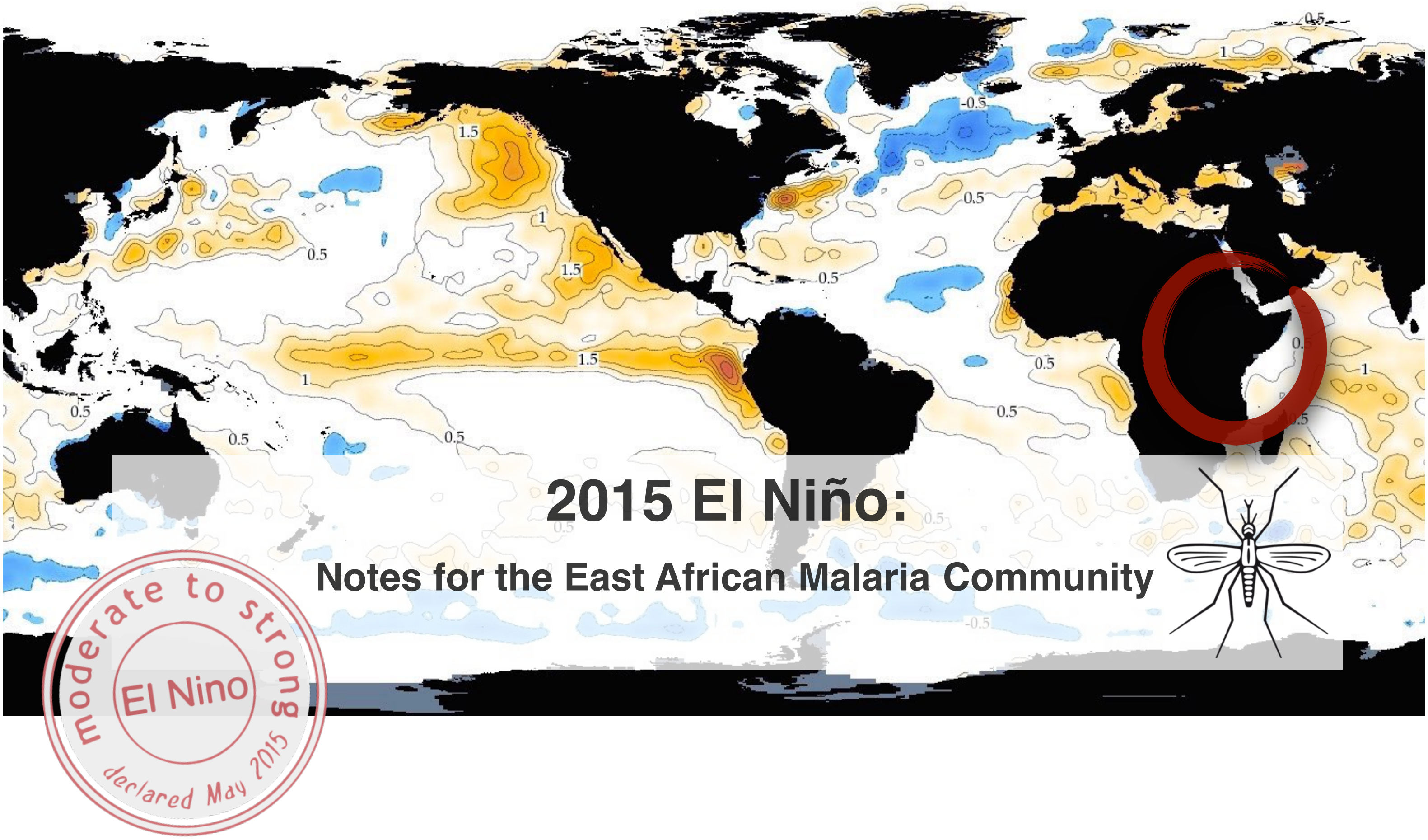
RELEASE: *22 June 2015*



2015 El Niño:

Notes for the East African Malaria Community

Climate Information for Public Health Action

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Background

El Niño conditions were formally declared by all major climate forecasting centers in May 2015. This follows a long period through 2014 and the spring of 2015 of considerable uncertainty as sea surface temperatures in the Eastern Pacific and other climatic indicators approached but did not cross the formal El Niño thresholds. indicative of a major shift in the climate system. The latest forecasts suggest this event will be moderate to strong with higher than normal temperatures around the world and an increased chance of high rainfall in East Africa during the forthcoming short rains (October-December). Understanding and monitoring the emerging climatic conditions offers an opportunity to improve regional, national and sub-national health system preparedness that can better prevent and manage malaria outbreaks associated with El Niño.

In the last 25 years, there have been six moderate-to-strong El Niño events: 1991-2, 1994-5, 1997-8 2002-3, 2006-7, and 2009-10. The impacts of El Niño are felt most in different regions and seasons in Africa. Previous events have been associated with drier- and hotter-than-normal conditions in some regions and seasons and wetter- and cooler-than-normal conditions in others (Fig. 1). El Niño tends to increase atmospheric temperatures across the tropics, but the local effects will in part be driven by rainfall, since cloud cover tends to increase minimum and decrease maximum temperatures. Thus, El Niño may increase minimum temperatures in areas in Eastern African where precipitation is forecasted to increase.

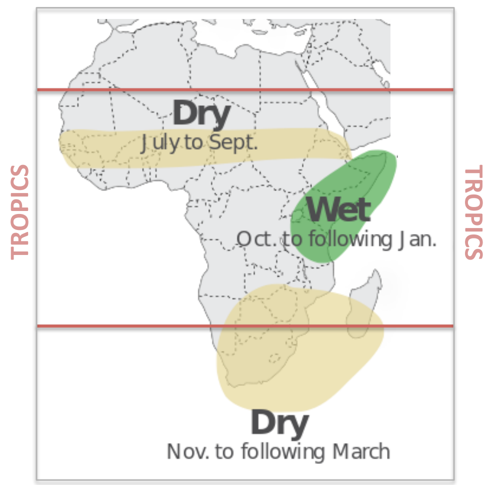

Figure 1. Likely El Niño rainfall impacts in Africa

