The projected consequences, innovative prevention strategies, and collaborative efforts aimed at combating malaria and its vector-borne diseases in the face of a changing climate

Lire en français

Lasiti Kios lives in the same area of south-central Kenya where he grew up 40 years ago, near the town of Narok, a gateway to the Maasai Mara National Reserve that draws hundreds of thousands of tourists each year. A Maasai himself, Kios grew up nomadically, sleeping each night inside wooden fences community leaders would build to protect their families and their livestock from predators, then moving with the seasons in search of water and fresh grass. Though life for many Maasai has changed little, today Kios works as a guide for tourists and lives in a concrete house with solar panels.

He has noticed another change in his community: the malaria season is longer and more intense than he remembers it being when he was a boy.

That observation tracks with projections published in *The Lancet* in 2021: As climate change persists, southern Kenya will be among the regions of the globe with the greatest lengthening of the malaria transmission season. It would also be among the areas with significant challenges to both mitigating against more malaria and adapting to it.

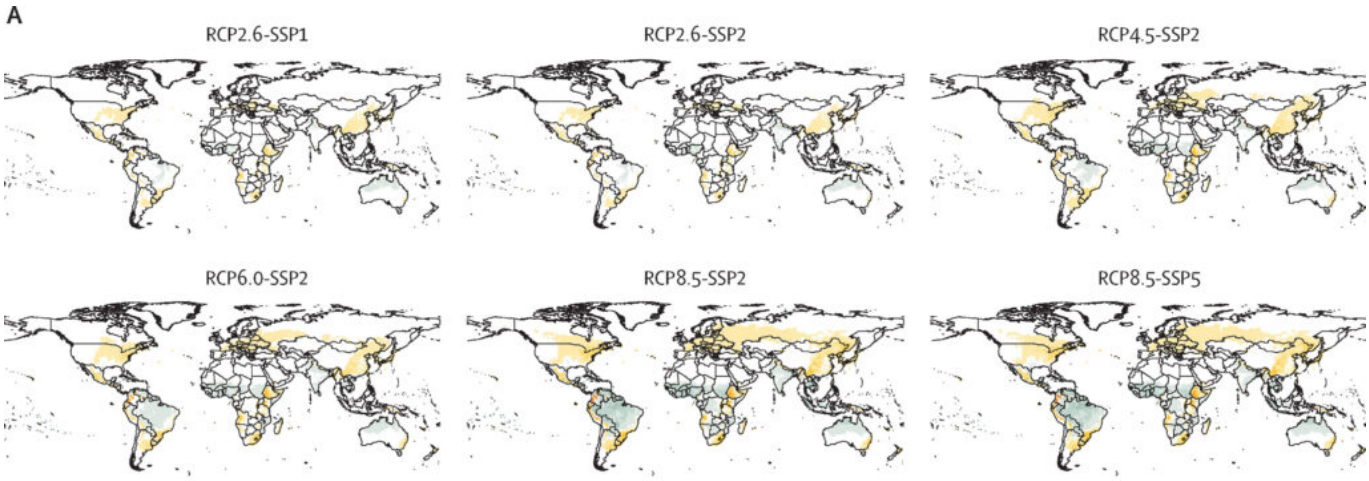
By one estimate, more than half of all people who have ever died, died of malaria[1]. But we have made significant progress this century. Though reductions have plateaued in the last few years[2], deaths fell by nearly two-thirds between 2000 and 2019[3]. (The Covid-19 pandemic disrupted prevention services, and deaths and cases climbed by more than 10% as a result). About 247 million people–equivalent to more than twice the population of Japan–contracted the disease in 2021, leading to 619,000 deaths[4]. About 95% of cases occur in Africa[4], where about 80% of deaths occur among children younger than 5[4]. Reducing these numbers would lift economies as well as families, especially in the poorest, hardest-hit countries—making malaria control a key priority for sustainable development.

For years, researchers have expected that climate change will lead to changes in the spatial and temporal distribution of the malaria-carrying mosquito species, specifically *Anopheles* spp. This expectation is hardly surprising, given the documented

phenomenon of various species shifting to higher latitudes and altitudes to adapt to their evolved temperature preference. If mammals, birds and butterflies can exhibit such behaviour, it is reasonable to assume that mosquitoes would do the same. Furthermore, the lengthening of warm or rainy seasons due to climate change in areas already affected by malaria can result in a greater presence of the parasite throughout the year, as in Kios's part of southern Kenya.

In February came the most compelling evidence yet of the climate migration of *Anopheles*: Researchers at Georgetown University scoured an enormous database, stretching back more than a century, of anopheline distribution in sub-Saharan Africa to parse changes in the species' range limits. With a relatively simple statistical analysis, they have learnt that African malaria-mosquito vectors have moved an average of 6.5 meters up and 4.7 kilometres south per year between 1898 and 2016. This movement is even faster than earthbound species[5] and corresponds remarkably closely to the pace of climate change over the same period. Already, vectors in sub-equatorial Africa have spread an average of more than 550 kilometres south–about the distance from Berlin to Vienna or San Francisco to Los Angeles.

