WORKSHOP REPORT

Improving Climate Information Availability, Access and Use for Malaria and Other Climate-Sensitive Health Issues

A Health and Climate Workshop

Addis Ababa, Ethiopia
24 - 27 October 2016

Elilly International Hotel

13 December 2016

Acknowledgements

Hosting Institution

Addis Continental Institute of Public Health (ACIPH)

Workshop Organizing Institutions

Ethiopian Public Health Institute (EPHI)
Addis Continental Institute of Public Health (ACIPH)
International Research Institute for Climate and Society (IRI), Columbia University
Ethiopia National Meteorological Agency (NMA)
Ethiopia Federal Ministry of Health (FMoH)

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Acronyms

AAU/ALIP	Addis Ababa University/Aklilu Lema Institute of Pathobiology
AAU/SPH	Addis Ababa University/School of Public Health
ACIPH	Addis Continental Institute of Public Health
CARE	CARE International - Kenya
CDC	Center for Disease Control
DFID	Department of International Development
EPHI	Ethiopian Public Health Institute
ENACTS	Enhancing National Climate Services
FMoH	Federal Ministry of Health
HDAMA	Health, Development and Anti-Malaria Association
IRI	International Research Institute for Climate and Society
NIH	National Institute of Health
NMA	National Meteorological Agency
NMCP	National Malaria Control Program
NPO	National Professional Officer
ORHB	Oromia Regional Health Bureau
OPD	Outpatient Department
PHEM	Public Health Emergency Management
PMI	President's Malaria Initiative
RHB	Regional Health Bureau
SMMES	Strengthening Malaria Monitoring and Evaluation System
WISER	Weather and Climate Information Services for Africa
WMO	World Meteorological Organization

Executive Summary

In Ethiopia, climate sensitive diseases (including malaria) and malnutrition continue to be a major public health concern. This was starkly bought home by the 2015-16 El Niño which resulted in extensive drought-related nutritional and health challenges in affected areas across the country.

Day 1
After opening remarks from key agencies, Ministry of Health National Malaria Control programme, National Meteorological Agency, the International Research Institute for Climate and Society, and the Ethiopian Public Health Institute, the 40 plus participants heard a number of key presentations describing climate and health interactions. The first presentation, on the impact of El Niño on historical cases of malaria in Ethiopia, responded to prior recommendations from a workshop entitled "Climate Variability and Change: Implications for Malaria Control and Elimination in Africa" held in Addis Ababa in April 2014. This was followed by a review of the current status of malaria control across the country. Four presentations were then made by researchers exploring different health/nutrition climate interactions. In the afternoon three Regional Health Bureaus then presented on the current status of malaria in Tigray, Amhara and Oromia, highlighting the possible impact of the 2015-16 El Niño. A fourth Regional Health Bureau presenter from SNNPR was unable to attend. All presentations resulted in extensive discussion amongst workshop participants and key issues raised where noted by rapporteurs. The day ended with a short review and an overview of practical hands on activities planned for Days 2 and 3.

Days 2 and 3
The hands-on activities for the workshop where preceded by three presentations providing technical insights to the Enhanced National Climate Services (ENACTS) initiative implemented at the National Meteorological Agency. A short overview of how this data is being used in Ethiopia and elsewhere was also given. The NMA ENACTS Maproom (http://www.ethiometmaprooms.gov.et:8082/maproom/) and associated materials http://iri.columbia.edu/resources/enacts/enacts-training-materials/ where worked through in a systemic way with participants able to learn how to use the Maprooms to produce images and graphs relevant to specific health issues. This was the first time that this level of training on ENACTS products and services has been done in Ethiopia and the response was extremely positive. Many valuable recommendations were made with regard to the use of this information source in Ethiopian health decision-making operations, education and research.

Day 4
This day was reserved for a smaller group discussion on the newly developed Malaria Elimination Climate Surveillance Suite (MECSS). The Suite uses all the tools and techniques discussed in Days 2&3 but consolidates the information in one place for each woreda. An additional set of recommendations were made to ensure that the MECSS met the identified climate information needs of the malaria elimination

community.

Workshop Background, Objectives, and Expected Outcomes:

Background
In Africa, in general, and in Ethiopia, in particular, climate is an important driver of variations in malaria transmission in highland and semi-arid areas. Because of this, the Ethiopian health community has long expressed the need for quality-assured and locally relevant climate information as part of their surveillance activities (Ghebreyesus et al., 2008). Yet, little attention has been paid to the systematic incorporation of climate information into malaria intervention programming. This has in part been due to the non-trivial challenges of accessing quality climate information with national coverage and local relevance over such a large and complex country.

This challenge is overcome by the creation and dissemination of Enhanced National Climate Services (ENACTS) climate products. The ENACTS initiative emerged in Ethiopia in direct response to perceived user needs. This initiative seeks to improve climate data availability, access, and use by national decision makers. It combines rigorously evaluated station data from a country's entire national meteorological agency's archive and operational system with globally available satellite and climate model reanalysis products. The resultant primary and derived products are then disseminated via a web enabled platform or 'Maproom' housed on the meteorological agency's website or through direct transfer. This unprecedented capability enables national meteorological agencies to provide quality-assessed and spatially and temporally complete data services which can out-compete traditional global products.

As the Ethiopian National Malaria Control Programme advances its strategy for malaria elimination, the demand to incorporate climate variables into the malaria surveillance system is increasing. The resources created through the ENACTS initiative have multiple applications for malaria. In addition, public health policy makers, practitioners and researchers can use them to explore the relationship of climate and other vector-borne diseases as well as other climate-sensitive health outcomes.

Overall Meeting Objectives:

The primary objectives of the workshop were to showcase the available climate information and tools to support the public health community for improved decision-making.

In particular, the four-day workshop consisted of the following main components:

(i) Review activities following the recommendations from the NIH 2014 Workshop including impact of the December 2015 Ethiopia El Niño Policy Brief

(ii) Share recent analyses/activities/endeavors regarding the relationship between climate/climate variability and malaria and other climate-sensitive diseases in Ethiopia
(iii) Review impact of 2015/16 El Niño on malaria in Ethiopia by region
(iv) Review the current Ethiopia ENACTS Maproom as a tool to support the analysis of climate sensitive diseases, including hands-on training session
    a. Why ENACTS?
    b. Tool for understanding seasonality of climate at any location
        i. Exercise: Seasonality: Rainfall
    c. Tool for understanding timing of seasonal malaria interventions
        i. Exercise: Climate Suitability for Malaria Transmission (CSMT)
    d. Tool for Assessing Climate as a Compounder in Malaria Impact Assessment
        i. Exercise: Weighted Anomaly Standardized Precipitation (WASP)
    e. Tool for understanding local impact of ENSO on historical rainfall and temperature
        i. Exercise: ENSO Probability – Rainfall
        ii. Exercise: ENSO Probability – Temperature
(v) Test and provide feedback for the Proxy Surveillance Malaria Suite for the elimination sites in Ethiopia

Expected Outcomes:

This workshop was expected to provide a unique opportunity for improving climate information access and use for malaria and other climate-sensitive health issues.

Specific expected outcomes of the workshop included:

- Knowledge shared on current challenges and opportunities for using climate information in health decision making
- Details of the impact of El Niño on malaria in Ethiopia established
- Public health policy makers and practitioners trained in the use of ENACTS climate products
- Recommendations for new Health Maprooms
- Recommendations for Proxy Surveillance Malaria Suite
- Assessment of training activities via verbal response and online survey
- Workshop report detailing
    - Participant experience in the use and relevance of climate information (e.g. ENACTS data, etc)
    - Summary of recommendations for future research and policy engagement.

Organization and Sponsorship

The four-day workshop was hosted by Addis Continental Public Institute of Health (ACIPH) and convened by both the Ethiopian Public Health Institute (EPHI) and ACIPH

with funding and technical support from the Department of International Development (DFID)'s Weather and Climate Information Services for Africa (WISER) initiative, the International Research Institute for Climate and Society (IRI), the Ethiopia Ministry of Health, and the National Meteorological Agency of Ethiopia (NMA).

Outcomes and Recommendations

Following presentations, technical hands-on trainings and open discussions, participants were asked to generate public recommendations for ENACTS within health operations, education and research. Included here are the consensus recommendations and feedback of the participants at the workshop:

	This Year (2016-17)	Next 3 years
Operations	• Establish National Meteorology Agency (NMA) and FMOH as a responsible body • Establish a technical working group. • Disseminate workshop information and recommendations • Allow access to data (10x10 km grid) for all Ethiopian districts • Improve NMA infrastructure • Develop prediction models (e.g. rainfall forecasting for predicting malaria and for planning interventions like flood forecast) • Enable NMA forecasts to link to Maproom • Refine forecasting information sent to FMOH so that it is more specific • Enable better and more varied season selection • Expand the Maproom development to the water sector to enable analysis around the river basins • Build an Agricultural map room with the daily data • Update rainfall and climatology to 2014 and rainfall monitoring data for every 10 days • Update the CSMT Maprooms country map to fill in gaps	• Incorporate analogue years within the Climate Monitoring Maproom in order to show ENSO impact • Promote awareness and education on the availability of the climate data. • Train health workers • Use the Media to promote climate data knowledge and its importance to the public • Strengthen the entomological surveillance system and build the capacity of the existing health workers • Support the utilization of climate information at all levels (even those smaller than districts) • Incorporate environmental management using irrigation data and climate data for malaria • Provide training of trainers (TOT) - cascading of training • When issuing health bulletin, use climate information to show it is an important influence but not the only one. (close the gap of meteorology and epidemiology)

Education	• Incorporate ENACTS into public health university curriculum at undergraduate, graduate and PhD levels • Provide training of trainers (TOT) - cascading of training • Provide short-term training on ENACTS for faculty • Develop certificate programme for ENACTS	• Advocate for intensive training on ENACTS for policy makers • Provide cascading training as outreach program at regional, zonal, districts level • Allow PhD candidates the opportunity to develop Maprooms on climate and heath as dissertation project
Research	• Hire consultants to provide assessments on knowledge, attitude and practice for climate information for climate sensitive diseases at national, regional, and district levels • Assess 2015/16 El Niño impact on climate sensitive diseases	• Assess the associations of malaria prevalence/incidence and vector dynamics in relation to climate variables in sentinel sites • Assess the associations of prevalence of malnutrition in relation to climate variables in hot spot areas • Assess the associations of prevalence of emerging and re-emerging diseases (yellow fever, Dengue, etc.) with climate variables in hot spot areas • Undertake inter -sectorial collaborative research on impact of climate on health, flooding, drought, and food security • Strengthen the national climate and health database

Conclusion

The workshop was well attended with knowledgeable and enthusiastic participants. It achieved its objectives in terms of updating the Ethiopian Health community on the impact of ENSO on malaria, and furthering the development of ENACTS in Ethiopia as a means to improve climate sensitive policy and practice in the health sector. The presence of individuals representing FMoH, NMA, researchers, university staff involved in curriculum development, international partners and local Non-Governmental Organizations provided the opportunity for a rich discussion going forward.

The recommendations provided for developing ENACTS as an opportunity for health-operations, -education and -research had the buy-in of the relevant stakeholders and were considered to be both needed and practical. The review of the Malaria Elimination Climate Surveillance Suite was insightful. The resource was identified as valuable but still highly technical and in need of refinement before being shared more widely with

local decision-makers. The NMA also had some concerns regaring the dissemination of actual data (e.g. annual totals or averages of climate variables).

Overall, the organizers were delighted with the level of active engagement by participants in the workshop and the detailed recommendations provided for next steps.

Opening Session

Day 1:

Monday, October 24, 2016 9:00 am -10:40 am

Chair of Morning: Adugna Woyessa, EPHI
Rapporteur of Morning: Ashenafi Assefa, EPHI

Opening Remarks

Figure 1: Opening remarks given by (L-R) Madeleine Thomson (IRI), Fetene Teshome (NMA), Amha Kebede (EPHI), and Hiwot Solomon (FMoH/NMCP). Adugna Woyessa (EPHI) is providing introductions.

Fetene Teshome, Director General, NMA

Dr. Amha Kebede, Director General of Ethiopian Public Health Institute,
Mrs. Madeleine Thomson, Senior Research Scientist IRI,
Mrs. Hiwot Solomon, Federal Ministry of Health/National Malaria Control Programme,
Distinguished Health sector representatives,
Ladies and Gentlemen,

I am really glad to make opening remark in this important Health and Climate workshop. As you all are aware, Ethiopia is one of the most climate resource dependent countries

of the world. Every socio-economic sector of the country depends on weather and climate. For instance, high yields are common during wet Kiremt season whereas very low harvest is observed during dry Kiremt. The same is true for the shorter rainy season which is locally called 'Belg'. Obviously, other sectors like water resources, health, transportation and many other sectors are sensitive for weather and climate shocks.

Understanding and characterizing the extent of the impacts of climate variability as well as climate change on socio-economic sectors is vital for proper management of shocks and stresses on the socio-economic sectors. To this end meteorological and sectoral data are key for attribution purposes.

Dr. Amha Kebede
Mrs. Madeleine Thomson
Mrs. Hiwot Solomon
Ladies and Gentlemen,

The National Meteorological Agency of Ethiopia, as the sole authoritative institution for meteorological issues in Ethiopia has evolved from department level to Agency due to the importance of meteorological data and services to the various socio-economic sectors. Meteorological observations started in Ethiopia by missionaries in early 19th Century. The importance of the service for the aviation sector laid the foundation stone for establishment of meteorological services in organized way at department level in the civil aviation. The growing demand and awareness about meteorology lead to the establishment of autonomous agency in 1980 that provides meteorological services in Ethiopia.

The agriculture sector which is the backbone of Ethiopia's economy has been the major socio-economic sector which has benefited from NMA's services followed by the water sector and health sector. The services rendered to the aviation sector are also significant as there is no flight without meteorological information.

Dr. Amha Kebede
Mrs. Madeleine Thomson
Mrs. Hiwot Solomon
Ladies and Gentlemen,

Climate sensitive health issues exist all over the world. Some parasites flourish when optimal climate conditions exist. Some vector borne diseases prevail when the vectors flourish under optimal climate conditions. Understanding the optimal climate conditions which create favorable conditions for the climate sensitive diseases is crucial to take appropriate management practices to minimize the number of affected people.

To this end, the National Meteorological Agency has established meteorological observation network all over the country. The data collected from more than 1200 conventional and 147 automatic weather stations are analyzed at various time scales to

provide daily, ten daily, monthly and seasonal forecasts. However, the number of stations we have at the moment and their distribution are not fare enough to represent the country. Therefore, NMA supplements the gaps with various proxy weather information sources. One of the proxy weather and climate information source is weather satellite. Rainfall estimates from meteorological satellites both geostationary and polar orbiting depend on the temperature reading at the top of the cloud. This temperature is converted using mathematical algorithm to rainfall amount and cross referenced with the ground truth using station rainfall data.

This rainfall estimate provides very important information for areas which are not represented by ground station. The National Meteorological Agency in collaboration with the International Research Institute has established blended rainfall and temperature data base which can be used as alternative for the station temperature and rainfall database which exists at NMA through Enhancing National Climate Services, ENACTS, initiative. This gridded database with 10km resolution for the moment can be used to generate climatology and climate monitoring purposes. Currently, NMA and IRI are collaborating to increase time and spatial resolution of the database and I hope this data will be available in the near future.

Dr. Amha Kebede
Mrs. Madeleine Thomson
Mrs. Hiwot Solomon
Ladies and Gentlemen,

NMA believes that this huge resource is nothing if the user community is not using the available data and products and the respective sectors use the information and advise decision makers and enable them to make informed decisions. NMA and IRI have made analysis of meteorological data easy and at fingertip. NMA's digital Maproom which was developed in collaboration with IRI is a useful tool for climate monitoring. This online information can be used to generate information in the form of maps and graphs which can easily be used in various sectors. For instance, this database and tool can be used to identify areas which are affected by El Niño and La Nina phenomenon. We have used the information from this database to advice the government and the government was able to avert the impacts of the devastating drought which was caused by one of the strongest El Niño 2015/16. NMA and IRI are also working to develop sector specific tools which make life easier for the users. We have started this development with the health sector specifically for malaria and continue developing tools for other climate sensitive diseases and other sectors like the agriculture and water resources.