Likely El Niño rainfall impacts in Africa, based on Niño3.4, a common region used to assess ENSO (bound by 120°W - 170°W and 5°S - 5°N). General atmospheric warming occurs throughout the tropics during El Niño events; however, the local temperature effects will also be influenced by rainfall. Adapted from the IRI/IFRC Maproom (http://iridl.ldeo.columbia.edu/maproom/IFRC/index.html#tabs-3).

Malaria impacts associated with El Niño will differ depending on local health vulnerability and health system capacities, as well as how El Niño and other climate drivers influences the local climate. Malaria is a complex disease. Its transmission, via *Anopheles* spp. mosquitoes can be highly climate sensitive with temperature being a significant driver of the development rates of both mosquito vector and *Plasmodium* parasite. In addition rainfall and humidity provide essential environmental characteristics for juvenile mosquito development and adult survivorship. The relationship between El Niño events, malaria, and other vector borne diseases has been well documented in Africa and parts of Latin America and Asia (Kelly-Hope et al., 2008).

This report provides information to assist health planners and practitioners in monitoring the vulnerability of communities and providing time-sensitive information for interventions to reduce malaria transmission in Eastern Africa. We urge health decision-makers to follow El Niño advisories for any new developments and monitor climate/weather forecasts as part of an early warning-early action approach, and as appropriate, create advisories targeting local conditions and/or specific malaria outbreaks.

Resources and recommendations for monitoring the situation are presented below. This Eastern African El Niño malaria bulletin can be utilized as a basis to develop more targeted policy-oriented documents concerning specific climate-induced malaria consequences for your locality.

