaria. This is also reflected in Ethiopia's 2021-2025 National Malaria Strategic Plan (NMSP), which explicitly recognizes the need for climate-informed malaria monitoring.<sup>11</sup>

The Ethiopian government collaborates with a number of partners, including PMI, to support its malaria-control work. PMI funds, including those associated with the Surveillance for Malaria Elimination (S4ME) activity, are used to improve the capacity of national and regional malaria elimination programs and to strengthen passive and active surveillance systems. Within Ethiopia, both PMI and the Ethiopian government have worked to roll out EPIDEMIA as an effective malaria early warning tool with significant potential to support malaria control and strengthen the health system.<sup>12</sup>

## APPROACH

Funded by the U.S. National Institutes of Health (NIH), the EPIDEMIA tool was co-developed with technical assistance from the University of Oklahoma, the Health Development and Anti-Malaria Association (HDAMA), the Amhara Public Health Institute, and the Bahir Dar University, among others. Following a successful trial of the tool in the Amhara region, in 2018 the Minister of Health officially requested support for EPIDEMIA from the U.S. Global Malaria Coordinator. This led to EPIDEMIA being expanded to the Oromia region and the development of a roadmap for national scale-up, financed by PMI and USAID.

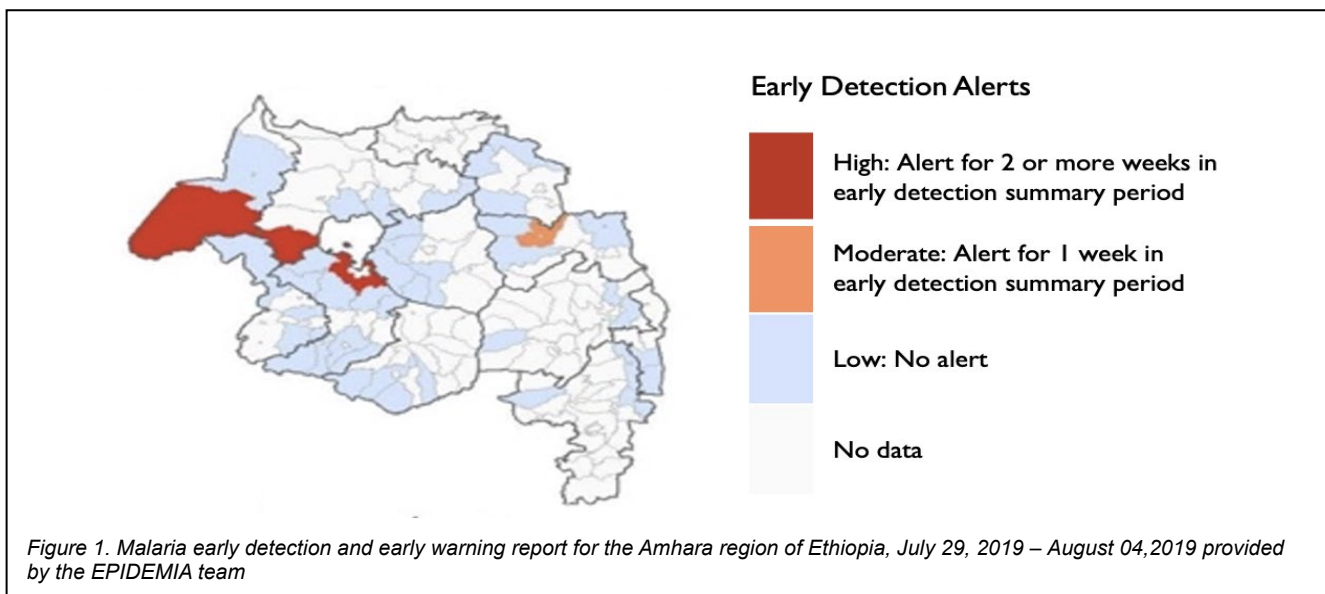
At its core, EPIDEMIA integrates malaria surveillance and climate data to generate malaria forecasts 8-12 weeks in advance of a potential outbreak, acting as an early warning system. The use of EPIDEMIA represents a pivot to previous approaches that have mainly relied on rainfall and temperature forecasts for specific malaria-prone areas. EPIDEMIA features the ability to automate time-consuming steps in the forecasting workflow. Forecasts are run weekly and forecast reports include various products such as alert maps (Figure 1), charts and tables for public health decision-makers.

The tool currently uses open-access software and integrates climate data from the Google Earth Engine (GEE). GEE offers a cloud computing environment for satellite remote sensing that only requires downloading specific data summaries, though nationally observed data sets are being considered to replace GEE in the future. Malaria data is acquired through the Public Health Emergency Management (PHEM) system.

The tool has benefited from substantial improvements in incidence data, attributed to significant investments by international development actors. The tool also has a validation module that automatically assesses the accuracy of climate-driven forecasts. EPIDEMIA outcomes have been shared and reviewed by the public health specialist in the Amhara Regional Health Bureau.