Dr. Amha Kebede
Mrs. Madeleine Thomson
Mrs. Hiwot Solomon
Ladies and Gentlemen,

I am confident that this web based tool which will be introduced to the health sector in this workshop will provide very important information that will help management of malaria outbreaks. I would like to take this opportunity to urge the health sector to use this web based tool and collaborate with NMA and IRI in the future development tools for other climate sensitive diseases.

Finally, I would like to thank IRI, Ethiopian Public Health Institute and NMA staffs for the wonderful collaboration to make this tool available. I also thank Department for International Development, DFiD, for their financial support.

I wish you fruitful deliberations.
I thank you!!!

Hiwot Solomon, NMCP

Dear Dr. Amha Kebede, Director General of EPHI,
Distinguished Guests,
Dear Organizers,
Ladies and Gentlemen,

First of all, I would like to express my utmost delight to make an opening remark on this important session, which deliberates on health and climate. I also would like to sincerely welcome all participants to this workshop. May I take this opportunity too to thank the Ethiopian Public Health Institute and other institutions for organizing such an important event.

As you might know, climate and health are so much interrelated; climate impacts on health of population and plays a very important role in transmission of diseases in general. Particularly climatic anomalies have detrimental effects on malaria transmission, especially in highland, highland fringe and semi-arid areas. Until recently, Ethiopia used to experience major malaria epidemics due to the global warming or climatic changes in most parts of the country. Areas which had no experience of malaria became malarious and also affected by devastating epidemics. The severe epidemics that cross our minds include the one that occurred in 1958, which reported to claim lives of 150,000 people; and the epidemics of 1998, which caused a devastating effects especially in West Shoa of Oromia region and West Gojjam of Amhara region. The most recent national scale epidemic was reported in 2003-2004.

The Ministry of Health of Ethiopia by recognizing the need to have quality climate information has started collaboration with the National Meteorological Agency since 2002 and supported the Agency financially to upgrade its weather stations. Accordingly, some weather stations have been upgraded and climate information sharing have been put in a place and still information sharing is going on.

However, the information that is being shared with the Ministry, though useful to issue alert to lower levels, does not have detailed data on average daily temperature, relative humidity and rainfall. I believe if these data are made available by woreda level, the Ministry would be in a better position to forecast and issue early warning regarding any anticipated unusual increase in malaria cases. This could be done by triangulating climate information with other epidemiological data, such distribution and density of malaria vectors and actual malaria cases reported. Having such temporal and spatial data by woreda is very crucial in our setting due to existence of extreme variability in malaria transmission dynamics throughout the country.

As indicated in the workshop's background creation and dissemination of Enhanced National Climate Services could address the existing gap in generating quality and relevant data. It is to be noted that the workshop is very relevant and timely to Ethiopia's context as the country has recently experienced El Niño and the La Lina effect might continue for sometimes. Additionally, the country is going to launch a subnational malaria elimination endeavor very soon, which in turn calls for having temporal and spatial climate data and information.

Thus, I hope, the meeting outputs of this workshop will indicate ways how to generate quality information and maximize use of climate data in the fight against malaria in Ethiopia.

Lastly, may I call up on all to join hands in ending malaria from Ethiopia.
Wish you pleasant time in Addis and productive deliberations.

I thank you.

Madeleine Thomson, IRI

Good Morning
Dear colleagues, Old and New

I am delighted to be back in Addis with my colleagues from the International Research Institute for Climate and Society at Columbia University. They are Aisha Owusu, John Del Corral and Adugna Woyessa from EPHI who is an Adjunct research scientist at our institute. I am grateful for the presence of Mrs. Hiwot Solomon, Team leader, National Malaria Control Programme, FMoH, the Director of the Ethiopian Public Health Institute, Dr. Amha Kebede and the Director of the National Meteorological Agency Mr. Fetene Teshome at our opening ceremony who have taken time out of their busy schedules to participate in this meeting and encourage us in our work. I am particular happy to be able to discuss climate and health issues with such knowledgeable colleagues, old friends and new

As many of you are aware, IRI has been working for over a decade in the area of climate and health with a particular focus on Africa and special attention to Ethiopia. Our

strong focus on Ethiopia was through the establishment of the Google project in 2008 and the "Climate and Health Working Group" chaired by the MoH and NMA and facilitated by the Anti-Malaria Association under the leadership of Mr Abere Mihrete. In many ways the Google project has underpinned all our subsequent work, both here in Ethiopia and in a number of other African countries. Key deliverables from this engagement include a strong working platform in Ethiopia involving climate and health specialists, clear guidance from the MoH for new products and services from the National Meteorological Agency, increased expertise at the National level which is now supporting activities across the country and – the development of quality climate information.

IRI is a boundary institute spanning climate science and sectoral decision-making and we are proud of our many long standing partnerships here in Ethiopia and elsewhere. As a WHO Collaborating Center for Malaria Early Warning and Other Climate Sensitive Diseases we work with a wide range of health stakeholders across a range of activities – from research, demonstration, education and training, advocacy and service. As a climate science institute we have long standing partnerships with National Meteorological Agencies, regional climate centers and the World Meteorological Organization. We are delighted to continue working with the Ethiopian Public Health Institute and Addis Continental Institute of Public Health to deliver this workshop. We are also indebted to many IRI colleagues who have supported the development of the partnerships, science, technology and materials we will be using in this workshop, including Tufa Dinku who currently works at the IRI but started his career as a meteorologist working at the National Meteorological Agency, here in Addis Ababa.

We are of thankful for the financial from the UKs Department for International Development who are funding this workshop through the WISER programme. This progrmme aims to improve the quality of weather and climate information and support its uptake and use in East Africa.

The motivation behind this workshop is, in part, as a follow-up, to a meeting we had here in Addis in April 2014, which resulted in key recommendations to better understand the impact of El Niño (and La Nina) on malaria epidemics across the country. With the 2015/16 El Niño recently over, the time is ripe to review what, if anything happened. It also provides an opportunity to share experience in the use of climate information in health research and decision-making in Ethiopia and to better understand the data, methodologies and tools currently available. We consider that there are a number of opportunities for using climate information to improve health outcomes. People often think that climate might be useful in the development of early warning systems for climate sensitive diseases but we consider this to be one of many opportunities. Others include:

- *improving understanding of the mechanisms of climates impact on transmission and disease*
- *estimating populations at risk (risk mapping)*
- *estimating seasonality of disease and timing of interventions*

- *monitoring and predicting year-to-year variations (and extremes) in incidence (including early warning systems)*
- *monitoring and predicting longer term trends(climate shifts and change assessments)*
- *improving assessment of the impact of interventions (by accounting for climate in analysis)*
- *we hope you will identify other opportunities as we go through this workshop.*

Use of climate information in decision-making is very dependent on the right data at the right time for the right spatial and temporal scale. I won't bore you with the details but experience tells us that the use of poor quality information can give misleading results and encourage inappropriate responses.

In a country such as Ethiopia, where the climate is exceedingly complex there are non-trivial challenges to creating quality climate information with national coverage and local relevance over such a large and varied country. It is no surprise then that it is here in Ethiopia that a significant development in climate services for the health sector (and other sectors) in Africa has been developed and implemented. Called the Enhanced National Climate Services programme (ENACTS) the initiative seeks to make relevant quality climate data available, accessible, useful and most importantly, used. The major advantage of ENACTS is that the products and services developed are not only nationally owned but include the national archived and monitoring data of the national meteorological services which are then blended with the most appropriate globally climate products (either satellite or modelled data). These new rainfall and temperature data bases are more accurate that global products which only include a fraction of the observed data and therefore can't resolve the information at the spatial scales needed – i.e. the Woreda level.

Having relevant quality assured data at the right temporal and spatial scale and appropriate tools for analysis are only part of the solution. An engaged health community with the skills to use the data is key to improving climate sensitive health outcomes such as malaria, leishmaniosis, meningococcal meningitis, acute watery diarrhea and malnutrition. I speak for the whole IRI team when I say we are thrilled to be working with you all over the next few days and expect that we shall all learn from each other and have a highly productive time.

Thank you in advance for your insights, energy and contributions.

Amha Kebede, Director General, EPHI

Good morning!
Dear delegates of various institutions and workshop participants,

The Ethiopian Public Health Institute has the responsibility to generating quality evidence on priority public health issues to help informed decision, ensuring health care

quality through improving laboratory capacity and managing public health emergency issues. Additionally, engaged in refresher and postgraduate training of public health professionals in key areas of major demand from the health system.

Many of the health issues that EPHI is concerned with, epidemic diseases including vector borne diseases (such as malaria, dengue, and Leishmaniasis), water borne diseases (such as acute watery diarrhea) and airborne diseases (such as meningococcal meningitis) are highly sensitive to climatic variations. In addition, good nutrition, the basis of good health, is also highly sensitive to climate related variations in nutritional status, whether as a result of seasonal food shortages or drought related food insecurity.

Thus climate is at the heart of much of what we do at EPHI and yet we still struggle to incorporate climate into our everyday activities. In 2008 EPHI, working with other Ethiopian partners and the International Research Institute for Climate and Society involved in Climate and Health Working Group to address gaps in the use of climate information for public health decision.

What we have learned through many different engagements linking climate and health is that climate information can be a valuable additional resource for use in a health surveillance system. For example, incorporating climate information in surveillance of malaria especially in areas at epidemic risk appears helpful in achieving malaria elimination. Malaria elimination is considered not only part of the country's development plan and but also commitment of African Leaders to be achieved in the upcoming two decades.

However, the complexity of the Ethiopian climate is such that it is difficult to use climate information unless it is more specific to local level like district.

This collaborative initiative has led to many things including the development of a new, high quality climate data made available at NMA which we will have the opportunity to learn about in the next few days.

EPHI is responsible in surveillance of climate sensitive diseases like malaria, yellow fever, dengue fever and others. Thus, in the last decade the Institute developed a dataset of those diseases that helped the Federal Ministry of Health to take action and design and interventions including for emerging and re-emerging ones. Cognizant of the importance of climate information various efforts have been underway. For instance, organizing training of health professionals is worth noting. EPHI has been instrumental in creating link with IRI and local institutions in this regard. On the one hand, recently, vulnerability assessment was under taken from the government of Ethiopia to guide in developing national adaptation plan. On the other hand, there is still a demand from the ministry to conduct similar assessment at local like district level or lower level. This is believed to have better understanding of local determinants and design preparedness plan and targeted solutions. This calls for creating adequate and qualified human resource capacity as well as collaboration with advanced institutions. Briefly,

understanding of short and long term climate variability is critically important to use climate information for health planning.

It is also worth noting that a previous similar workshop entitled as "Climate Variability and Change: Implications for Malaria Control and Elimination in Africa - 2014" conducted here in Addis Ababa recommended:

- *emphasizing the need to understand impacts of climate variability and El Niño,*
- *need for invested efforts in climate sensitive health decisions and leveraging the use of climate information and data, and*
- *partnership with the IRI*

In Africa, in general, and in Ethiopia, in particular, climate is an important driver of variations in malaria transmission in highland and semi-arid areas. Because of this, the Ethiopian health community has long expressed the need for quality-assured and locally relevant climate information as part of their surveillance activities (Ghebreyesus et al., 2008). Yet, little attention has been paid to the systematic incorporation of climate information into malaria intervention programming. This has in part been due to the non-trivial challenges of accessing quality climate information with national coverage and local relevance over such a large and complex country.

This challenge is overcome by the creation and dissemination of Enhanced National Climate Services (ENACTS) climate products. The ENACTS initiative emerged in Ethiopia in direct response to perceived user needs. This initiative seeks to improve climate data availability, access, and use by national decision makers. It combines rigorously evaluated station data from a country's entire national meteorological agency's archive and operational system with globally available satellite and climate model reanalysis products. The resultant primary and derived products are then disseminated via a web enabled platform or 'Maproom' housed on the meteorological agency's website or through direct transfer. This unprecedented capability enables national meteorological agencies to provide quality-assessed and spatially and temporally complete data services which can out-compete traditional global products.

As the Ethiopian National Malaria Control Programme advances its strategy for malaria elimination, the demand to incorporate climate variables into the malaria surveillance system is increasing. The resources created through the ENACTS initiative have multiple applications for malaria. In addition, public health policy makers, practitioners and researchers can use them to explore the relationship of climate and other vector-borne diseases as well as other climate-sensitive health outcomes.

I believe this workshop will be instrumental to familiarize ourselves with NMA tools and areas of application. We have to use this opportunity to generate ideas and recommendations in using both health and climate data to well inform decision making process.

I would like to thank workshop participants especially IRI staffs who travelled long distance to share their expertise and mobilizing resources. Let me take this opportunity to thank Addis Continental Institute of Public Health for hosting this training workshop. I thank the participants gathered from various institutions. It is my expectation that this training will help us to put our concerted efforts in unraveling more information to support decision.

My appreciation also goes to all involved in designing and this workshop. Finally, I would like to assure you that EPHI in collaboration with FMOH will put your recommendations into action and continue its partnership in capacity building of health professionals.

Now I would like to declare this workshop is officially opened and wish you a nice stay in Addis as well as a successful deliberation.

Background

Title: **Review of El Niño and Malaria 2014/16 and El Niño Policy Brief (follow-on from Climate Variability and Change: Implications for Malaria Control and Elimination in Africa - 2014)**
Speaker: Adugna Woyessa, EPHI

In Ethiopia, weather variability is a key driving force for malaria transmission (Siraj et al. 2014; Midekisa et al. 2015). Strong evidence that anomalies in both rainfall & temp. are precipitating factors for malaria epidemics (Abeku et al., 2003). MC&E program in Ethiopia is both a public health & national development priority (MOH, 2014). Surveillance plays an increasing role in guiding malaria prevention, control and elimination (Jima et al. 2012) as well as assessing the impact of interventions (Aregawi et al. 2014). Malaria transmission varies & depends on local climatic and environmental conditions and detailed knowledge about each locality as well as global drivers and needed for designing better & more focused interventions.

During the April 2014 National Institute of Health (NIH) funded research capacity building workshop in Addis Ababa, Ethiopia, entitled "Climate Variability and Change: Implications for Malaria Control and Elimination in Africa," the malaria community & the MOH of Ethiopia became aware of the potential emergence of El Niño conditions (Platzer et al. 2014) and considered the possible risk to the observed declines in malaria case numbers (Aregawi et al. 2014). Recommendations also emerged centered around research, education and training, awareness and advocacy, services, and data.

ENSO Phase	Total Years	Widespread Epidemic Years	Local Epidemic Years	No Spatial Info Provided
El Niño Phase* (El Niño + Neutral/El Niño)	29	9	2	1
La Niña Phase (La Niña + Neutral/La Niña)	16	2	4	0
Neutral Phase	8	2	4	0
Combined ENSO (El Niño/Neutral/La Niña)	12	2	1	0

Figure 2: Total Years of ENSO and Widespread/Local Epidemics with Corresponding ENSO Phase (1951-2015)

Following the research recommendation, historical analysis was undertaken to analyze the impact of El Niño on malaria in Ethiopia – 1950-2015. The study, in conjunction with the Ethiopian Public Health Institute (EPHI), the Ethiopian National Meteorological Agency (NMA) and the International Research Institute for Climate and Society (IRI),

evaluated the premise that Ethiopian malaria epidemics/outbreaks are associated with ENSO and potentially predictable. It also provided a detailed analysis of the spatial and temporal impact of ENSO on temperature and rainfall for the periods of 1981-2014 and 1983-2014, respectively, was undertaken using high resolution climate data made available through the Enhancing National Climate Services (ENACTS) initiative implemented at the Ethiopian National Meteorological Agency. The relationship of historical malaria epidemics in Ethiopia documented between 1953 and 2010 to ENSO events. Thus, it was concluded that epidemics may occur during any ENSO state, widespread epidemics appear to be more common during El Niño phases. Also while local epidemics are more frequently identified with La Niña or Neutral periods. However, inconsistencies in epidemic reporting make it impossible to quantity the precise relationship. And still, not all malaria epidemics were preceded by ENSO events.