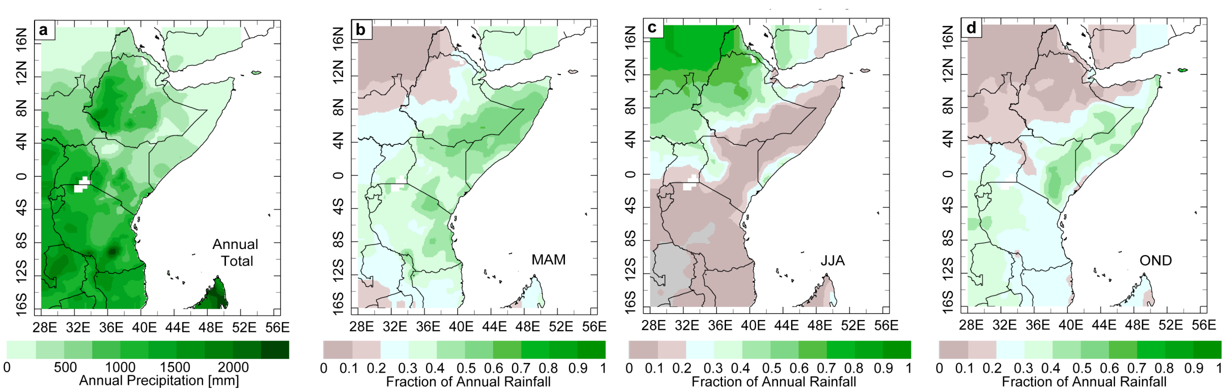

Figure 2. Seasonality of Rainfall in Eastern Africa

October-December (OND) is strongly impacted by El Niño. Annual precipitation in Eastern Africa throughout (a) the year, (b) in March-May, (c) June-August, and (d) October-December. From Lyon, 2014.

What is El Niño?

El Niño is a periodic appearance of unusually warm sea-surface temperatures (SSTs) in the central and eastern Pacific Ocean. It is the most prominent known driver of interannual variability in weather and climate around the world. El Niño events are associated with increased probability of drought in some areas and excess rainfall in others, together with regional warming across the tropics. Read about El Niño at: http://www.climate.gov/news-features/understanding-climate/can-we-blame-el-niño

Once developed, El Niño conditions in the Pacific typically persist for 9-12 months or longer, starting around June and peaking between November and February. Peak impacts do not necessarily coincide with the peak of the El Niño period: impacts generally occur during a region's main rainy season. Because the progress and strength of the El Niño can be monitored through near-real-time ENSO observing systems, it is possible to generate probabilistic seasonal climate forecasts months in advance. Such forecasts may be useful for planning for and mitigating malaria outbreaks associated with climatic extremes. A major potential benefit of 'El Niño years' is that the climate is likely to be more predictable.

Seasonal forecasts incorporate ENSO and other predictors

A pattern of warmer-than-average SSTs in the western equatorial Indian Ocean with cooler-than-average conditions in the east has been called the "positive phase" of the Indian Ocean Dipole (IOD), which can sometimes be triggered by El Niño events. Positive IOD phases typically result in wetter conditions in Eastern Africa and drier conditions in Southeast Asia and Australia. In both the highlands and lowlands of Eastern Africa, there is a positive correlation between IOD phase and precipitation in October-December with few significant changes in precipitation in March-May (Fig. 3).

It has been well document that El Niño can influence malaria in Eastern Africa (Kelly-Hope et al., 2008, Thomson et al., 2011). Additionally, IOD has been suggested as a good predictor of malaria (Hashizume et al., 2009). However, as El Niño and IOD interact, both should be considered (Fig. 4). The best guidance for seasonal mean climate is to monitor the seasonal forecasts, which incorporate all key predictors and real-time conditions for your area of interest. Information about the latest IRI El Niño briefing and tools for monitoring updates on the strength of the El Niño can be found at http://iri.columbia.edu/enso or at: http://www.icpac.net/. Follow #*ENSOQandA* and #*IRIForecast* on Twitter to monitor updates.