Of course, as some areas see more malaria, others might see less. But the World Health Organization forecasts an additional 60,000 malaria deaths annually from 2030 to 2050 as a result of climate change, a 15% leap. That's on top of the cascading damage to biodiversity resulting from climate change and species migration it induces. Under a business-as-usual scenario with little reduction in greenhouse gas emissions, 700 million more people could be at risk of contracting the disease[6]. And in places where malaria becomes less prevalent, the arboviruses dengue and chikungunya could grow to a greater extent[7].



This figure examines the length of the transmission season (LTS) for malaria, considering a combination of emission levels and socioeconomic conditions from 2070 – 2099 compared to 1970 – 1999. Figure taken and cropped from: https://www.thelancet.com/journals/lanplh/article/PIIS2542-5196(21)00132-7/fulltext

In short, many places that are unprepared to deal with malaria may soon have to confront this disease. The World Bank found a 50% higher probability of malaria transmission in East Asia, South America, and Africa[6]. Meanwhile, insecticide resistance is spreading rapidly in areas where malaria is already endemic.

Such new patterns are expected to burden many communities without concerted action. Some of these places are already experiencing disproportionate changes in temperature and rainfall patterns while struggling through poverty which provides them with the least capacity to deal with such problems.

Bed nets or long-lasting insecticidal nets (LLINs), considered the most cost-effective intervention for preventing malaria transmission[4], provide a protective barrier over sleeping areas when mosquitoes are most active, and people are most vulnerable. Vestergaard, a company with over two decades of expertise in testing and manufacturing bed nets, has produced nearly a billion nets that have been distributed in more than 100 countries. These nets, among others, are credited with averting 68% of all malaria cases in Africa from 2000 – 2015[8]. To address the evolving parasite and climate change, ongoing innovation of bed nets is imperative.

In March, the World Health Organization issued new recommendations, favouring pyrethroid-chlorfenapyr nets, like Vestergaard's PermaNet Dual, over pyrethroid-only nets in areas of pyrethroid resistance among mosquitoes[9]. Climate change introduces a new

challenge as malaria adapts to shifting climatic conditions, emphasising the need to adapt malaria prevention resources accordingly. In this context, forging partnerships becomes crucial to effectively address the evolving dynamics of the disease.

For instance, in collaboration with the Kenyan Medical Research Institute's Centre for Global Research (KEMRI-CGHR), Vestergaard and KEMRI developed the insecticide-resistance reporting system and map, IRMapper.com. IR Mapper, which has since been cited in several academic papers, represents a remarkable success story of the African scientific community and the private sector . More recently, the international NGO Malaria No More, which receives support from Vestergaard alongside the Bill & Melinda Gates Foundation, the Skoll Foundation, and others, developed an online prediction tool to predict areas of malaria outbreaks while there's still time to deploy prevention resources. The tool combines surveillance and health data with environmental variables like weather and vegetation, utilising algorithms to find the best predictive model. During testing in India, the tool achieved over 90% accuracy.

By accurately predicting areas that will experience increased susceptibility to malaria, we can seize the opportunity to protect and prioritise at-risk populations for bed net distributions. Additionally, this forecasting can enablegovernments and multilateral agencies to plan a clinical trial of new drugs or vaccines with ample time.

The intricate relationship between climate change and public health is gaining recognition, as mentioned at the 76thWorld Health Assembly and included as part of the focus of a dedicated 'Health Day' at the upcoming COP28 conference. Connecting the fields of climate and health is crucial for developing practical solutions and policies to address the interconnected impacts on individuals and communities. With greater collaboration among stakeholders, sufficient funding for more effective next generation tools like PermaNet Dual, and commitment across academic, civil society, governmental and multilateral sectors, we can bring our talents and resources to bear on beating back malaria and other vector-borne diseases.

Hopefully, someday Lasiti Kios's children will speak to their own children of the old days, when malaria was rampant.

[1] https://www.washingtonpost.com/climate-environment/2023/02/14/climate-change-malaria-mosquito/

[2] https://www.who.int/teams/global-malaria-programme/reports/world-malaria-report-2021

[3] https://www.who.int/data/gho/data/themes/malaria

[4] https://www.who.int/news-room/fact-sheets/detail/malaria

[5] https://www.nytimes.com/2023/02/14/health/malaria-mosquitoes-climate-change.html

[6] https://malarianomore.org.uk/world-environment-day

[7] https://www.thelancet.com/journals/lanplh/article/PIIS2542-5196(20)30178-9/fulltext

[8] https://pubmed.ncbi.nlm.nih.gov/26375008/

[9] https://www.who.int/news/item/14-03-2023-who-publishes-recommendations-on-two-new-types-of-insecticide-treated-nets