4.3 PROVIDING A CLIMATOLOGICAL PERSPECTIVE FOR MALARIA EARLY WARNING SYSTEMS IN AFRICA

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1. INTRODUCTION

It is estimated that more than 110 million Africans live in areas prone to epidemics of malaria. Populations in these areas are infrequently challenged by malaria and, therefore, do not fully develop acquired immunity. As a result, the disease remains life threatening to all age groups. The impact of malaria epidemics could be greatly reduced by timely detection or, ideally, by prediction and prevention through vector control and deployment of appropriate drugs (WHO 2003).

Variability of malaria transmission in the warm semi-arid and desert-fringe areas of the Sahel, the Greater Horn and Southern Africa is largely influenced by rainfall, as well as other factors. Excessive rains can contribute to explosive epidemics, usually with a lag of several weeks during which time mosquito vector populations and malaria infections increase rapidly. Communities already dealing with poor food security or recent periods of drought are often most affected by these epidemics (WHO 2002b). Recent research has found that rainfall estimates would provide useful epidemic early warning information, even in highland-fringe settings, such as those in Kenya and Ethiopia, where temperature is also an important limiting factor for the development of the malaria parasite (Hay et. al 2003, Teklehaimanot *et al.* 2004a, Teklehaimanot *et al.* 2004b). Consequently, rainfall monitoring forms one of the essential elements for the development of integrated Malaria Early Warning Systems for sub-Saharan Africa, as outlined by the World Health Organization (WHO 2001, WHO 2004a).

According to discussions by the Roll Back Malaria Technical Resource Network on Prevention and Control of Epidemics (RBM-TSN), immediate benefit could be realized from the routine availability of an indicator of changes in epidemic risk in regions of marginal transmission (WHO 2002a). The indicator was to be based on the difference between current rainfall and the expected rainfall for the particular time of the year (i.e., climatological average) and made available on the internet in a frequently-updated format. It was anticipated that this product would assist malaria control program staff and RBM-TSN partners working in areas of increased epidemic risk (WHO 2002b).

The following article provides a brief history of efforts focused on providing climate information to the malaria control community and a description of a new rainfall-monitoring resource that was recently developed.

2. DISCUSSION

A consensus map of epidemic risk zones was produced by members of the RSM-TSN based purely on climatic constraints to malaria transmission (WHO 2002a). The map was used as a mask to exclude areas where malaria transmission is considered absent or endemic, as opposed to epidemic (WHO 2002b).

Rainfall anomaly data, based on the CPC/Famine Early Warning System Dekadal Estimates (hereafter CPC RFE2.0), which was shown to have a good relationship with malaria incidence figures in Southern Africa (Connor 2003), was then combined with the epidemic risk map to provide a simple indicator of changes in risk in epidemic prone areas. The resulting dekadal rainfall anomaly maps have been available in experimental form through the Africa Data Dissemination Service (ADDS)[a] since June 2002.

Field visits commissioned by the WHO and further dialogue with malaria control programs in

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[a] The ADDS is an operational part of the Famine Early Warning Systems Network (FEWS NET) which is maintained by the United States Geological Survey (USGS) and supported by the U. S. Agency for International Development (USAID).

West and Southern Africa yielded constructive feedback about the use of this product. Included in this feedback was the issue that a single dekadal rainfall anomaly map could raise an alert in their systems when the rainfall levels were not abnormally high, but just 10 days earlier than expected, based on the normal seasonal cycle. This suggested that additional information about the temporal distribution of rainfall was necessary.

In order to respond to this issue, USGS and WHO agreed to collaborate on the development of the dekadal rainfall anomaly maps in a format which could be downloaded, viewed and archived by surveillance staff directly in HealthMapper, a basic mapping software developed by WHO's Communicable Disease Surveillance and Response Department. Dekadal maps from May 2004 to the present can now be downloaded from ADDS and be integrated with malaria data from a seasonal perspective within HealthMapper.