Summary state of 2015 El Niño

17 June 2015: El Niño conditions were formally declared by all major climate forecasting centers in May 2015. The latest forecasts suggest the current moderate El Niño could become strong in the coming months - see http://iri.columbia.edu/news/june-climate-briefing-el-nino-certainty-increases/.

In Eastern Africa, **El Niño events are usually associated with wetter and warmer conditions during the short rainy season of October-December**. Thus, it will be important to monitor rainfall and associated flooding and minimum temperatures given their impact on malaria outbreaks. The long rains of March-May are less likely to be impacted (Fig. 4), as they demonstrate weak correlation with SSTs in all ocean basins. It will be the short rains of October-December (Fig. 4) that will be primarily affected as they are more dependent on large-scale climate drivers like El Niño and positively correlate with SSTs in both the tropical Pacific and western Indian Oceans (Lyon, 2014).

Furthermore, the strength of an El Niño provides only a rough indication of how widespread and severe the associated impacts are likely to be on a regional level and is less certain as an indicator of impacts on a local level.

Enhanced National Climate Services (ENACTS)

In some East African Countries the quality of available climate information is being enhanced through the Enhancing National Climate Services (ENACTS) initiative: an ambitious effort to simultaneously improve the availability, access and use of climate information by working directly with National Meteorological and Hydrological Services (NMHS) and their national development partners. It enables the NMHS to provide enhanced services by overcoming the challenges of data quality, availability and access – while at the same time fostering stakeholder engagement and use. It includes the creation of 'best available' data for the national level by combining rigorously evaluated station data with satellite and climate model reanalysis products; the dissemination of primary and derived products via the web. Included in the suite of products made available is information on the historical relationship of El Niño and rainfall and temperature in country. ENACTS is currently available in Ethiopia, Tanzania and Rwanda.

Recommendations for Action

Monitoring emerging climatic conditions offers the opportunity to improve risk management and malaria surveillance. With integrated surveillance systems and early warnings, malaria risks can be better identified and anticipated, so that effective action is taken to reduce vulnerability and mitigate outbreaks. The following actions are recommended for health professionals:

1. Understand and assess how El Niño can alter malaria transmission in your area

Review the evidence on which populations or geographic regions are generally vulnerable to climate variability and how El Niño events have been observed to affect malaria in the past. To establish the likelihood of various health impacts, analysis of historic climate and malaria data and El Niño events (or associated SSTs) is needed. Research, climate impact assessments, historical malaria surveillance, or health vulnerability, adaptation, and emergency risk assessments may provide this background. Sub-populations, such as pregnant women, children, refugees, and those in areas bordering epidemic zones where natural immunities are low, should be identified as their health status contributes to greater health risks. Preparedness and response planning can greatly benefit from the creation of risk maps indicating the most likely risk areas at the sub-national level. Consult with experts, as needed, to learn from experiences in other countries or regions. Sharing information and accessing the latest scientific knowledge will help ensure that the health risks associated with El Niño events are managed in the most effective way possible.

To assess current risks, it is important to promote dialogue between health actors, incorporating malaria control agencies, emergency management committees, partner organizations at all levels, national meteorological agencies, and disaster management organizations. National climate and malaria working groups may be created to provide an appropriate forum for discussion.

