EPIDEMIOLOGY

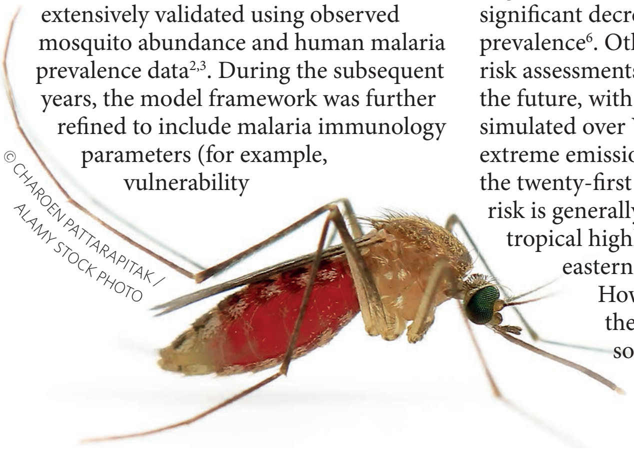
Malaria in a warmer West Africa

Malaria risk in West Africa is expected to fall (western region) or remain the same (eastern region) in response to climate change over the twenty-first century. This is primarily due to extreme temperature conditions projected under a high greenhouse gas emissions scenario.

C. Caminade and A. E. Jones

Malaria is a major vector-borne disease transmitted to humans by the bites of infectious *Anopheles* mosquitoes. It particularly impacts vulnerable people — such as children, pregnant women, and the elderly — and is highly prevalent in sub-Saharan Africa. Following the pioneering work of Ronald Ross and George MacDonald, different mathematical models, with varying degrees of complexity, have been developed and refined over the past 70 years to model the risk of malaria in space and time[1].

In the early 2000s, the African Multidisciplinary Monsoon Analysis (AMMA) project brought researchers from different disciplines together to carry out detailed analysis of the West African monsoon. As part of this project, hydrologists, entomologists and public health experts worked together to develop a malaria model at high spatial and temporal resolutions for the village of Banizoumbou in Niger. Malaria is a climate sensitive disease: rainfall is a necessary condition for mosquito breeding sites, and temperature impacts the development and mortality of the vector and the incubation period of the malaria parasite in the mosquito. Pond levels and other environmental parameters were monitored in real time over Banizoumbou and used to drive the malaria model. The model simulations were then extensively validated using observed mosquito abundance and human malaria prevalence data[2,3]. During the subsequent years, the model framework was further refined to include malaria immunology parameters (for example, vulnerability estimates of exposed populations to malaria) and was validated for other locations in West Africa[4]. The HYDREMATS malaria model was born.



Writing in *Nature Climate Change*, Yamana *et al.*[5] extrapolate the HYDREMATS malaria model from village scale to the whole West African region, and from the present to the warmer world of the future. This is the first time that a dynamical model, developed and validated at the village scale, has been employed to carry out climate change risk assessment over West Africa. First, the authors sub-selected climate model simulations that showed the best agreement with historical climate observations over the region. The HYDREMATS model was then driven by this sub-ensemble of climate models under the extreme RCP8.5 emission scenario to assess potential changes in future malaria risk. The results suggest that malaria risk is not significantly affected by climate change over the eastern part of West Africa, whereas the risk decreases over the western part due to extreme temperature conditions.

These results are consistent with analogues from past observations. Following the severe drought that occurred during the 1970s and the 1980s over the Sahel, *An. funestus,* an important malaria vector, almost disappeared in northern Niger and northern Mali, leading to a significant decrease in observed malaria prevalence[6]. Other recent multi-model risk assessments show similar trends for the future, with a decreased risk generally simulated over West Africa under the most extreme emission scenario at the end of the twenty-first century, whereas malaria risk is generally simulated to increase over tropical highland regions, especially over eastern Africa[7].

However, these results address the impacts of climate solely on future potential malaria burden. They do not consider other critical factors such as socio-economic development, vulnerability, land use, potential population movements, disease control measures already in place, or the development of vaccines. Since 2000, the numbers of malaria cases and deaths have respectively decreased by about 12% and 48% over the African continent[8] thanks to funding efforts that improved the implementation of vector control measures (distribution of impregnated bed nets, insecticide spraying), and developed new rapid diagnostic tests. The IPCC was careful about providing recommendations for future malaria risk because of this complex, multi-factorial nature of the risk. However, there is increasing evidence that recent climate change, in conjunction with increased travel of goods and people, is already favouring the spread of important vector-borne diseases (such as dengue fever and Lyme disease) to higher latitudes and altitudes. Large temperature increases simulated over West Africa might, logically, be a limiting factor for malaria in the future. It is noteworthy, however, that these high temperatures will also be an increasing stress factors for many important sectors in the region such as agriculture and water resources. ❐

C. Caminade and A. E. Jones are at the Institute of Infection and Global Health, University of Liverpool, Merseyside, Liverpool L69 3GL, UK.
e-mail: Cyril.Caminade@liverpool.ac.uk

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Published online: 18 July 2016