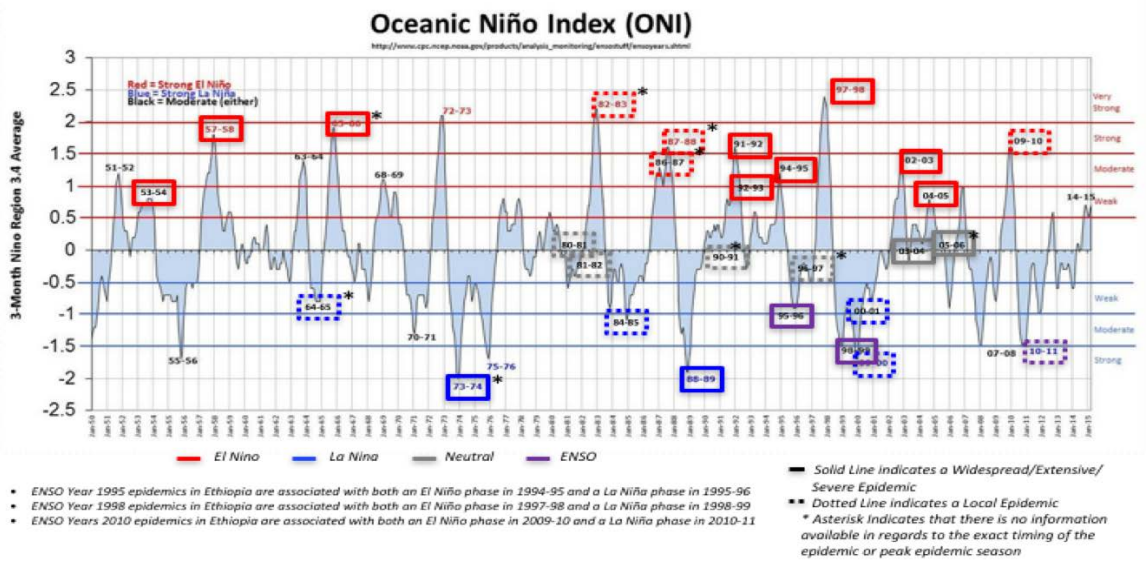


Figure 3: The relationship of ENSO and malaria epidemics between 1951 and 2011 in Ethiopia

Additionally, from the awareness and advocacy recommendation, a 2015 El Niño Policy Brief for Ethiopia was developed for the FMoH, EPHI, and NMCP with clear language on climate and impact uncertainties, opportunities and threats (refer to Appendix 4).

Title: **Current status of Malaria Control and Elimination in Ethiopia**
Speaker: Hiwot Solomon, NMCP
Key Messages:

- Malaria occurrence affected by **altitude** and **temperature**
- Malaria transmission in Ethiopia occurs up to 2,000m but it rarely occurs up to 2,400m elevation
- 3/4th of the geographic area, 60% population
- PV and PF are causes of almost all infections
- Strategic Objectives:

    - By 2020, all households living in malaria endemic areas will have the knowledge, attitudes and practice towards malaria prevention and control.
    - By 2017 and beyond, 100% of suspected malaria cases are diagnosed using RDTs or microscopy within 24 hours of fever onset.
    - By 2015 and beyond, 100% of confirmed malaria cases are treated according to the national guidelines.
    - By 2015 and beyond, ensure and maintain universal access of the population at risk to at least one type of globally recommended anti-vector intervention
    - By 2020, achieve and sustain zero indigenous transmission of malaria in 50 selected districts.
    - By 2020, 100% complete data and evidence will be generated at all levels within designated time periods to facilitate appropriate decision making
- Gaps and Challenges:
    - Occurrence of climatic changes/anomalies;
    - El Niño and La Lina
    - Lack of complete and relevant climate information, such woreda level temperature, rainfall and relative humidity data for early warning;
    - Lack of capacity to analyze and provide regular feedback on correlation of climate data with malaria incidence.
    - Inadequate research activities that guide policy and interventions
- Way Forward:
    - Creation of better understanding of currently available climate information;
    - Strengthen capacity for interpretation and use of climate data for malaria forecasting;
    - Strengthen partnership of health and climate stakeholders;

Summary of Sessions on Climate/Climate variability and Climate-Sensitive Diseases in Ethiopia

Day 1: Session 1 - Recent Analyses/Activities/Endeavors

11:15-12:00
Chair of Morning: Adugna Woyessa, EPHI
Rapporteur of Morning: Ashenafi Assefa, EPHI

Title: **Climate and Child Nutrition**
Speaker: Seifu Hagos, Addis Ababa University
Key Messages:

- Children are more susceptible
- Children have less effective heat adaptation capacity than do adults
- Higher exposures per unit body weight
- Exposures during utero and early childhood can cause devastating damage in adult life
- Newly developing or worsening environmental hazards in the future

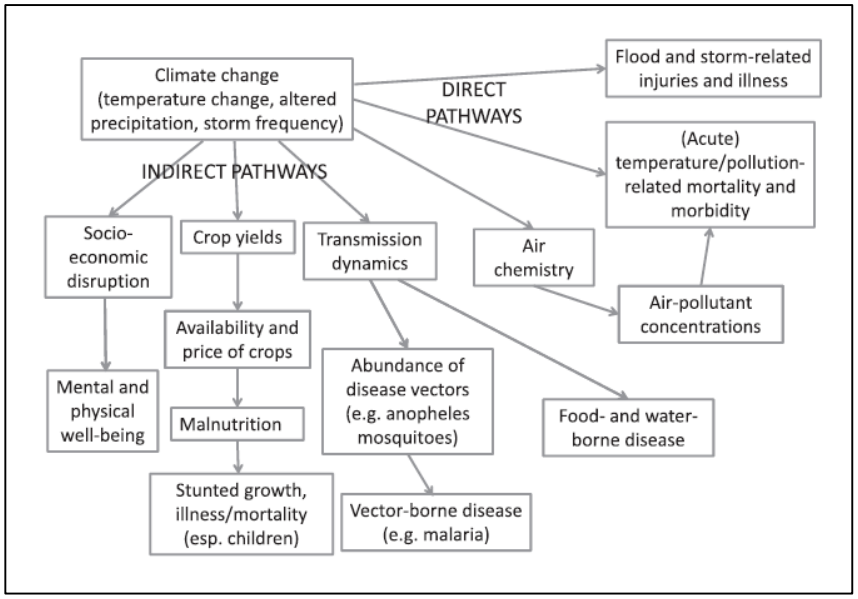


Figure 4: Climate and Child Nutrition Pathwork Framework, Conceptional and Statistical Driven Modeling (Epidemiology, Volume 23, Number 6, Nov 2012)

- Climate change nutrition epidemiology – Challenges
  - Complex climate-health/nutrition relationships
  - Multifactorial sources and pathways that contribute to changes
  - Dynamic and complex interactions between factors
- Key Challenges:
  - **Scale of analysis**

    - Climate impacts on populations rather than individuals
    - Differences in exposure among individuals
    - Spatial (local, national, global) and temporal (season, year) scales
    - Defining the appropriate spatial scales for investigating climate–health/nutrition relationships
- **Complexities: nonlinearity and agroecology**
    - Exposure-response relationships often do not follow linear trends
    - Complex nonlinear relationships might exist
    - Relationships could vary within and between areas
- **Absence of longitudinal data**
    - Incorporating surveillance in the Ethiopian DSS

Title: **PHEM System in regard to Climate Sensitive Health Issues**
Speaker: Emana Alemu, PHEM
Key Messages:

- PHEM Objective: To prepare for, detect early, and contain epidemics locally ; respond timely to other public health emergencies and recover quickly from their impacts.
- Specific Objectives:
    - To set a robust early warning system
    - To create fast and dependable information exchange capacity at all levels
    - To detect emergencies on a timely basis
    - To build capacity at all levels

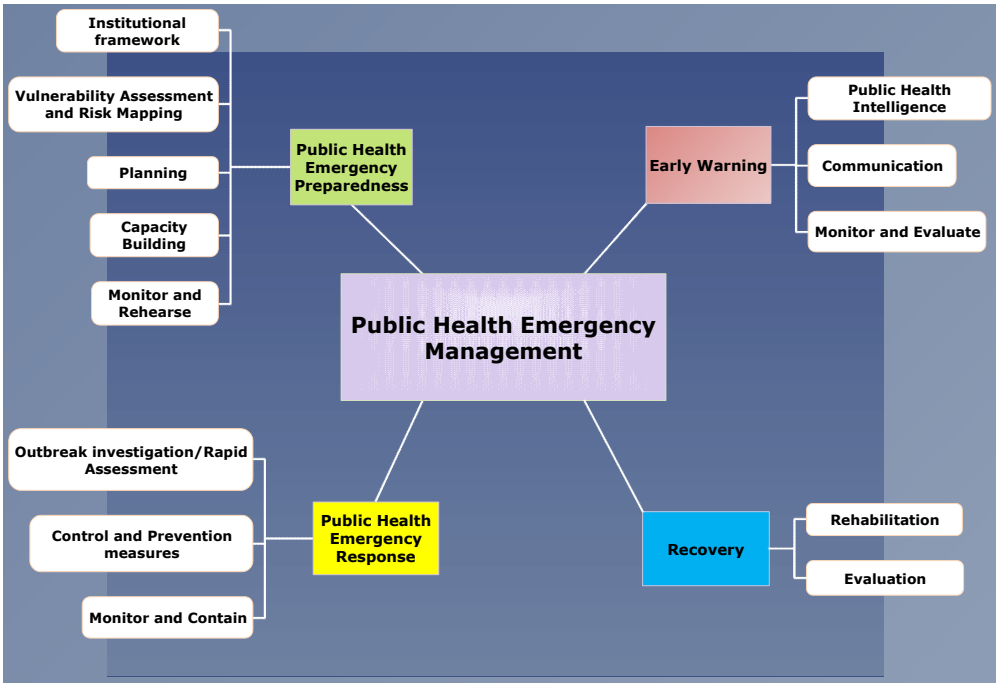


Figure 5: PHEM Emergency Management Structure

Title: **Climate Change, Nutrition, and Gender**
Speaker: Tesfaye Hailu, EPHI, Nutrition and Food Science Department
Key Messages:

- Women are particularly vulnerable to climate change because they are more prone to the adverse impacts from climate change.
- Their limited adaptive capacities arise from prevailing social inequalities and ascribed social and economic roles that manifest itself in differences in
    - property rights,
    - access to information,
    - lack of employment and
    - unequal access to resources.

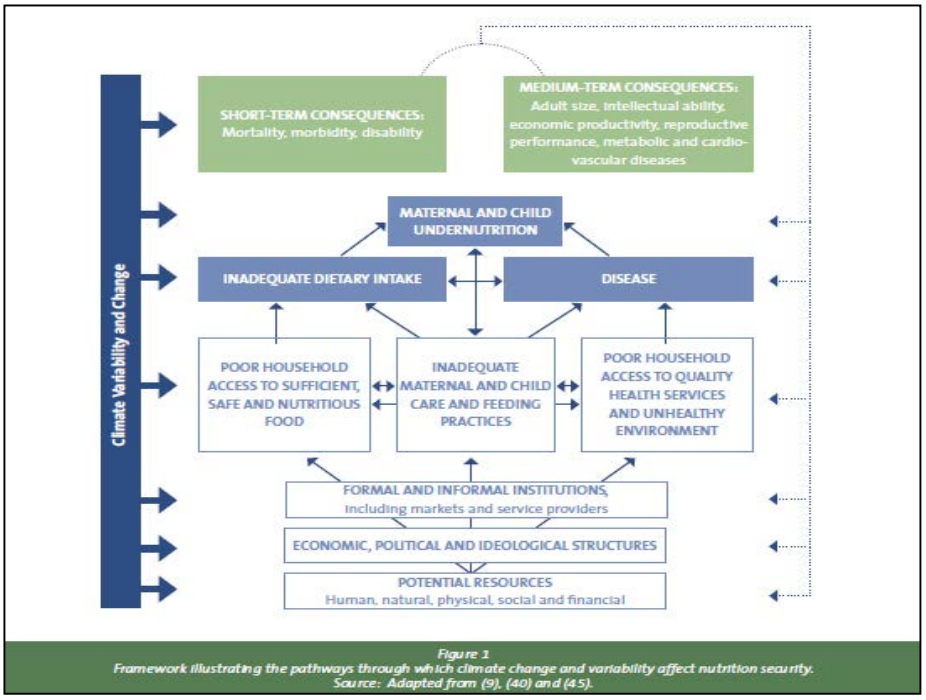


Figure 6: Framework illustrating the pathways through which climate change and vulnerability affect nutrition security.

- It's possible to link nutrition and climate change adaptation with gender perspective with the existing work.
- There are projects and programs currently existing in the country.
- Platform to learn from each other and share finding for better linkage and implementation of nutrition and climate change
- Working on policy brief will be very important to have a policy direction in different sector on linkage
- It's good to have national research agenda on linking nutrition and other health issue with gender and climate change adaptation

Title: **Ten Year Trend Analysis of Malaria Prevalence and Its Correlations w/ Climatic Variables in Sibu Sire District, West Ethiopia (2004-13)**
Speaker: Abdi Samuel, Wollega University

Malaria is one of the most devastating diseases in the World and caused by a protozoan parasite of the genus Plasmodium. The species of Plasmodium falciparum and Plasmodium vivax are the two predominant malaria parasites, distributed all over Ethiopia and accounting for 60% and 40% of malaria cases, respectively. The disease remains one of the most important causes of human morbidity and mortality with enormous medical, economic and emotional impact in the world, and in most African countries including Ethiopia.

The complexity of the disease control process, expensiveness of the control program, resistance of the parasite to anti-malarial drugs and vectors to insecticides are some of the challenges. Therefore, the study was initiated to analyses the ten-year trend analysis of malaria prevalence and its association with climatic variables also determine the level of correlation between meteorological variables and malaria in the Sibu Sire district, Western Ethiopia. These districts were found in East Wollega Zone Oromia Regional State of Western Ethiopia. Ten-year malaria clinical and epidemiological data were collected from health facilities and climatic variables data from Ethiopian Meteorological agency. The data were analyzed using SPSS software package 16.0. During last ten years (2004-2013), a fluctuating trend of malaria transmission was observed with *P.falciparum* becoming predominant species. Pearson's correlation analysis was conducted to see the correlation between plasmodium species and climatic variables the result showed that maximum temperature, mean temperature and average relative humidity showed significant association with malaria ($p < 0.01$). But minimum temperature ($P=0.094$) and rainfall ($P=0.729$), these were not significant. Also, regression analysis suggested that minimum temperature, rainfall, and average relative humidity ($P<0.001$) were statistically significant but the mean temperature ($P=0.706$) was insignificant. Within the last decade (2004–2013) a total of 30,070 blood films were examined for malaria in Sire health center and of this 6036 (20.07%) microscopically confirmed malaria cases were reported in the health center. In general, transmission of malaria is very complicated and detailed ecological and epidemiological studies are still needed to assess the true local risk.