2. Develop strategies and activate malaria epidemic preparedness measures

Rather than focusing on predicting specific impacts, risk management strategies must identify and prepare for the multi-scale and diverse sources of national and local vulnerability to climatic extremes, and the potential of cascading interconnected impacts that can be triggered by El Niño events. Increases in transmission due to more suitable climatic factors, flooding impacting roads and access to health facilities, and other diseases compounding the burden of disease (e.g. Rift Valley Fever), should be anticipated. Most countries have specific plans designed to reduce the impact of climate-related hazards (e.g. droughts or floods), such as disaster risk reduction strategies, evacuation or epidemic preparedness plans, emergency response plans, etc. These plans will need to be reviewed against emergency risks, including the influence of El Niño on malaria, by the mandated agencies. If national climate experts and meteorological services identify a high likelihood of dangerous conditions (e.g. a heavy flood season), malaria workers are encouraged to activate epidemic preparedness efforts in advance, such as reviewing contingency plans, medical stocks, the availability of essential personnel, activating early warning systems, and the functioning of response systems. Particular attention should be paid to the preparedness of hospitals and health clinics to avoid damage and to provide emergency health response in disasters.

> “*Coordinated communications about malaria risks associated with El Niño can improve health outcomes and the cost-effectiveness of interventions by targeting support at the right time to the communities that need the greatest protection.*

Given the uncertainties associated with any climate forecast, the implementation of ‘no regret’ strategies (those that are beneficial to malaria control whether or not the specific predicted climate event occurs) should be prioritized. In particular, in areas where El Niño may be associated with diminished malaria risks, diligence in malaria control should not be reduced in any way.

3. Follow climate forecasts to monitor developments in this year's El Niño event

Scientists will have a better sense of the likely magnitude of this event over the coming months, which can provide helpful information for regions that tend to experience the same type of recurring impacts during El Niño events. It is extremely important to follow the forecasted climate for your region as a standard of good practice for malaria preparedness. When engaging with meteorological services and regional centers, it is important to use forecasts that are made with specific tools like the Climate Predictability Tool (CPT), which are designed to eliminate observer bias and to quantify uncertainty. Additional information is available from regional climate centers, in the IRI Maproom (http://iridl.ldeo.columbia.edu/maproom/ENSO/).

Because of interactions between the IOD and ENSO, the impacts of ENSO may be altered by the IOD phase. The best guidance for seasonal mean climate is from regional forecasts, that are available 3-6 months in advance of the season of interest. Some national meteorological services can provide forecasts on multiple timescales (seasonal, monthly, weekly, daily, etc.) and information about how the current El Niño and other climatic influences are likely to affect rainfall or temperature in your area. These forecasts should indicate how likely your region is to experience rainfall or temperature anomalies (e.g. below-average, near normal, or above-average). Health decision-makers are encouraged to also understand how good (skillful) the forecasts are for particular locations, seasons, and time periods. In countries with ENACTS, the historical relationship of El Niño to rainfall and temperature over the last thirty years can be readily assessed from the ENACTS Maprooms on the National Meteorological Services website (see above)

In addition, users can follow the forecasts from local climate services, the IRI (http://iridl.ldeo.columbia.edu/maproom/ENSO/) and by searching #*IRIForecast* on Twitter.

4. Monitor weather/climate/environmental data in real-time

Up-to-date information on the actual rainfall/temperature situation along with environmental factors may be obtained from national meteorological services (including via ENACTS websites for some countries), other appropriate agencies, or via the internet from reliable sources (see links below). For example, remote sensing information in near-real-time provides information to indicate water bodies are increases in vegetation greenness). Current and forecast information is always best understood in the context of historical data to highlight deviations from the expected conditions for a particular location. Monitoring information is a critical complement to malaria surveillance and can extend the lead-time of preparedness efforts before outbreaks occur. Policy makers and practitioners (e.g. hospital and emergency response personnel, local health officials, etc.) must be able to access historical data and monitored information in a timely manner to incorporate into routine decision-making. Relevant information on climate and malaria is available in the IRI Health Maproom: http://iridl.ldeo.columbia.edu/maproom/Health/Regional/Africa/Malaria/index.html.