The tool benefits from significant leadership on climate and health in Ethiopia and previous investments in the larger partner ecosystem.<sup>13</sup> Climate and health networks, such as the Climate and Health Working Group (CHWG) supported by an initial grant from Google.org and the World Bank, have the potential to further support, align, and scale additional deployment of CIS for health systems strengthening, but are heavily contingent on sustained funding models. Future engagement with members of the national CHWG, as well as focal points at the Ministry of Health and the National Meteorological Services, is planned under future EPIDEMIA rollout activities.

While the tool was preferred over others for its accessibility, it does require trained analysts to operate the software and interpret the outputs. This requires skills and knowledge in the use of coding languages, remote sensing science, and predictive modelling of malaria outbreaks. PMI supports the facilitation of EPIDEMIA training for S4ME, EPHI, and Ministry of Health staff, as well as for public health professionals from the Amhara and Oromia regions, to enable them to use the tool.<sup>12</sup>



The initial 2021 EPIDEMIA roadmap outlined a required four-year scale-up period. PMI is currently targeting the roll-out to an additional region by the end of 2024. The roadmap also includes recommendations for a comprehensive governance structure, consisting of a Steering Committee with national health and meteorological authorities and international partners that monitor the system implementation and make key decisions. It advises the creation of a core operational group responsible for the day-to-day and technical management of the program, as well as exploration of the utility of the tool for other infectious disease applications.

## IMPACT

The successful implementation of EPIDEMIA in the Amhara region and roll out to the Oromia region has demonstrated the tool's utility in delivering dedicated CIS for health system strengthening. The effectiveness of the tool is undergoing rigorous evaluations but has already shown:

**Enhanced surveillance and response capabilities and the potential to reduce malaria cases and mortality rates.** EPIDEMIA provides forecasts up to 8-12 weeks in advance to help public health officials better anticipate and respond to likely increases in malaria cases. In Amhara, the tool detected and facilitated response to outbreaks at least twice. Alerts generated by EPIDEMIA can be used throughout the public health system, though the information requirements and public health responses may be different at national, regional, and district levels.

**Optimized outbreak responses.** In the pilot regions, the EPIDEMIA tool has been especially valuable in informing the regional public health authorities. EPIDEMIA's accurate forecasts helped to improve planning and guided resource

**“Without systematic, integrated and long-term support, there will always be an immediate choice between investing in the development of a malaria early warning system, such as EPIDEMIA, and addressing the immediate needs by buying life-saving drugs against the disease. We need a meaningful and sustained commitment and to bring actors together to change that.”**

Hiwot Teka, Malaria Advisor, President's Malaria Initiative (PMI), USAID Ethiopia

allocation, such as the purchase and distribution of malaria medication. Due to the improved early warning system, public health officials were also able to reach and support vulnerable populations more effectively (such as agricultural migrant workers, where malaria rates were detected to be spiking among young men).

**Enhancement of health system capabilities.** EPIDEMIA has the potential to strengthen the overall health system by informing more cost-effective prevention and control strategies for one of the top public health priorities in Ethiopia. The tool improves the quality of surveillance and enables collaboration and cross-sectoral linkages between sectors. Additionally, it aids more strategic resource allocation, guiding decisions on medical procurement and logistics. The region-by-region roll-out will further incorporate and enable learning and adaptation.



## Primary Partners Engaged

The **Ethiopian Public Health Institute (EPHI)** and its **Public Health Emergency Management (PHEM)** Center lead on implementing and scaling the EPIDEMIA tool.

The **Ethiopian Ministry of Health and the National Malaria Eradication Programme (NMEP)** oversee Ethiopia's malaria programs and are involved in the rollout of the tool.

The **University of Oklahoma** and the **Malaria Research Network**, a consortium of malaria researchers from universities throughout Ethiopia, contributed to the design of the tool.

**Members of the Climate and Health Working Group**, including the National Meteorological Agency and other governmental and non-governmental partners are part of the wider ecosystem informing evidence on climate and health impacts, including malaria outbreaks.

**USAID** Ethiopia and the **President's Malaria Initiative (PMI)** support the tool's rollout and have financed the development of a roadmap to scale it to the national level. PMI is further involved in integrating the tool into wider malaria surveillance and elimination activities and training.

Seed investments through **NIH, Google.org and the World Bank** supported the initial exploration and use of climate information services for health.