Key Messages:

- General Objective: To assess ten year trends of malaria prevalence and its association with climatic variables in Sibu Sire district, Western Ethiopia
- Specific Objective: To determine the correlation between climatic variables and malaria in the past ten years in Sibu Sire district
- Results:
    - 6036 (20.07%) microscopically confirmed malaria cases were reported in the district

    - Malaria occurred in all months of the year with different fluctuation rate
    - The highest peak of malaria cases in almost all years was observed during the major malaria transmission seasons, with prevalence rate of (68.36%) and with prevalence rate of (31.64) in the other seasons
- Conclusions:
    - prevalence of malaria is highly reducing but it has a fluctuating trend
    - Since the metrological variables are affecting the trend of malaria in the study area a control and prevention strategies that takes the metrological variables in to consideration is important
    - It is also important to note that the may be the problem is associated with socio-economic factors including agricultural practices, water availability, urbanization and deforestation in finding out a specific cause in the malaria incidence and transmission
    - In general, detailed ecological and epidemiological studies are still needed to assess the true local risk

Open Q&A and Panel Discussions:

Participants gave their reactions to the presentations and posed questions to the panelists. Key questions and issues raised were:

Q1. Madeleine Thomson (IRI) to Emana Alemu (PHEM): What is the frequency of reporting from woredas in PHEM - monthly or weekly?
A1. Emana Alemu (PHEM): PHEM has different disease reporting mechanisms - daily, weekly, and monthly.

Q2. Delenasaw Yewhalaw (Jimma Univ) to Emana Alemu (PHEM): (1) Although it's good to have epidemiological data on dengue, are there any other data on vector bionomics particularly from the vector side? (2) Also, there was Yellow Fever outbreak in 1956 in Ethiopia. Are the 2013 epidemics in some areas of the 1st or last epidemics?
A2. Emana Alemu (PHEM): (1) For Dengue entomology, PHEM is working together with EPHI entomology unit and thus there is information on the entomology version of the disease. (2) Before 1956 there were no reports about Yellow Fever - the 2013 is the latest information.

Q3. Delenasaw Yewhalaw (Jimma Univ) to Abdi Samuel (Wollega University): Is there any variation on malaria on the three agro ecologic zones and explanation for any variation?
A3. Abdi Samuel (Wollega University): In the agro ecological zones and malaria. Three Agro ecological zones identified and 70% has a mid-land. Malaria case is high in the mid land may not be scientifically sound. The relation with El Niño and La Niña was not the interest of the study but may be good research question in the future

Q4. Matthew Murphy (CDC) to Abdi Samuel (Wollega University): Is there any statistical significance between the variability reported and any combined significance?

A4. Abdi Samuel (Wollega University): We have used for analysis, regression model… independent effect and combined effect of the explanatory variable is looked and 64% is explained by the model.

Q5. Teklehaimanot Gebrehiwot (Amhara RHB) to Emana Alemu (PHEM): Some regions need emergency response, and some do not. (1) What is the involvement of EPHI and PHEM on response? (2) Why are HMIS and PHEM data different? Do new plans include environment related issues like food and water borne diseases?
A5. Emana Alemu (PHEM): Malnutrition control and EPHI involvement is strong. During 2015/2016 drought command post is formed, led by the minster, we are part of that command post. The command post Prepare and respond to epidemics particularly for health issues. For each epidemic or issue task force is formed that work in collaboration with national team. (2) HMIS is monthly or quarterly report and PHEM has daily, weekly and monthly information may be the reason for the variation. The new PHEM structure will address emergency and response, it is developed based on the CDC Atlanta bench marking.

Q6. Teklehaimanot Gebrehiwot (Amhara RHB) to Abdi Samuel (Wollega University): Is surveillance and response in the same department at EPHI? Nutritional surveillance must go together with response in the national nutrition program. Surveillance without response is meaningless. We are doing the surveillance and we are not sure on the response…. Resources for acute nutrition and knowledge is required in our region (Amhara)
A6. Abdi Samuel (Wollega University): We need to look for the determinants in next research. There is variation on the kebele level malaria; the big malaria epidemics were seen in the midlands, and this was not as expected. If we need to see the effect on based on agro eco zones, we need to change our sampling. As most cases are observed in midlands 75%.

Q7. Asefaw Getachew (PATH/MACEPA) to Emana Alemu (PHEM): PHEM coordinates surveillance and response across Ethiopia. However, is there is a disconnection within a ministry itself? Also, what work is being done in malnutrition?
A7. Emana Alemu (PHEM): We are working with other directorate for the response, they use the data for their intervention. In malaria, we also work on response. For malnutrition, UNICEF and other partners are working together. But there is a plan for addressing response for malnutrition in collaboration with partners under the EPHI. PHEM emergency is still young the data for malnutrition was set for another sector like DRSS, but this does not give meaning. There is a need for data sharing and combining it with PHEM data for combined response.

Day 1: Session 2 - Review of Malaria Transmission from El Niño 2015/16 in Ethiopia

2:00-3:15
Chair and Moderator of Session 2: Mathew Murphy, PMI
Rapporteur of Afternoon: Maurine Ambani, CARE

Title: **What is ENSO? and the 2015/16 El Niño in Ethiopia**
Speaker: Henock Hailu, NMA
The presentation was prepared with a non-climate scientist audience in mind. Explanations were given on key climate phenomenon, El Niño Southern Oscillation (ENSO), and it's relation to rainfall in different parts of Ethiopia, especially during the Kiremt rainfall.
Key Messages:

- El Niño and La Nina do not affect the whole of Ethiopia in the same way
- Most of the droughts and famine that have occurred in Ethiopia over the years have been associated with El Niño conditions. However, it was emphasized that no two El Niño events are the same considering severity, spatial extent and impacts. For example, the 2015/16 El Niño caused severe drought, but the government was well prepared to avert negative impacts, with support from donors
- For areas that benefit from Kiremt rainfall, if El Niño persists, they will face unseasonal rainfall during Bega season

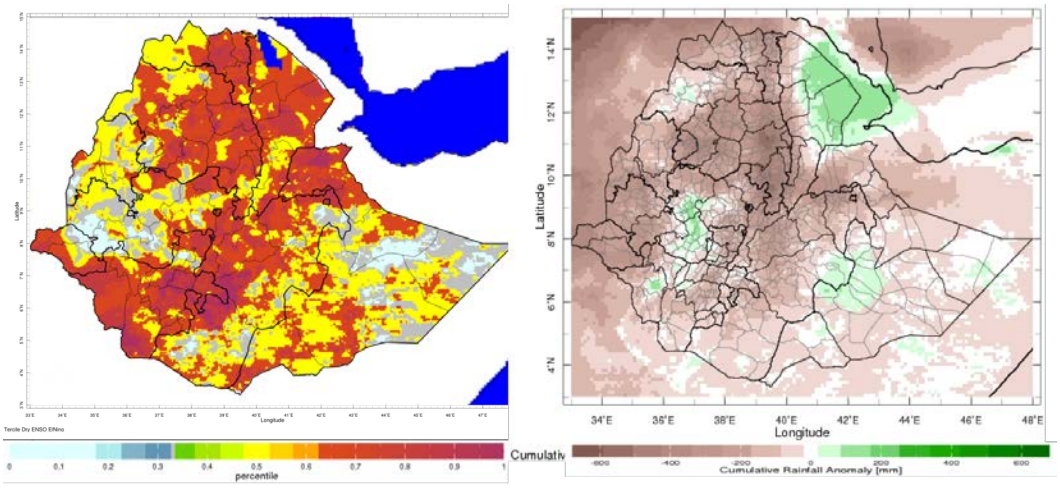


Figure 7: Left – Historical probability of seasonal monthly averages conditioned on El Niño in Ethiopia for low rainfall for July-September; Right – July-September Drought (From Climate Monitoring Rainfall Maproom)

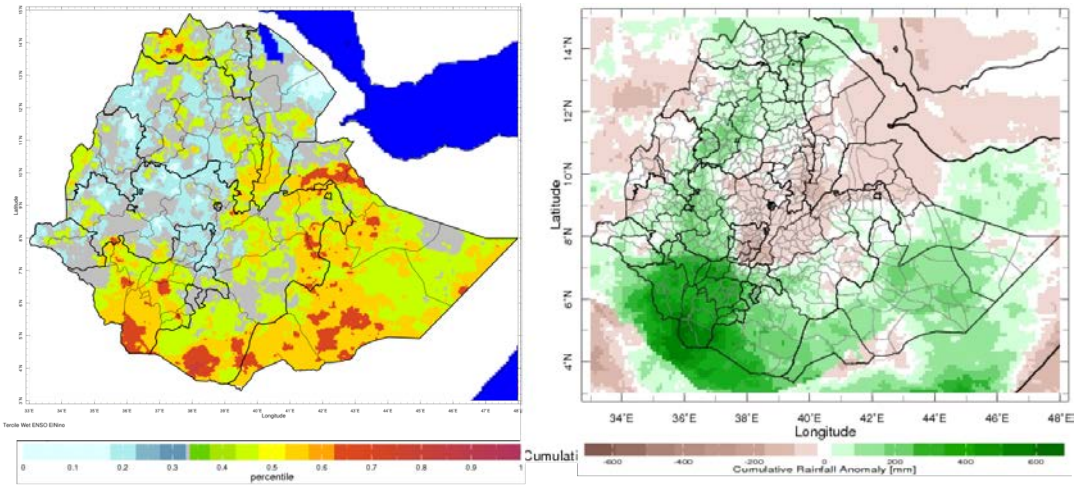


Figure 8: Left – Historical probability of seasonal monthly averages conditions on El Niño in Ethiopia for high rainfall October-December; Right – October – December 2015 unseasonal rainfall (From Climate Monitoring – Rainfall Maproom)

Title: **Current Malaria Situation in Tigray Region**
Speaker: Tsaedu Araya, Malaria Focal Person
Key Messages:

- There was an upsurge of malaria cases in 2008, and the trend between Jan 2013 and Sept 2016 showed an increase in malaria transmission

Title: **Current Malaria Situation in Amhara Region**
Speaker: Teklehaimanot Gebrehiwot, Malaria Focal Person
A hierarchy of reporting on malaria with feedback at the different levels was presented (see presentation). A shift in reporting was however experiences, so the presentation focused on 2005 to 2008.
Trends showed that:

- Malaria cases were decreasing over time while total OPD is increasing
- Positivity rate decreasing in some zones, but increasing in others. The rate was highest in the major transmission season
- There has been a 16% decrease in malaria transmission in the region, with 2 zones having zero malaria cases. A few districts have shown increase in malaria transmission

It was noted that all malaria indicators vary from season to season. Also, that some areas are corridors where transmission occurs due to interaction with infected people.
The decrease in malaria transmission in Amhara Region is attributed to more people visiting health facilities for treatment due to increased awareness, some districts started house to house home testing, alerts are given to zones and woredas at weekly and monthly timescales from malaria monitoring charts that are prepared in local language and a malaria health workers guide has been developed.

Title: **Current Malaria Situation in Oromia Region**
Speaker: Tufa Abdissa, Malaria Focal Person
Key Messages:

- The 30-year trend showed a small number of malaria cases treated, due to low capacity of health services. With increased expansion of health services, the number of malaria cases has decreased. The main strategy for malaria prevention in the region is environmental management, together with IRS and LLINs distributions.
- Malaria seasonality in the region showed: Minimum positivity rate of 15.5 occurs in Jan, which is very high during normal conditions in the month. July should have a lower positivity rate but the highest malaria cases where registered in 2015.
- From 2003, Ethiopia growth and development plan has improved clinical treatment of malaria and strengthened malaria prevention strategies and institutions has resulted in a decrease in malaria cases. More is still to be done on improving service delivery and strengthening collaborations.

Panel Discussion w/ Regional Presenters and Q&A:

Participants gave their reactions to the presentations and posed questions to the presenters/panelists. Key questions and issues raised were:

C1. Madeleine Thomson (IRI): There is need to put some of the malaria results on the map to see if they overlap with climate anomalies, highlighting areas with unusual decline in transmission to check if it corresponds with the climate.

Q1. Adugna Woyessa Gemeda (EPHI): NMA has digital data that can be used at district level, but from MOH there is gap on malaria information at district level. How then can the two sets of information be brought together?
A1a. Henock Hailu (NMA): NMA Maproom has information at woreda and point level, which everyone can access and get graphs. The availability of raw data has to follow NMA procedure.
A1b. Teklehaimanot Gebrehiwot (Amhara RHB): Access to meteorology data is an issue and it is tough to incorporate climate and malaria data
A1c. Asefaw Getachew (PATH/MACEPA): The ENACTS maproom is capable of giving information at district level. There used to be malaria data at the same level, which may have improved but don't think they have lost the data.

Q2. Aisha Owusu (IRI): Do you all work with NMA on dissemination of climate information and how are people interpreting the information?
A2a. Henock Hailu (NMA): Interpretation of data is happening and there is a working relation between NMA branch and woreda administration. Information is disseminated at woreda level, through awareness campaigns, especially when providing seasonal forecasts. The communication channels however need improvement, and there are some challenges in reaching the grassroots.

A2b. Tsaedu Araya (Tigray RHB): The relationship between sectors and NMA is not strong enough, and it is a process to buy required data to use for epidemic or post epidemic analysis.

Q3. Asefaw Getachew (PATH/MACEPA) Why is the variation in scale up of microscopic and RDT in Oromia and Amhara regions?
A3a. Teklehaimanot Gebrehiwot (Amhara PHB): Health workers have low capacity in testing so there is a chance of missing malaria during tests and need to avail test kits. There are also different approaches to control malaria in different places based on livelihood activities e.g. working on farm areas at night time so nets will not help. Screening was done at bus stations where people move about to the farm areas.
A3b. Tufa Abdissa (ORBH) Treatment is different in Amhara – case reported in cities with high number of people from different places outside of Oromia. They are trying to communicate and work with other partners on training on malaria diagnostic strategy

Q4. Wondatir Nigatu (EPHI) There was mention that El Niño effect is not same in different areas; can it be positive and negative at the same place?
A4. Henock Hailu (NMA): El Niño can affect same area in different manner. The strength of El Niño is different so the impact is different; interaction with dominant local systems can affect the strength of El Niño.

Q5. Adugna Woyessa (EPHI): Since morning, malaria is a problem and it is related to climate. But there is disconnect between regional malaria info and Met data – how are we going to use available data?
A5a. Tsaedu Araya (Tigray RHB): This is a good idea to be discussed. Some influencing factors are capacity building and sectoral planning for use of the data
A5b. Tufa Abdissa (ORBH): In Oromia region, they have to discuss with ministry what type of information in needed and who would get this information. It would be good to have centralized communication of information from both MOH and NMA. But there is no clear plan to use climate information.
A5c. Teklehaimanot Gebrehiwot (Amhara PHB): Certain districts in Amhara forecast malaria using met data, and they have developed a manual for malaria early warning. In some district forecasted and actual malaria varies and in some districts the malaria forecast works. It means that other variables may need to be included to correlate with malaria burden. Also, places with high immigration makes malaria cases correlation with met data difficult.

Summary of Technical Sessions: Hands-on ENACTS Training

Day 2: Enhancing National Climate Services (ENACTS)

9:05-10:00

Chair and Moderator of the Day: Madeleine Thomson, IRI
Rapporteurs of the Day: Wondatir Nigatu, EPHI, and Samson Wakuma, Addis Ababa University

Title: **Introduction to the Data Library**
Speaker: John del Corral, IRI
Significant challenges to building the capacity of health professionals to use climate information in research and decision-making include the difficulties experienced by many in accessing relevant and timely quality-controlled data and information in formats that can be readily incorporated into specific analysis with other data sources. We present here the capacities of the IRI climate data library and show how we have used it to build an integrated knowledge system in the support of the use of climate and environmental information in climate-sensitive decision-making with respect to health. Initiated as an aid facilitating exploratory data analysis for climate scientists, the IRI climate data library has emerged as a powerful tool for interdisciplinary researchers focused on topics related to climate impacts on society, including health.

