



Climate Services crucial for early warning of malaria epidemics

In some areas, where the malaria parasite *Plasmodium* is continuously transmitted through the *Anopheles* mosquito, the disease is endemic and best contained by routine prevention and control measures. But as well as endemic diseases, and in other, non-endemic areas, malaria can also occur in sudden outbreaks, or epidemics. This can happen if environmental conditions change and mosquitoes that carry the malaria parasite are more able to breed, multiply, and come into contact with people.

The World Health Organization (WHO) estimates that approximately 300 to 500 million cases of malaria occur worldwide with about 2 million people being killed each year, 80% of which occur in Sub-Saharan Africa. Malaria is endemic in a broad band around the equator in parts of the Americas, Asia, Africa, Oceania and certain Caribbean Islands.

Malaria is the most serious and common vector-borne disease in the world, but most importantly, it is preventable and curable. Malaria mitigation strategies require a combination of preventive and curative treatment methods and close collaboration between the health and climate sectors. The timely provision of climate information with several months lead-time should be combined with a well-developed national and regional response strategy that allocates resources for public outreach and distribution of medication and insecticides well in advance.

Geographical distribution of malaria is complex and topographically induced 'regional pockets' with different climates may result in malarial and malaria-free areas close to each other. Given the limited resources many tropical and sub-tropical countries have in detecting and controlling malaria outbreaks, seasonal climate predictions with high spatial resolution

are necessary to prepare for the most effective response in well-targeted areas.

A global increase in malaria may be associated with deforestation, water development projects, and agricultural practices in poor countries. High altitude regions have been protected from malaria endemicity because parasite multiplication and mosquito development are inefficient in temperatures below 18°C. However, there appears to be an emergence of malaria in the African highlands which may be attributable to a true change in disease pattern caused by increasing temperatures associated with climate change. The recently released Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) noted that climate change was expected to have some mixed effects on health, such as the decrease or increase of the range and transmission potential of malaria in Africa. As global temperatures continue to rise and precipitation patterns appear to alter, it is



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important to have a system that allows public health practitioners to forecast where and when malaria epidemics may occur.

Temperature, precipitation and humidity are considered risk factors for malaria transmission. Increasing temperature accelerates the rate of

mosquito larval development, the frequency of blood feeding by adult females on humans, and reduces the time it takes the malaria parasites to mature in female mosquitoes. Increased rainfall creates additional breeding sites for mosquitoes, thus increasing their numbers. Rainfall is recognized as one of the major factors influencing variability in malaria transmission in warm semi-arid and desert-fringe areas of the Sahel, the Greater Horn and Southern Africa. Explosive epidemics may occur in these regions after excessive rains, usually with a lag-time of several weeks during which time the mosquito populations and malaria infections in humans increase rapidly.

Many countries in Africa do incorporate malaria early detection into their malaria control efforts. Early detection means carefully monitoring rates of malaria incidence, in order to detect an impending outbreak. Early detection can provide enough lead time (days to over a week) to deliver malaria control drugs to the affected region, and thereby minimize the morbidity and mortality associated with the outbreaks.

In addition, the climate conditions favouring mosquito breeding, parasite development, and hence transmission need careful and constant monitoring. The Mapping Malaria Risk in Africa (MARA) collaboration was initiated in the mid 1990s by the International Development Research Centre of Canada (IDRC) to provide a continental-wide atlas of African malaria occurrence, containing relevant information for national and targeted implementation of malaria control. MARA provides an excellent example for a validated predictive malaria model, which incorporates climate impacts on vector and parasite population biology and malaria distributions, for which the climate observations of the African NMHSs constitute crucial input. This information is used to define areas that are climatically suitable for malaria transmission, and therefore with the population at risk, throughout Africa. Soon after its establishment, the MARA project received additional support from the South African Medical Research Council, the Wellcome Trust, UK, the Swiss Tropical Institute and the UNDP/World Bank/WHO Special Programme