5. Activate nationally and locally prepared communication and response plans

Experience suggests that El Niño events and their potential impacts on society may be ignored or over-sensationalized by the media. It is essential to work with national meteorological agencies to establish clear and consistent messages that keep both response agencies and the public informed about potential rainfall and temperature anomalies, and keep the risks in perspective (given other societal challenges and the uncertainties associated with climate forecasts). Coordinated communications about malaria risks with multi-sectorial El Niño preparedness communities can improve health outcomes and the cost-effectiveness of new and existing interventions by targeting support at the right time to the communities that need the greatest protection.

When the above monitoring and forecasts indicate that your locality is likely to be affected by El Niño, appropriate preparedness measures should be implemented. Activation of response plans will need to be considered. Climate-related disasters, such as enhanced precipitation and flooding, can be of rapid onset, and become geographically widespread within a short time period. Early coordination in the health sector by government, private, community, and international agencies can provide immediate financial, technical and logistical support, particularly in high-risk areas or zones already experiencing compound crises.

6. Monitor and evaluate the effectiveness of interventions that use climate information in their design and execution

Climate has been identified as one of a number of possible confounders in the evaluation of malaria interventions. Climate information, based on routinely collected data, obtained via globally recognized standards at defined regular time intervals, can be systematically incorporated into malaria analysis at multiple spatial and temporal scales. If climate is not taken into account, then the measurement of achievements may be overly pessimistic in years that experience an elevated climate risk for malaria in relation to the baseline period, and conversely overly optimistic when climate risk for malaria is low. El Niño events provide an opportunity to test the resilience of the national control programs that have been greatly strengthened in recent years.

Examples of Observed Malaria Impacts of Climate Indices (ENSO/DMI) in Eastern Africa

- **East African Highlands**: Higher temperatures and increased rainfall attendant with El Niño have resulted in a greater prevalence of malaria (Kovats et al., 2003)
- **Tanzania Highlands**: Heavy rainfall during the El Niño of 1997-1998 washed away many mosquito breeding sites in specific localities, reducing the malaria burden of disease (Lindsay et al., 2000)
- **Kenya Highlands**: Increase in malaria incidence with a positive DMI phase, even after accounting for ENSO impacts (Hashizume et al., 2009)
- **Ethiopia Highlands**: Approximately three million people contracted malaria in 1958 due to great-than-normal rainfall and higher-than-normal temperatures throughout the area (Fontaine et al., 1961)
- **Northeastern Kenya Lowlands**: Catastrophic death rates occurred after the 1997-1998 El Niño caused increased rainfall and flooding, the worst outbreak since 1952, damaging and destroying health facilities across the region (Brown et al., 1998)

Assessing the impact of malaria intervention efforts in response to El Niño, and other climate indices, advisories and seasonal climate forecasts is important to best prepare for future ENSO events and ensure the greatest efficiency and effectiveness of their implementation. Coordination of this information between multiple agencies will allow for successful communication between the malaria, climate, and other societal sectors. Intervention evaluation will support evidence-based policy, improve national and local health system preparedness, and prevent avoidable negative malaria impacts associated with future El Niño events at the global, regional, and national levels.

Available climate monitoring resources

1. IRI's El Niño forecasts:
   http://iri.columbia.edu/our-expertise/climate/forecasts/enso/
2. WMO El Niño/La Niña Updates Archives
   http://www.wmo.int/pages/prog/wcp/wcasp/enso_updates.html
3. IRI's seasonal rainfall forecasts
   http://iri.columbia.edu/our-expertise/climate/forecasts/seasonal-climate-forecasts/
4. IRI's interactive map room on Climate and Malaria in Africa
   http://iridl.ldeo.columbia.edu/maproom/Health/Regional/Africa/Malaria/index.html
5. ICPAC: Intergovernmental Authority on Development (IGAD) Climate Prediction and Applications Center
   http://www.icpac.net/
   http://www.icpac.net/products/products.html#products

Please cite this document as: IRI (2015). 2015 El Niño: Notes for the East African Malaria Community. 22 June 2015, 8pgs., Climate Information for Public Health Action: International Research Institute for Climate and Society, New York.

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