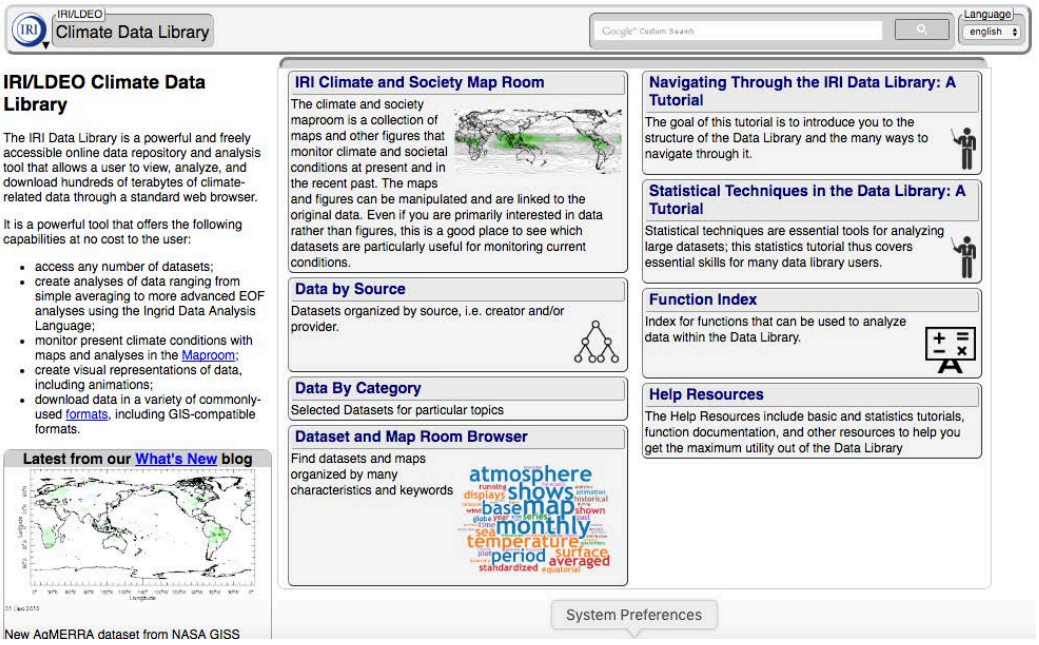


Figure 9: Image of IRI Data Library

Key Messages:

- Data information can put in to tool to form data library so that atmospheric data can be used

- 100-200 files can be put into a set of data (annual climate average, monthly average) can be extracted.
- Data library makes data available into different formats for statistical analysis, geographical transformation etc.
- Now we have Maproom tailored made for user groups friendly

Title: **ENACTS Development in Ethiopia**
Speaker: Tsegaye Ketema, NMA

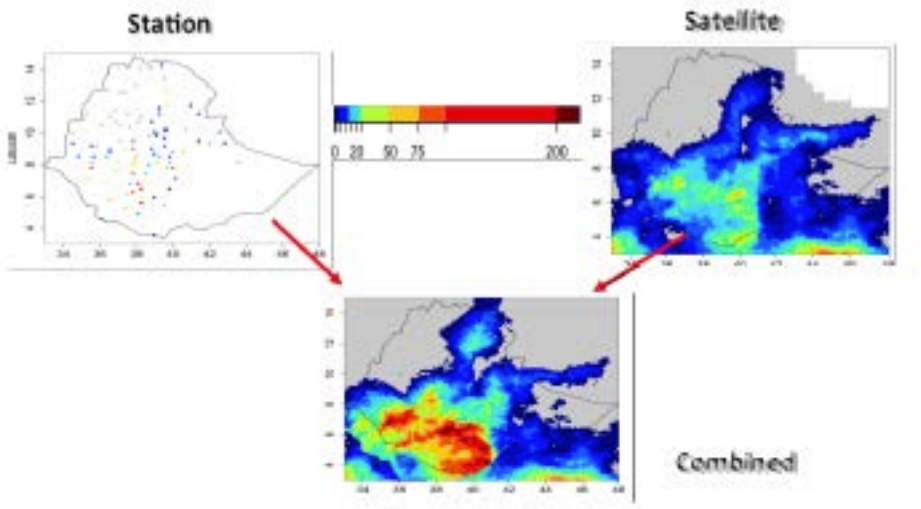


Figure 10: Ethiopian Station Data Combined with Satellite Data to create ENACTS Data

Key Messages:

- Quality Control of Station Data made by collecting data from different station types distributed across the country and and combine them with satellite and reanalysis products.
- Satellite Rainfall estimation measure radiation emitted or reflected by hydrometeors and/or surface and convert to precipitation information
- Interpolation of Climate Variables: This happens if the group of stations used for the interpolation is all on one side of the grid point
- Merging Station Observations with Satellite and Reanalysis products: Satellite and reanalysis provide information on the spatial structure rainfall/temperature with excellent spatial coverage, but may not be accurate; the merged data combines the strengths of the two different data sets.
- Maproom:- NMA Website application Maproom provide Climate Analysis, Climate Monitoring and Daily Rainfall Analysis

Title: **Overview of ENACTS for the Health Community**
Speaker: Madeleine Thomson, IRI

The purpose of the session is to emphasize the importance of using climate information and services to understand and manage climate sensitive health risks, support health delivery, and improve outcomes. It sets out the premise that climate is both a challenge and a resource and that, while there are many other drivers of health outcomes the structured characteristics of climate make it ideal for integration with health surveillance data. Evidence based approaches to integrating climate into health decision-making may

- improve understanding of the mechanisms of climates impact on transmission and disease
- estimate populations at risk (risk mapping)
- estimate seasonality of disease and timing of interventions
- monitor and predict year-to-year variations (and extremes) in incidence (including early warning systems)
- monitor and predict longer term trends (climate shifts and change assessments)
- improve assessment of the impact of interventions (by removing climate as a confounder)

In our approach, we must first identify "What is the user problem - policy relevant research question? and what are its spatial and temporal dimensions? We then explore climate information at multiple spatial and temporal scales and discuss its relevance to specific health decisions in Latin America (Zika virus) and Africa (Malaria).
Key Messages:

- Improving Climate Information Availability, Access and Use for Malaria and Other Climate-Sensitive Health Issues
- Climate is unique because its structured characteristics make it ideal for integration with health surveillance data
- Climate information improve health outcomes (intervention, prediction, monitoring and estimation) by understanding of the mechanisms of climates impact on transmission and disease
- ENACTS transform local, national and regional climate-sensitive development decisions through the widespread uptake of timely, relevant, locally enhanced, quality assured climate information.

Day 2: Why ENACTS? And ENACTS Maproom Navigation

10:00-11:00

Chair and Moderator of the Day: Madeleine Thomson, IRI
Rapporteurs of the Day: Wondatir Nigatu, EPHI, and Samson Wakuma, Addis Ababa University

Title: **Why ENACTS? And ENACTS Maproom Navigation**
Speaker: Aisha Owusu, IRI
Key Messages:

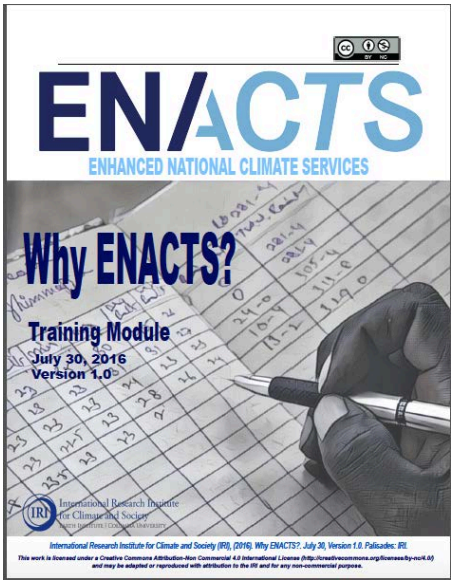


Figure 11: Cover of 'Why ENACTS?' Training Module

- ENACTS improve the availability, access and use of climate information
- ENACTS goa l is to transform climate sensitive development decisions
- ENACTS data produced from national observation network and combining station observations with satellite estimates of climate
- ENACTS can be used for: - Climate analysis, climate monitoring, climate predictability, and utilization of sector based Maprooms.

Day 2: Exercise 1 – Seasonality: Rainfall (Ethiopia)

11:30-1:30

Chair and Moderator of the Day: Madeleine Thomson, IRI
Rapporteurs of the Day: Wondatir Nigatu, EPHI, and Samson Wakuma, Addis Ababa University

Aisha Owusu, IRI, facilitated this session, inviting all participants to go through the Seasonality: Rainfall (Ethiopia) training together from beginning to end. John del Corral, IRI, helped in establishing a cloned NMA Maproom and stand-alone server in order for participants to follow examples within the Maproom.

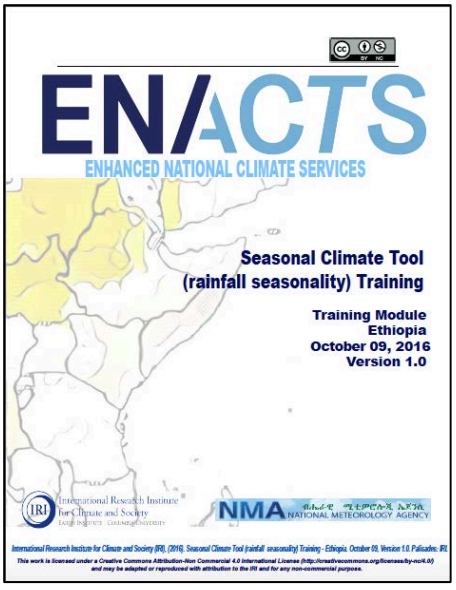


Figure 12: Cover of "Seasonal Climate Tool - Rainfall (Ethiopia) Training Manual

Key Messages:

- East Africa has an annual cycle tends to be bi-modal. Therefore, the climate patterns are markedly complex can change over short distances.
- Rainfall seasonality affects health and well being of life
- Seasonal climate tool can be used to assess the average climatology of the region.
- Exercise: Seasonality: Rainfall - Case study in Ethiopia demonstrated the utilization of this tool

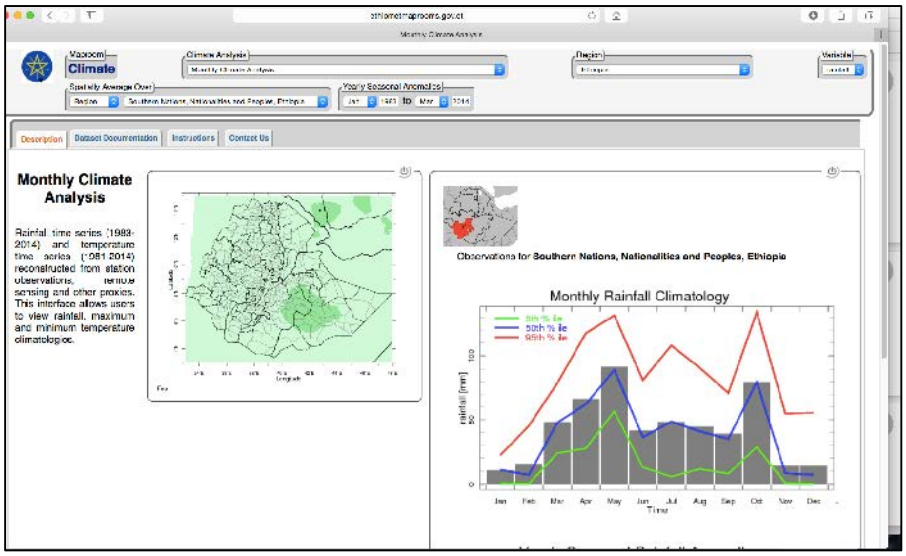


Figure 13: Screen shot of Monthly Climate Analysis Ethiopia Maproom

Group Presentations:

- One participant volunteered to present their observation on the demonstration of the tool for assessing seasonal rainfall related to health (malaria, acute watery diseases, meningitis) and other events (harvest, farming and flooding seasons) in Lome district of East Oromia region.
- The presenter clearly demonstrated the importance of seasonality and rainfall for the decisions of livelihood in this specific district.

Key questions raised and answers following the day 2 morning presentations included:
Q1. Maurine Ambani (CARE-Kenya): Does data library deals with missing data in time and space?
A1. John del Corral (IRI): Yes, it is possible to handle the missing data by marking them as missing and also try to escape over missing data. It is also possible for some of the functions to set the threshold of how much missing data is tolerating. So, for example you can set that I don't want more than 10% missing data or I don't want any missing.

Q2. Asefaw Getachew (PATH/MACEPA): Is there validation between satellites and ground stations and if they are validate from time to time?
A2. Tsegaye Ketema (NMA): Yes, validation is always performed. In the areas where ground stations are found, the blended data is more precise but in areas where ground stations are not available the accuracy is not very good - approximately 75% accurate because the data is obtained from interpolated data based on regression found from the nearby stations. So, blending data can help to get values for areas we don't have stations.

Q3. Mathew Murphy (PMI): Is NMA linked to work with other sectors like Ministry of Agriculture, Ministry of Health and other sectors?

A3. Tsegaye Ketema (NMA): Yes, there are a lot of efforts from NMA to work with other sectors. For example, there is a plan for preparing malaria monitoring map in the near future that can be used by Ministry of Health. There is also a plan to incorporate relative humidity, and evapotranspiration that can be used by Ministry of Agriculture to develop moisture index and crop specific water requirements as fraction index. These things can help agrarian communities of Ethiopia. NMA is also working with Water Sector to develop a map for different basins like Blue Nile basin, Awash river and others. After developing the map it is possible to incorporate different map room inputs into that basin.

Q4. Jimee Hwang (CDC): Please explain the difference between the four types of weather stations found in Ethiopia and what type of variables they measure?
A4. Tsegaye Ketema (NMA):

- The first class is synoptic weather station -it is designed to observe every three hours and send information to the world community for global monitoring system. There are eighteen synoptic stations in Ethiopia.
- The 2nd class is Agromet weather monitoring stations- they are observed every 24 hours, and measure more than 12 parameters. They are crucial for merging because they are many number (250) and can give good estimate from ground stations.
- The 3rd class weather stations record rainfall, Tmax and Tmin
- The 4th class weather stations record only rainfall. The 3rd and 4th class station cannot be relayed on because we receive the data at the end of every month, so they are not useful for real time monitoring for map room.
- The 5th station is automatic weather station- it mainly serves agriculture sector and it is inbuilt with different sensors like RH, Tmax, Tmin, sunshine duration hour, radiation, soil moisture and the leaf wetness indicators.
- The 6th station is upper air weather station- currently there are 2 upper station, these are balloons carrying radio that can go up to 30 km in the atmosphere. They measure humidity of the atmosphere, temperature and different pressure layers.

Q5. Samson Wakuma (AAU/SPH): It is difficult to give the accurate weather forecast for temperature and rainfall. What confidence interval does the NMA use to predict the temperature and rainfall?
A5. Tsegaye Ketema (NMA): In the highlands of Ethiopia, there is high dense station network and blended data from this area, this it is more than 95% accurate. But in areas with less stations, the accuracy may be approximately 60%. So the accuracy is highly depending on the stations network density.

Q6. Delenasaw Yewhalaw (Jimma University): Based on temperature, rainfall and humidity data, it is possible to predict areas with malaria risk. Can NMA estimate a lag point in time based on these data?
A6. Tsegaye Ketema (NMA): For malaria monitoring, there is no fear in terms of lag time because in Ethiopia context when we predict for one month, it can serve for two

month. That means predictions for October are often valid for December. And in some areas, predicitions it can serve for more than three months.