for Research and Training in Tropical Diseases. In 1998, the Roll Back Malaria (RBM) Partnership was launched by the WHO, the United Nations Children's Fund (UNICEF), the United Nations Development Programme (UNDP) and the World Bank to provide a coordinated approach to fighting malaria. Since its establishment, the Partnership has expanded exponentially and is now made up of a wide range of partners including NGOs, partners from the private sector, and research and academic institutions. An integrated framework for an epidemic Malaria Early Warning and Response System (MEWS) was developed by the RBM Partners jointly with the International Research Institute for Climate and Society (IRI) and national ministries of health in Africa. MEWS is based on the principles and recommendations of the Famine Early Warning System (FEWS), which was operationalized in 1986 following the widespread famine in Africa in the early 1980s. MEWS includes seasonal forecasts and climate monitoring as well as vulnerability assessments, case surveillance and response planning. The first operational MEWS has now been put in place in the Southern African countries – with a focus on Botswana – and the initial results are promising. Climate outlooks with three to four months' lead-time are likely required in responding to an imminent malaria epidemic and stockpiling at the national level the supplies that may be needed effectively to respond.

A new malaria early warning technique recently proposed by researchers at the European Centre for Medium-Range Weather Forecasts (ECMWF), the IRI and the Ministry of Health in Botswana incorporates climate forecasts from multi-model ensembles to predict when malaria risk will be at its peak, by examining climatic variables which influence the proliferation of mosquitoes. The team successfully deployed the technique in Botswana and was able to give policy-makers and health programme officers up to four months of advance notice. Dr Timothy Palmer from the ECMWF and his colleagues received the 2006 Norbert Gerbier-MUMM International Award for their work on the relationship between climate and malaria. Initiated by the World Climate Research

Programme (WCRP), they developed an ensemble forecast model based on the DEMETER project, that predicts a probability distribution of climate scenarios and hence, peak times for malaria transmissions. The Award's prize money was recently invested in a project lead by the Tanzania Meteorological Agency, studying the impacts of climate variability on malaria in Tanzania. The main objective of the project was to further develop and apply the DEMETER methodology of integrating seasonal forecasts and malaria statistics into an end-to-end early warning system for malaria outbreaks. A new database of clinical cases was collected and made available for the wider scientific community, the seasonal cycle of malaria outbreaks determined and the high risk areas identified.

Since 2004, the WHO's office in the southern African region, the Drought Monitoring Centre Harare (DMCH) in Harare, Zimbabwe (now relocated to Gaborone, Botswana, and known as SADC-DMC), and the IRI have been working with the WMO, its Members, the National Meteorological and Hydrological Services (NMHSs), and the Ministries of Health in the southern African countries to conduct a pre-season Malaria Outlook Forum (MALOF). The MALOF meeting has so far been held three times in the southern African region and, for the first time in March 2007, in the East Africa-Greater Horn of Africa region. The MALOF is and has been the cornerstone for implementing an early warning system for malaria in the member states of these African regions. The Intergovernmental Authority on Development (IGAD) Climate Prediction and Applications Centre (ICPAC) located in Nairobi, Kenya, which serves the East Africa-Greater Horn of Africa region, has taken responsibility in developing a regionally specified early warning system for malaria comparable to the one established in southern Africa.

The Climate Information and Prediction Services (CLIPS) project, a component of the World Climate Applications and Services Programme (WCASP) under the World Climate Programme (WCP) of WMO, working together with the World Bank, the National Oceanic and

Atmospheric Administration (NOAA) of the USA, the IRI, the European Commission, and the NMHSs, has been a major driving force for developing seasonal climate prediction in Africa. One of the most significant result of these coordinated efforts is the establishment of the Regional Climate Outlook Forums (RCOFs), the first of which took place in 1996 in Zimbabwe. In response to an initiative from the WMO, the NMHSs have nominated CLIPS Focal Points, many of whom have received training as part of CLIPS capacity-building remit. At the RCOFs, several of these focal points are involved in developing an authoritative seasonal outlook for the region, which they further disseminate within their own countries. The outlooks are also passed on to the general public, through the active participation of the media, and to various governmental agencies usually by direct interaction. The concerned ministries and other decision makers then make use of the outlooks nationally and locally, particularly in the agriculture, water, energy and health sectors and early warning agencies. An integral part of the RCOF sessions held since 2004 in the Southern Africa region and since 2007 in the East Africa-Greater Horn of Africa region is the MALOF, with the primary mission to establish an operational early warning system for malaria. The RCOF-MALOF joint sessions enable the experts from the NMHSs to interact with the representatives from the health sectors, and together they jointly develop malaria detection and response products best suitable for various sectors, spatial and temporal scales. [ca]

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