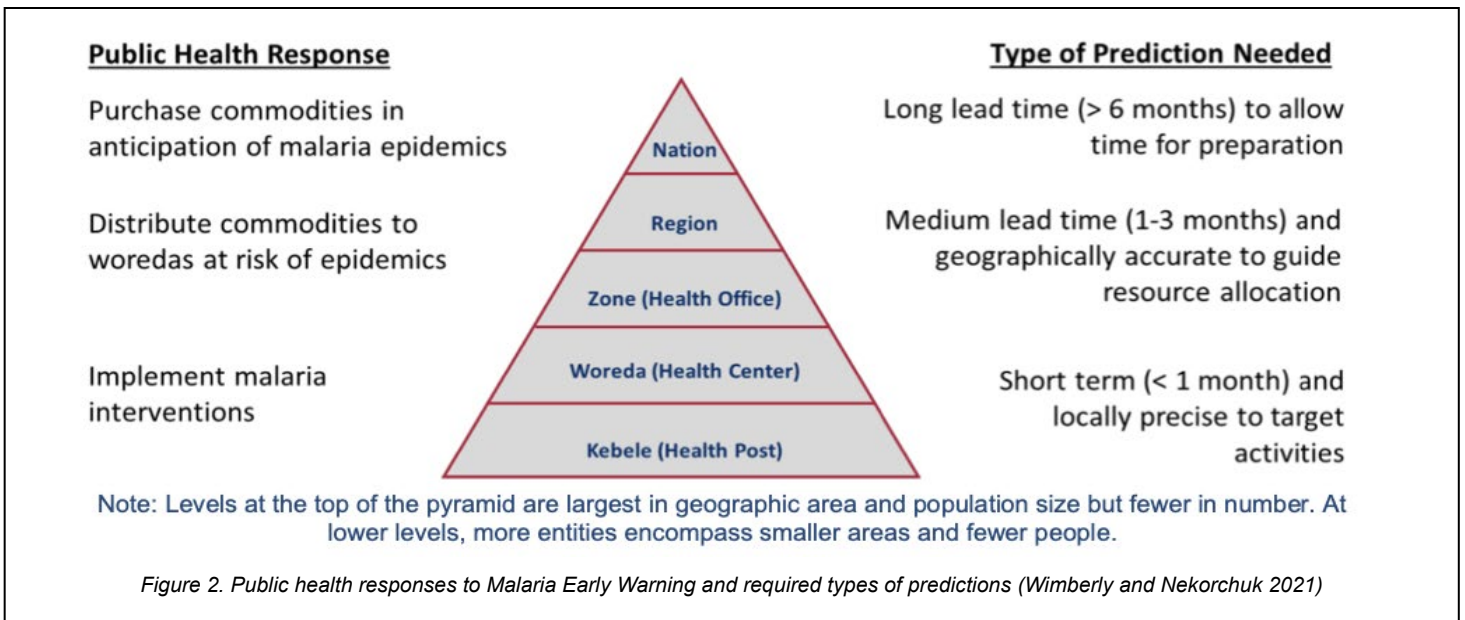
## LESSONS LEARNED

The implementation of the EPIDEMIA system has highlighted several aspects crucial to its success, including: the need for national leadership and for committed partner support and financing; the importance of local capacity strengthening and effective coordination among diverse stakeholders; and the critical role of robust surveillance data and data harmonization.

**National leadership.** Ethiopia's national leadership has played a crucial role in advancing CIS for health. The commitment of the Ministry of Health and the National Meteorological Agency has been essential for the development of climate early warning systems and the enhancement of data quality. Successive Ministers of Health (including current WHO Director-General Tedros Ghebreyesus in his former role) have made public commitments to leveraging the best available climate information for improved health sector planning.

**Sustained partner support and finance.** For those responsible for rolling out tools like EPIDEMIA, it is critical to support and be responsive to the national leadership, moving beyond project cycles and recognizing that these initiatives, as well as coordination efforts such as the CHWG, require long-term commitment and stable funding.

**Connecting malaria forecasts with public health responses across multiple levels of the health system.** Effective malaria control requires an adaptable multi-level approach in forecasting and response to address the dynamic nature of malaria outbreaks across different geographic and time scales. Different public health responses undertaken at each level of the health system require distinct types of CIS at varying lead times (see Figure 2). To improve the utilization of forecasts like those from EPIDEMIA, it is crucial to effectively connect malaria early warning to response mechanisms at each level of the health system.



**Local capacity strengthening.** Tools such as EPIDEMIA are complex and require skilled technical expertise to operate. The ongoing training of local health professionals is essential to address turnover. As personnel changes occur, systematic investments are needed to safeguard the initiative's effectiveness.

**Local ownership and effective coordination.** Committed ownership from diverse stakeholders is crucial for the system's implementation and effectiveness. With the participation of various actors – including national and regional public health authorities, malaria-related research and civil society organizations – and in light of the potential to integrate national climate data, clear incentive and coordination mechanisms are critical. Initiatives like the CHWG have the potential to ensure the deployment of improved climate information services and tools like EPIDEMIA.<sup>13</sup>

**Accurate surveillance data and data harmonization.** Successful malaria early warning relies heavily on integrating robust and diverse data sets, including nationally owned climate and health surveillance data. Substantial funder investments in national malaria surveillance data have paid off and can be further leveraged through the development of pioneering early warning systems. However, further work is needed to harmonize PHME data to scale to the national level and to support anticipatory actions over traditional responses. Additionally, further integration of national climate data should be explored for sustained buy-in over global climate products like the Google Earth Engine. Lastly, a culture of preparedness also needs to be actively curated through evidence-informed evaluations that demonstrate the value of CIS tools like EPIDEMIA to health leaders managing competing priorities.

## KEY RESOURCES

- 1 [WIMBERLY, M. AND D.M. NEKORCHUK \(2021\): MALARIA EARLY WARNING IN ETHIOPIA: A ROADMAP FOR SCALING TO THE NATIONAL LEVEL. USAID: ATLAS.](#)

## ENDNOTES

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