Q7. Ashenafi Assefa (EPHI): MoH is always challenged by dengue and yellow fever. Both diseases are appearing recently and health officials are quite certain on what exactly happened to the environment and climate. Does the IRI have any advice based on these diseases based on the research work that has already been done with malaria?
A7a. Madeleine Thomson (IRI): It is important to approach this in a structured way, it like understanding the seasonality, understanding mechanisms. So in general start from basics like checking inter annual variability with any other diseases and if there is a difference you may think long term trends.
A7b. Tsegaye Ketema (NMA): Suggested that EPHI look at climate and health bulletin, as there is useful information about many vector borne diseases including dengue and yellow fever

Q8. Kashmira Kale (CDC): Aware that malaria goes down with seasonal changes like drought. Given the limited amount of resources we may have for malaria, do we take the advantage of the drought and still implement the intervention to reduce further the malaria cases or do we say drought has reducing effect on malaria so let us relocate resources to and focus in another season?
A8: Madeleine Thomson (IRI): This depends on the way of thinking and local policy. For example, if you are planning to eliminate malaria, it is good to implement the intervention during the drought time because this the time when you can kill and push out the parasite.

Q9. Ayele Zewde (ACIPH): Is it possible to stop or block the occurrence of El Niño cycle?
A9. Aisha Owusu (IRI): El Niño is natural but El Niño shouldn't be seen only as threat, it is also an opportunity because El Niño allows us to forecast. For example, when it is El Niño we can do something to prevent malaria epidemics.

Q10. Ayele Zewde (ACIPH): Are there training materials and modules for woreda levels workers or malaria focal person?
A10. Madeleine Thomson (IRI): Will be addressed at the end of this workshop after the participants look at the different materials.

Q11. Muluberhan Assefa (Mekelle University): How can we integrate climate information and health information.
A11. Madeleine Thomson (IRI): NMA has a long history of making climate data available for researchers in particular, so it is up to the research to go and use the data. It is also important to have cooperation at institutional level.

Day 2: Exercise 2 – ENSO Probability: Rainfall and Temperature (Ethiopia)

2:30-5:00
Chair and Moderator of the Day: Madeleine Thomson, IRI
Rapporteurs of the Day: Wondatir Nigatu, EPHI, and Samson Wakuma, Addis Ababa University

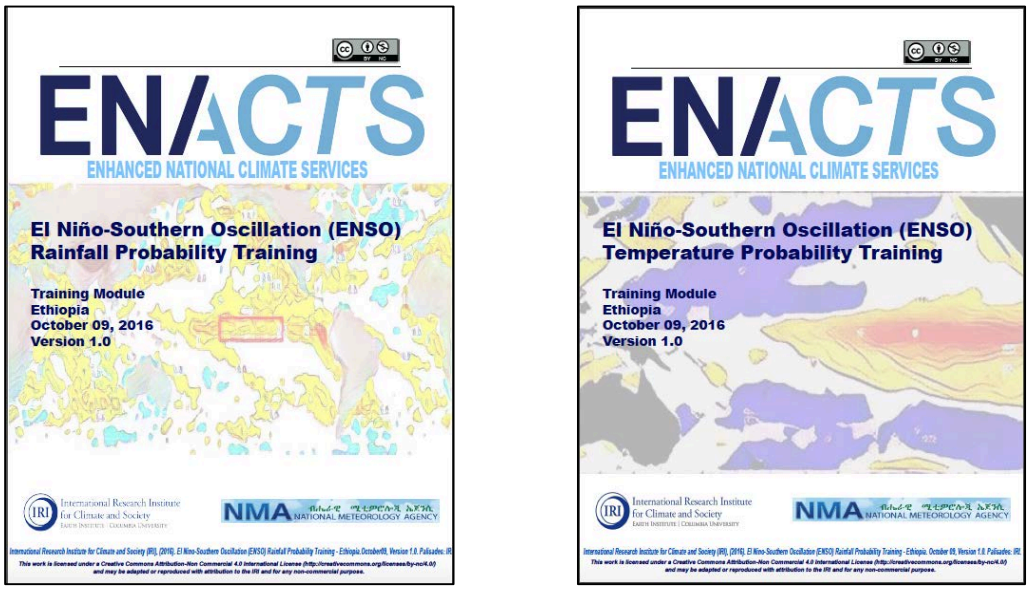


Figure 14: Left to Right - Cover pages of ENSO Rainfall and Temperature Probability Training Manuals

Aisha Owusu, IRI, facilitated this session, inviting all participants to divide into five smaller groups of 5 to 6. Each group was given either an ENSO Probability Rainfall or Temperature training manual for Ethiopia and asked to complete the training and while preparing a relevance slide for presentations for the next morning.

Day 3: Exercise 2 – Presentations and Discussion

9:05-10:00
Chair and Moderator of the Day: Aisha Owusu, IRI
Rapporteurs of the Day: Wondatir Nigatu, EPHI, and Samson Wakuma, Addis Ababa University

Aisha Owusu, IRI, facilitated this session, inviting one member from each group to present slides from the ENSO

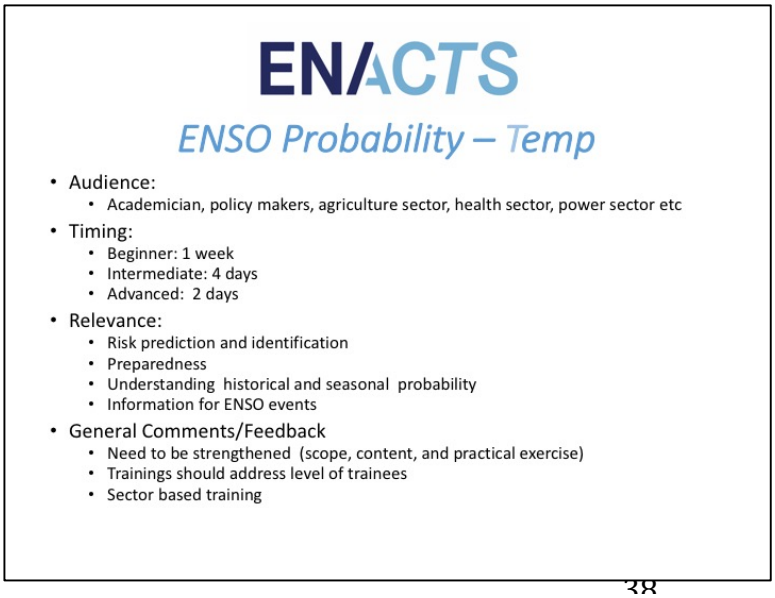


Figure 15: Example of group presentation slide for ENSO Training

Probability training from the previous day.

Highlight of five groups' presentations for discussion:

- The first group presented the practical exercise on ENSO Probability on Rainfall by identifying stakeholders that can utilize the rainfall information, time, relevance, and feedback. They also showed the tally results drawn from barograph that generated from long-term database and then classified under different ENSO states as EL Niño, Neutral and La Nina for Afar, Amhara and Tigray regions. The ENSO phases are tallied for October-December season.
- The second group presents similarly the exercise on ENSO Probability on Rainfall for Somali and Afar regions.
- The third group presents similarly the exercise on ENSO Probability on Rainfall for Tigray, Amhara and Afar regions for July-September season.
- The fourth group presents similarly the exercise on ENSO Probability on Rainfall for Tigray, Amhara, Oromia, Somali and Afar regions.
- The fifth group presents similarly the exercise on ENSO Probability on Temperature for Tigray, Oromia, Somali and Afar regions.

Key questions raised and comments following the day 3 morning presentations included:

C1. Asefaw Getachew (PATH/MACEPA) commented on the idea raised by group five that recommended to have unilateral training for each sector. He said at least combining climate sector with other sector is great instead of having unilateral training for each sector. This comment was also supported by Madeleine Thomson (IRI).

C2. Tsegaye Ketema (NMA) commented on the group presentations, stressing the importance of making sure for which months or seasons the analysis were done because we can have different outcome for single locality based on the different seasonal analysis. He also commented that the analysis of El Niño impacts outcome based on the region is misleading, because regions cover large area and the impacts different from one locality with another locality.

-

Day 3: Exercise 3 – CSMT and WASP (Tanzania)

10:00-11:30

Chair and Moderator of the Day: Aisha Owusu, IRI
Rapporteurs of the Day: Wondatir Nigatu, EPHI, and Samson Wakuma, Addis Ababa University

Aisha Owusu, IRI, facilitated this session, inviting participants to remain in their previous groups of 5 to 6. Each group was given either an CSMT or WASP training manual for Tanzania in order to explore a different Maproom.

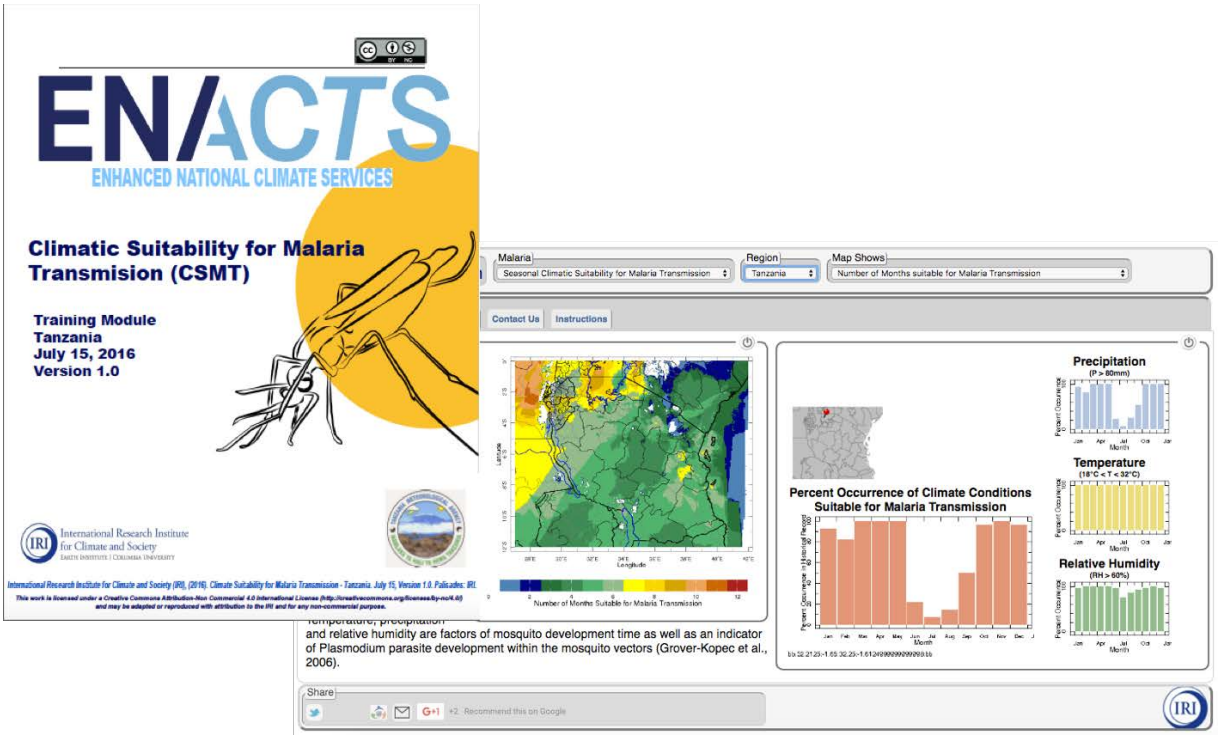


Figure 16: Cover of CSMT Training Manual for Tanzania and screen shot of CSMT Maproom

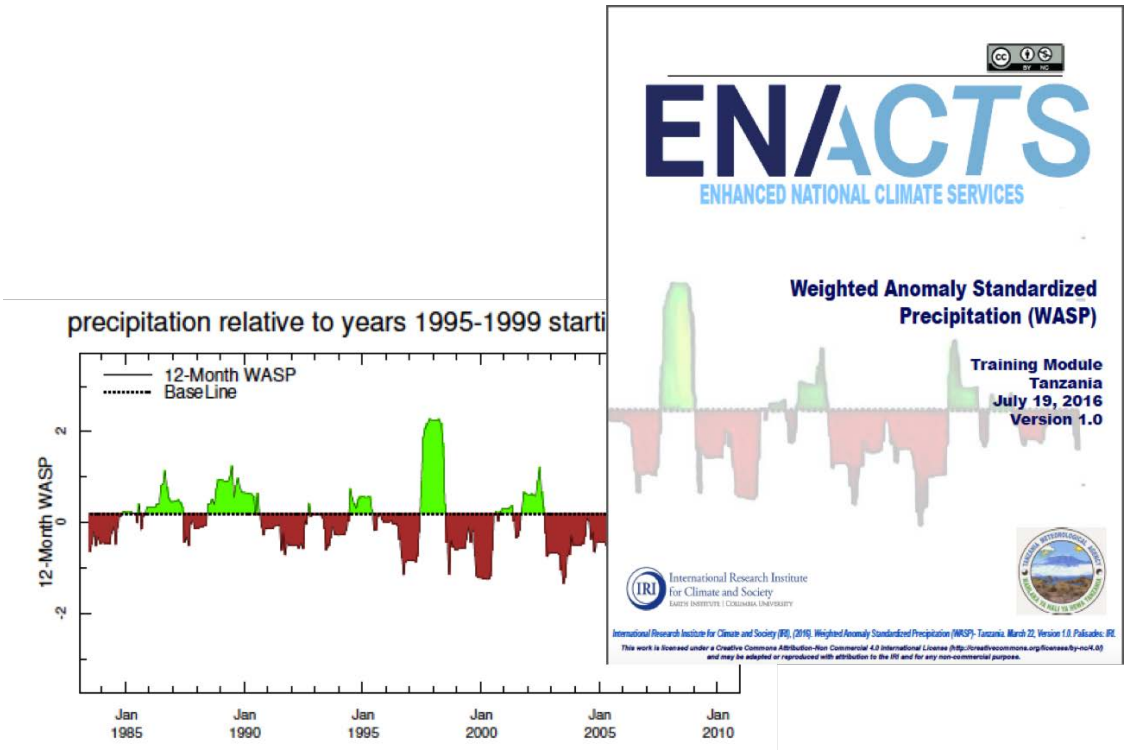


Figure 17: Cover of WASP Training Manual for Tanzania and screen shot of WASP Maproonm

Key questions raised and comments following group presentations on CSMT and WASP Training included:

Q1. Kashmira Kale (CDC): Data from CSMT and WASP tool is already available for countries like Tanzania and Ethiopia. How have you seen these countries use this data in the public domain specifically for decision making for programs and even for policy making?
A1. Madeleine Thomson (IRI): Currently, simply teaching public health community on how to use them because if they don not know how to use them there is no way they can use it for policy making.

Q2. Asefaw Getachew (PATH/MACEPA): Suitability analysis is very important but interventions are not going to be straight forward based on suitability. Can other layers like morbidity data, control data and other data to calculate actual risks and take measures be added to the Maprroms?
A2a. Aisha Owusu (IRI): This is important comment and we expect participants to give feedback like this that can help in improving the Maproom. However and again, the ENACTS tools are not meant for prediction, they are meant to show historical data and probabilities. Historical data is very important for prediction because you have to see what happened the past
A2b. Adugna Woyessa (EPHI) reminded the participants to differentiate prediction and forecast as they are technical words.

C1. Asefaw Getachew (PATH/MACEPA): Stressed the importance of allocating responsibilities to perspectives institutions before prioritizing the recommendations. For example, extending the Maproom output into actual risk on the ground is responsibility of Ministry of health because the morbidity data, mortality data and coverage of IRS is with ministry so they have to input that and see where the actual risk is, so we have to divided the responsibilities among the sectors NMA should take its own responsibilities, public sectors should take its own responsibilities and IRI will take its own responsibilities so we have to classify the recommendation by institution.

Q3. Tsaedu Araya (Tigray RHB): Can we ask the Met services for access to the raw and merged ENACTS data?
A4a. Aisha Owusu (IRI): Yes; however, raw data is not released to the community because there may be exploitation of it, to make sure it is used properly, so the reason we are using ENACTS map is to strengthen the national data as there was a need to control the data quality and to help people see what is happening in climate data and what happened in the past.
A4b. Tsegaye Ketema (NMA): ENACTS data is accessible to anyone but the individual requesting the data should follow the appropriate procedure.