Staff working at the International Research Institute for Climate Prediction (IRI) have since developed a web-based Malaria Early Warning System (MEWS) interface that enables the user to gain a broader contextual perspective of the current rainfall season by comparing it to previous seasons and climatological averages. The interface is in the IRI Data Library and takes the form of an online interactive map of Africa (http://iridl.ldeo.columbia.edu/maproom/.Regional/.Africa/.MEWS/). It displays the most recent dekadal rainfall estimates from CPC RFE2.0 (Figure 1) over which administrative boundaries and the epidemic risk zone mask can be overlaid. These visual features can be toggled on or off and

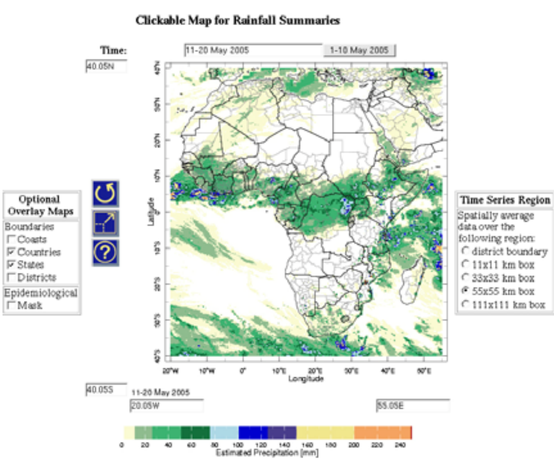

Figure 1: Malaria Early Warning System (MEWS) clickable map interface for rainfall monitoring.

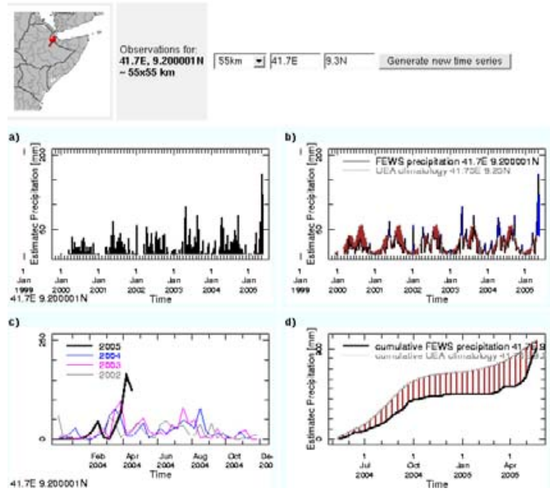

Figure 2: Time series generated by MEWS interface which describe current seasonal rainfall with respect to previous seasons and climatology.

the user can zoom in to any region for more clarity. The user can also create an animated image of data from multiple dekads.

Dekadal rainfall can be spatially-averaged over a variety of user-selected areas, including administrative districts and 11x11km, 33x33km, 55x55km and 111x111km boxes. Upon the selection of this sampling area and a specific location of interest (by a click on the map at the location of interest), four time-series graphs are generated that provide an analysis of recent rainfall (Figure 2). The analysis compares recent dekadal rainfall with that of previous seasons, based on CPC RFE2.0, and climatology, based on a long-term (i.e., 30-year) average (New *et. al* 1999). A comparison of cumulative rainfall from the most recent 12-month period and the corresponding cumulative climatology is also shown. A description of the time-series figures and the datasets utilized in the analysis are also provided to the user.

3. SUMMARY AND FUTURE WORK

Access to frequently-updated rainfall information is an important requirement for the development of integrated early warning systems for malaria and other climate sensitive diseases (WHO 2004a, WHO 2004b). These operational rainfall monitoring tools have been developed primarily for application in warm semi-arid regions where rainfall anomalies are the main determinant of epidemic outbreaks, however they may also be an important resource for highland-fringe epidemic settings.

It is anticipated that the MEWS product will continue to be modified in the future in response to user feedback. Among these modifications will be the inclusion of the Africa Rainfall Estimate Climatology dataset (Love *et al.* 2004) as the climatological reference. The MEWS product will also benefit from the development of other interactive maps aimed at providing climatological information for the malaria control community, such as those that display the climatic suitability of malaria transmission based on climatological precipitation, temperature and relative humidity.

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