Some of the general last comments by participants are:

- Priority should be to develop a good manual to help people understand the maproom.

- Better to give training based on CSMT tool made for Ethiopia
- Training manuals should be prepared in local language and training should be given for people at woreda level as they are the one who use the data
- The training manuals should be enriched with more case studies for Ethiopia, like epidemics from Ethiopia. In addition, the training should also include other infectious diseases like meningitis and other vector borne diseases
- It is not possible to bring big changes or sustain it with this kind of training manuals and workshops. There should be a plan to build the capacity here in Ethiopia by training a lot of Ethiopians on climate science. IRI should work with the universities in Ethiopia to train Ethiopians' on climate sciences.
- Many relevant institutions including the university people who are working on climate change did not know the existence of these tools and climate data. So there should be advocacy for the availability of these tools by NMA or partners' sides. In the near future, you need to bring different sectors onboard for training.

Day 3: New Maproom and Training Brainstorming & Group Presentations

12:00-1:00

Chair and Moderator of the Day: Aisha Owusu, IRI

Rapporteurs of the Day: Wondatir Nigatu, EPHI, and Samson Wakuma, Addis Ababa University

Aisha Owusu, IRI, facilitated this session, asking groups to brainstorm about new Maproom development and present their findings.

Highlight of seven groups' presentations for discussion:

- Group one appreciated the availability of the Data Library/Map Room for public health use and recommend the updating the Map Room database regularly in sustainable fashion, need strong advocacy for popularizing the tool. Related to modules recommend tailored training and services to users at all level for operation, research and education.
- Group two recommended related to the seasonality & suitability of the training manual. To include maps that show change of intensity in malaria transmission over the year; include other vector borne diseases (climate sensitive diseases), identify specific locality (zone Woreda, kebele etc.), if the training for peripheral (can be used a sort of TOT can be used to reach the lower level).
- Group three recommendations were similar to Group two and included above.
- Group four recommendations were similar to other groups. What different mentioned were to incorporate other similar Map rooms such as hydromet, Agro met.
- Group five recommendations were similar to other groups. What different mentioned was to introduce other Maproom for land use (Irregation, dam…). They also suggested Sector based climate data training, specific training on the role of climate variablity for specific disease.
- Group six recommendations were similar to other groups.
- Group seven recommendations were comprehensive and most are similar to other groups. What were differently recommended were adding certainty or

confidence intervals for Maprooms, more updated Maprooms that include recent data (continuously updated, climate/health and administrative boundaries), and add forecasting for climate changes which can help with program development and policymaking. Regarding to trainings recommend to describe added value of Maprooms from a practical perspective, especially as it relates to program development/implementation and policy making, include analysis within training materials. Technical focus on navigating the system is important but to be usable, should describe how it can be used/how to analyze. Communication recommendations include communicating cross-sectorally within the country to enhance operationalization of this data, and combine this data into what already exists within the MoH and extending further to make programmatic decisions and refining disease risk maps.

Recommendation Session

2:00-4:00

Chair and Moderator of the Day: Aisha Owusu, IRI
Rapporteurs of the Day: Wondatir Nigatu, EPHI, and Samson Wakuma, Addis Ababa University

Break-out Groups:

Aisha Owusu, IRI, facilitated the break-out group recommendation session, inviting participants into three larger groups. Each group was given a particular theme for the advancement of ENACTS in public health:

- Operations
- Education
- Research

Each group's discussion was structured around these three themes along with two time frames: the potential upcoming La Niña in 2016-17 and for the next three years (2018-2020). The participants discussed their assignments for about 60 minutes and reported the main findings on each of them during the closing session.

Group 1 - ENACTS in Operations			
No	**Name**	**Institution**	**G**
1	Dr. Jimee Hawang	CDC- Atlanta	F
2	Tsion Demissie	PMI	F
3	Dr. Samuel Girma	PMI	M
4	Dr. Ayele Zewde	ACIPH	M
5	Teklehaymanot Gebrehiwot	Amhara RHB	M
6	Tufa Abdissa	ORHB	M
7	Tsaedu Araya	Tigray RHB	M

Group 2 - ENACTS in Education			
No	**Name**	**Institution**	**G**
1	Hunachew Beyene	AAU-PhD Student	M
2	Tigest Shiferaw	ACIPH	F
3	Muluberhan Assefa	Mekele University	M
4	Dr. Abebe Animut	AAU/ALIP	M
5	Abdi Samuel	Wollega University	M
6	Maurine Ambari	Care-Kenya	F

Group 3 - ENACTS in Research			
No	**Name**	**Institution**	**G**
1	Dr. Delenesaw Yewhalaw	Jimma University	M
2	Dr. Adugna Woyessa	EPHI	M
3	Samson Wakuma	AAU-PhD student	M
4	Dr. Wondatir Nigatu	EPHI	M
5	Tsegaye Ketema	ENA	M
6	Yoseph Beyene	EPHI	M
7	Dr. Hirpa Legesse	Wollega University	M

Closing Session

Final Recommendations:

Below is a summary of final recommendation and identified next steps from the workshop for ENACTS.

	This Year (2016-17)	Next 3 years
Operations	• Establish National Meteorology Agency (NMA) and FMOH as a responsible body • Establish a technical working group. • Disseminate workshop information and recommendations • Allow access to data (10x10 km grid) for all Ethiopian districts • Improve NMA infrastructure	• Incorporate analogue years within the Climate Monitoring Maproom in order to show ENSO impact • Promote awareness and education on the availability of the climate data. • Train health workers • Use the Media to promote climate data knowledge and its importance to the public

	• Develop prediction models (e.g. rainfall forecasting for predicting malaria and for planning interventions like flood forecast) • Enable NMA forecasts to link to Maproom • Refine forecasting information sent to FMOH so that it is more specific • Enable better and more varied season selection • Expand the Maproom development to the water sector to enable analysis around the river basins • Build an Agricultural map room with the daily data • Update rainfall and climatology to 2014 and rainfall monitoring data for every 10 days • Update the CSMT Maprooms country map to fill in gaps	• Strengthen the entomological surveillance system and build the capacity of the existing health workers • Support the utilization of climate information at all levels (even those smaller than districts) • Incorporate environmental management using irrigation data and climate data for malaria • Provide training of trainers (TOT) - cascading of training When issuing health bulletin, use climate information to show it is an important influence but not the only one. (close the gap of meteorology and epidemiology)
Education	• Incorporate ENACTS into public health university curriculum at undergraduate, graduate and PhD levels • Provide training of trainers (TOT) - cascading of training • Provide short-term training on ENACTS for faculty Develop certificate programme for ENACTS	• Advocate for intensive training on ENACTS for policy makers • Provide cascading training as outreach program at regional, zonal, districts level Allow PhD candidates the opportunity to develop Maprooms on climate and heath as dissertation project
Research	• Hire consultants to provide assessments on knowledge, attitude and practice for climate information for climate sensitive diseases at national, regional, and district levels • Assess 2015/16 El Niño impact on climate sensitive diseases	• Assess the associations of malaria prevalence/incidence and vector dynamics in relation to climate variables in sentinel sites • Assess the associations of prevalence of malnutrition in relation to climate variables in hot spot areas • Assess the associations of prevalence of emerging and re-emerging diseases (yellow fever, Dengue, etc.) with climate variables in hot spot areas • Undertake inter -sectorial collaborative research on impact of climate on health, flooding, drought,

		and food security • Strengthen the national climate and health database

Closing Remarks:

Closing remarks were given by Aisha Owusu (EPHI), Henock Hailu (NMA), Ayele Zewde (ACIPH), and Adugna Woyessa (EPHI)

- Aisha Owusu, IRI, reviewed the workshop activities in short and indicated its importance by briefing the likely impacts of La Niña on malaria, WMO and IRI La Niña declarations and forecasts, and policy brief.
- Closing remarks from Henock Hailu, NMA, indicated that applications tools were not there in the past workshops, but now it is on board for health and further strengthening in the future is important.
- Closing remarks from Ayele Zewde, ACIPH, indicated the importance of closely working relationships with EPHI and continue this by increasing participation from different institutions and universities across the country.
- Closing remarks from Adugna Woyessa, EPHI, indicated the importance of the workshop for research, education and operation working institutions and universities. Also indicates the importance of sharing responsibilities that are outlined in the recommendations. Hoping things will improve by implementing the important recommendations in the coming few years.

Summary of Launch of Malaria Elimination Climate Surveillance Suite (MECSS)

Day 4: Background of Idea

9.00-9.15

Adugna Woyessa, EPHI, welcomed a smaller and selected group of individuals to a half day workshop by explaining the background and development of the Malaria Elimination Climate Surveillance Suite (MECSS). He noted the high malaria variability in Ethiopia and emphasized that surveillance is a key tool in malaria eliminations, especially within the woredas (districts) and lower administrative units. Thus, he recommended that climate information was essential to surveillance for malaria elimination.

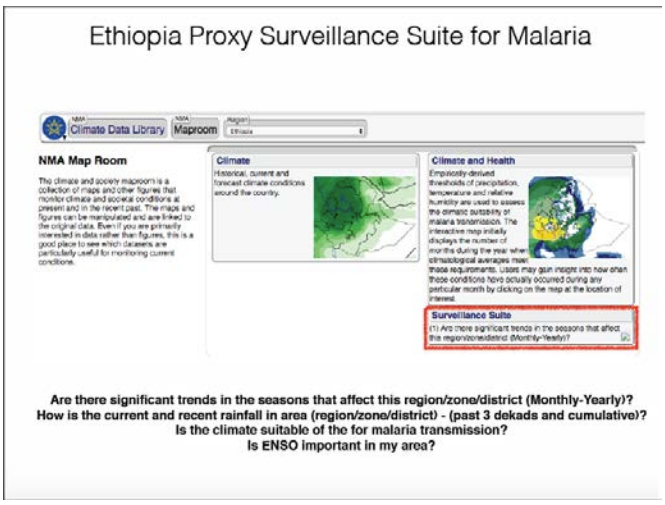
Woyessa also explained that the MECSS was developed from a direct request form the EPHI, FMoH/NCMP, PMI, and AAU/SPH. NMCP shared the first 50-80 districts for initiating the malaria surveillance suite and EPHI and the IRI applied for a small Earth Clinic grant from Columbia University to develop the MECSS.

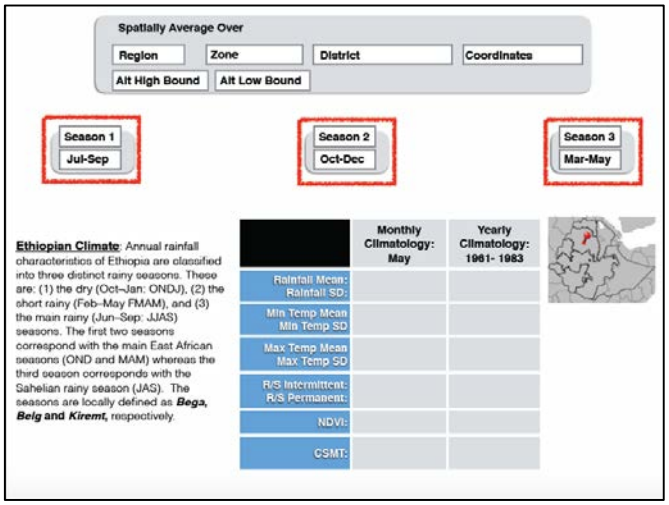
He asked and expected for sound feedback and input from key members of the malaria community to further this tool.

Day 4: Presentation of MECSS and Navigation

9.15-9.45

Aisha Owusu, IRI, presented/launched the MECSS with the help of IRI's John del Corral. She explained which ENACTS tools and services were being presented and prioritized for automation. She then invited participants to join her in navigating through the MECCSS by selecting woredas, zones, or regions of choice and explaining the functionality and current restraints.





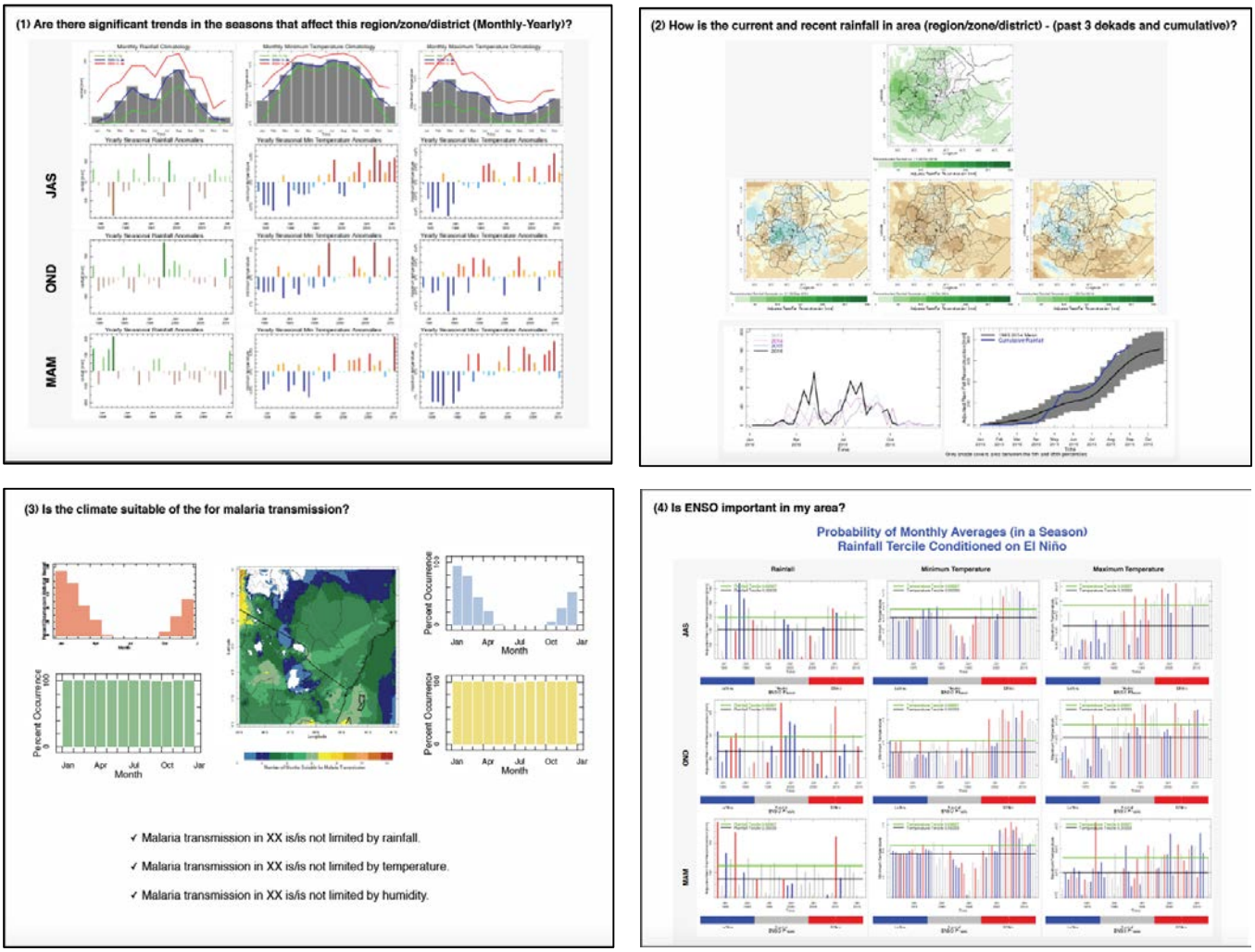


Figure 18: Screen shots of Ethiopian MECSS

Feedback and Recommendation Session

Owusu then asked participants to work in pairs to generate preliminary recommendations via one PPT slide for the MECSS. The pairs discussed their findings for about 30 minutes and reported their main recommendations in an open forum with questions and discussion.

Below is a summary of final recommendations identified for the MECSS.

- Include Woreda location on rainfall and CSMT maps (shaded or point)
- Include Woreda names throughout the Maproom
- Filter OUT area that is NOT selected (either for region/zone/woreda) – only including area of interest
- Allow the selection of different in elevations (high/low) and terrain for all woredas
- Allow the selection of any months to show anomalies

- Included units in variables
- Provide explanations of variables (esp for acronyms and abbreviations)
- Provide actual maps for NDVI to associate with value OR direct values of RH
- Cancel out redundancies in anomalies and standard deviations
- Update data until 2015
- Increase the number of woredas
- Include New Variables:
    - NDVI from eMODIS (clean) for every 10 days
    - Chill and Heat Indices (Comfort) w/ RH calculations (evapotranspiration)
    - Number of rainy days/heat spells and min/max values by pixels
    - Historical epidemiological variables (morbidity, morality, vectors population averages, species, drugs currently being used, resistance, interventions, etc)
    - Peak rainfall (>80 mm for favorable for to set malaria transmission)
    - Historical Morbidity and Mortality data
    - Irrigation data
    - Population mobility

Appendix

Appendix 1: Workshop Agenda

Improving Climate Information Availability, Access and Use for Malaria and Other Climate-Sensitive Health Issues
Addis Ababa, Ethiopia

24 – 27 October 2016
Location: Elilly International Hotel

Day 1: Monday, Oct 24, 2016

8:00-8:45
Registration

Chair of Morning: Adugna Woyessa, EPHI
Rapporteur of Morning: Ashenafi Assefa, EPHI

9:00-9:40
Official Welcome and Introductions

- Keynote address – Fetene Teshome, Director General, NMA
- Keynote address – Hiwot Solomon, NMCP
- Keynote address – Madeleine Thomson, IRI
- Opening Remarks – Amha Kebede, Director General, EPHI
- Introduction of Participants

9:40-10:40
Background

- Introduction to the Workshop (Outline) - Aisha Owusu, IRI
- Review of El Niño and Malaria 2014/16 and El Niño Policy Brief (follow-on from Climate Variability and Change: Implications for Malaria Control and Elimination in Africa - 2014) – Adugna Woyessa, EPHI
- Current status of Malaria Control and Elimination in Ethiopia – Hiwot Solomon, NMCP

10:40-11.15
Group Photo & Coffee Break

11:15-12:00
Session 1: Recent analyses/activities/endeavors regarding the relationship between climate/climate variability and malaria and other climate-sensitive diseases in Ethiopia

- Climate and Child Nutrition – Seifu Hagos, Addis Ababa University (10 min)
- PHEM System in regard to Climate Sensitive Health Issues – Emana Alemu, PHEM (10 min)
- Climate Change, Nutrition, and Gender –Tesfaye Hailu, EPHI, Nutrition and

Food Science Department (10 min)
- Ten Year Trend Analysis of Malaria Prevalence and Its Correlations w/ Climatic Variables in Sibu Sire District, West Ethiopia (2004-13) – Abdi Samuel, Wollega University (10 min)

12:00-12:30
Open Q&A on morning presentations

12:30-2:00
Lunch

Chair and Moderator of Session 2: Mathew Murphy, PMI
Rapporteur of Afternoon: Maurine Ambani, CARE

2:00-3:15
Session 2: Review of Malaria Transmission from the El Niño 2015/16 in Ethiopia
- What is ENSO and 2015/16El Niño in Ethiopia,Henock Hailu, NMA (15 min)
- Current Malaria Situation in Tigray Region –Tsaedu Araya, Malaria Focal Person (15 min)
- Current Malaria Situation in Amhara Region –Teklehaimanot Gebrehiwot, Malaria Focal Person (15 min)
- Current Malaria Situation in Oromia Region –Tufa Abdissa, Malaria Focal Person (15 min)

3:15-4:00
Panel Discussion w/ Regional Presenters and Q&A

4:00-4:30
Coffee Break& Barriers to Climate Data Survey

4:30-5.00
Preparation for Day 2 and Wrap-Up, Aisha Owusu (IRI)
- Intro to ENACTS and Training Materials/Manuals (distribute Why ENACTS? and Seasonality - Rainfall)

5:00-6:30
Cocktail Reception

Day 2: Tues, Oct 25, 2016

Technical Session: Hands-On ENACTS Training
Chair and Moderator of the Day: Madeleine Thomson, IRI
Rapporteurs of the Day: Wondatir Nigatu, EPHI, and Samson Wakuma, Addis Ababa University

9:00-9:05
Review of Day 1 - Madeleine Thomson, IRI

9:05-10:00
Enhancing National Climate Services (ENACTS)

- Introduction to the Data Library – John del Corral, IRI
- ENACTS Development in Ethiopia – Tsegaye Ketema, NMA
- Overview of ENACTS for the Health Community – Madeleine Thomson, IRI

10:00-11:00
Why ENACTS? and ENACTS Maproom Navigation, Aisha Owusu, IRI

11:00-11:30
Coffee

11:30-1:30
Exercise 1

- Tool for understanding seasonality of climate at any location
    - Exercise: Seasonality: Rainfall (Ethiopia)

1.30-2:30
Lunch

2:30-3:30
Exercise 2 - Break Out Groups (Groups of 5)

- Intro to follow-on training manuals (PPT) – Aisha Owusu (10 min)
- Each group selects one (1) training manual to complete:
    - Exercise: ENSO Probability – Rainfall (Ethiopia)
    - Exercise: ENSO Probability – Temperature (Ethiopia)

3:30-4:00
Coffee

4:00-5:00
Cont'd Exercise 2 Break Out Groups

5:00-5:30
Preparation for Day 3 and Wrap-Up, Madeleine Thomson (IRI)

Day 3: Wed, Oct 26, 2016

Technical Session: Hands-On ENACTS Training (cont'd)

Chair and Moderator of the Day: Aisha Owusu, IRI
Rapporteurs of the Day: Wondatir Nigatu, EPHI, and Samson Wakuma, Addis Ababa University

9:00-9:05
Review of Day 2, Aisha Owusu, IRI

9:05-10:00
Presentations from Exercise 2 and Open Discussion

10:00-11:30
Exercise 3 - Break Out Groups (Groups of 5)

- Each group selects one (1) training manual from the following to complete:
  - Exercise: Climate Suitability for Malaria Transmission (CSMT) (Tanzania)
  - Exercise: Weighted Anomaly Standardized Precipitation (WASP) (Tanzania)

11:30-12:00
Coffee

12:00-1:00
New Maproom and Training Brainstorming (30 min)
Group Presentations (30 min)

1:00-2:00
Lunch

2:00-4:00
Break-out Groups (3) for Recommendations

- ENACTS in Operations
- ENACTS in Research
- ENACTS in Education

4:00-4:30
Coffee

4:30-5:30
Closing Session

- Presentations of recommendations (3)
- Closing Remarks by IRI, NMA, ACIPH, EPHI

Day 4: Thurs, Oct 27, 2016

Launch of Malaria Elimination Climate Surveillance Suite (MECSS)
Participants: NMCP, EPHI, ACIPH, NMA

9:00-9:15
Background of Idea – Adugna Woyessa, EPHI

9:15-9:45
Malaria Elimination Climate Surveillance Suite (MECSS) and Navigation - Aisha Owusu, IRI

9:45-10:30
Feedback and Recommendation Session (Pairs – 2)

- Select woreda of choice and generate automated report
- Create of PPT of recommendations and feedback for Malaria Elimination Climate Surveillance Suite (MECSS)

10:30-11:00
Coffee

11:00-12:15
Presentation of recommendations and group discussion
Wrap-up and Close, Aisha Owusu, IRI and Adugna Woyessa, EPHI

Appendix 2: Participant List

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Appendix 3: Workshop Organizing Institutions

Addis Continental Institute of Public Health (ACIPH)

Addis Continental Institute of Public Health (ACIPH) is an independent center of excellence for public health research and training. It was established in mid-2006 by highly qualified health experts to provide technical services and training in major health issues in Africa. ACIPH is located in Addis Ababa and Bahir Dar, both in Ethiopia.

Vision

ACIPH supports the attainment of a healthier life for Africans by establishing and maintaining centers of excellence for health training and strategic health information to enhance the quality of health services and promote evidence-based public health practices.

Mission

ACIPH strives for the health of the African population by enhancing the implementation capacity organizations dealing in public health and related issues in the government, non-governmental and private sectors through training, research and technical assistance. ACIPH provides short-term trainings, assists in generating strategic information through research, monitoring and evaluation, and establishing routine database systems. ACIPH provides consultancy services in the area of public health training, research, and services. Medium and long term training directed in attaining Masters and Ph.D. degrees are available in collaboration with national and international academic institutions. The Institute strives to support organizations in achieving their mission by offering timely professional services. ACIPH focuses on major public health problems of the continent such as reproductive health, HIV/AIDS, Tuberculosis, and Malaria. ACIPH deals with emerging and re-emerging public health concerns as and when necessary. It provides training and technical assistance on methodological issues such as data management, analysis and reports writing based on both quantitative and qualitative research approaches.

Values

ACIPH maintains a high ethical and moral standard and respects social norms. ACIPH believes in equality and mutual respect; everyone has equal merit. The Institute offers a high level of service to its clients and comfortable working environment for its employees. It strives to support community and public initiatives in advancing public health by actively supporting professional and community organizations striving for a healthier life for Africans.

Main Objectives

Conduct training programs to enhance performance in health services and program management. Support evidence-based practice by conducting research and monitoring and evaluation activities. Provide technical support for organizations and individuals engaged in collecting, analyzing, and dissemination of health and population data/information. Develop and undertake training programs to support human resource development in the continent.

Ethiopian Public Health Institute (EPHI)

The Ethiopian Public Health Institute (EPHI) was recently established according to the Council of Ministers Regulation No. 301/2013 and launched on January 15, 2014, envisioned to support healthy, productive and prosperous Ethiopians. It was previously known as the Ethiopian Health and Nutrition Research Institute (EHNRI), established under the Regulation No.4/1996 following the merger of the former National Research Institute of Health (NRIH), the Ethiopian Nutrition Institute (ENI) and the Department of Traditional Medicine under the Ministry of Health. The mission of EPHI is to undertake research, based on the national public health agenda and priority health and nutrition problems, and to generate, absorb and disseminate scientific and technological knowledge to improve the health of the general public. EPHI is also mandated to produce vaccines for major infectious diseases and to improve the public health laboratory system at a national scale. In addition, EPHI is responsible for contributing to the national research agenda on public health and nutrition, conducting priority research, submitting policy briefs based on analysis and evidence, disseminating research findings and evaluating their impact, establishing a framework for the integration and effectiveness of research conducted throughout the country, putting in place a national research database, and providing assistance to regions and other entities conducting research.

International Research Institute for Climate and Society (IRI)

The mission of the IRI is to enhance society's capability to understand, anticipate and manage the impacts of climate in order to improve human welfare and the environment, especially in developing countries. The IRI conducts this mission through strategic and applied research, education, capacity building, and by providing forecasts and information products with an emphasis on practical and verifiable utility and partnership.

The IRI was founded in 1997 on the belief that scientific breakthroughs in our understanding of climate can help developing countries defeat persistent and often devastating problems. Climate has an impact on health, water, agriculture and most other vital sectors, giving us the opportunity to help societies confront a whole range of hardships-from malaria epidemics to food shortages. Population growth, changing livelihoods, rapid urbanisation, and climate uncertainty put pressure on resources and ecosystems. Under these heightened stress conditions even minor climate fluctuations are significant.

The IRI is a catalyst for the creation and provision of scientific information that meets the needs of the developing world. We collaborate with partners in Africa, Asia and Latin America, with local institutions that understand local needs and capacity. Our research and tools are "demand-driven" in that they help solve specific development, adaptation and research management issues.

Ethiopia National Meteorological Agency (NMA)

A small meteorological unit was established in 1951 within the then existing Civil Aviation Department of Ethiopia. The National Meteorological Services Agency of Ethiopia was established as an autonomous government organization on 31 December 1980. The mission and vision of the NMA is to provide world-class meteorological services, including weather forecasts and early warnings on the adverse effects of weather and climate of Ethiopia that contribute to economic and social development of the country and safeguard of life and property by collecting, analyzing and studying meteorological and related data.

The powers and duties of the NMA are to:

- Establish and operate a national net-work of meteorological stations designed to represent various climatic regions of Ethiopia
- Collect all meteorological data
- Exchange meteorological data in accordance with international agreements to which Ethiopia is a party
- Establish and operate communication systems, in accordance with the law, for the collection and dissemination of meteorological data
- Publish and disseminate analyzed and interpreted meteorological data and meteorological forecasts
- Give advance warnings on adverse weather conditions; disseminate advice and educational information through the mass media; and provide, upon request meteorological services to any person
- Collect and centrally administer any meteorological data collected by any person in the country
- Control air pollution and maintain the natural balance of the air in the country

Appendix 4: Ethiopia El Niño 2015 Policy Brief

NMA NATIONAL METEOROLOGY AGENCY

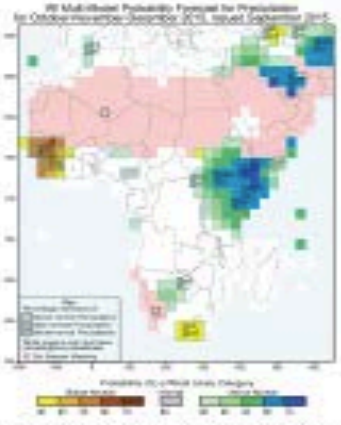
IRI

POLICY BRIEF

The 2015 El Niño – Implications for Malaria in Ethiopia

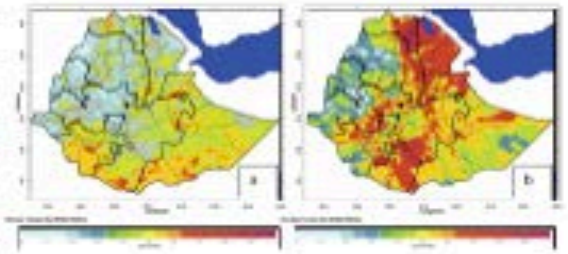
Introduction

The 2015 El Niño conditions were formally declared by all major climate forecasting centers by May 2015[1]. The September forecast from National Meteorology Agency, supported by the global forecast from the IRI[2,3] indicated that the strong 2015-16 El Niño, currently in progress, could bring regional warming and above normal rainfall to eastern Africa during the last quarter of 2015.



Seasonal October-November-December 2015 precipitation forecast for Africa, issued September 2015

In Ethiopia, the historical impact of El Niño on the seasonal climate is highly significant. The impact on the July-September rainfall has already been observed with prolonged drought, causing major challenges across large portions of northern, central and southern Ethiopia. The abnormal wet October-December season, currently being experienced, can be observed

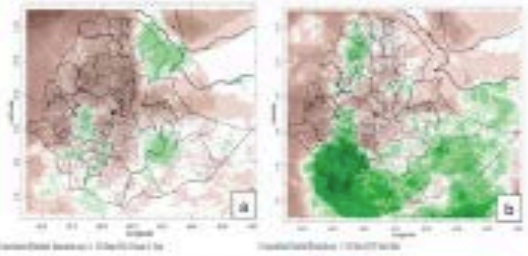


Images created from NMA Maproom: Historical probability of seasonal monthly averages conditioned on El Niño in Ethiopia a) high rainfall Oct-Dec (b) high minimum temperatures Oct-Dec. (Thomson et al., 2015).

using the National Meteorological Agency rainfall monitoring Maproom (www.ethiometmaprooms.gov.et) that provides 10 daily updates for the whole country. The cumulative rainfall observed already exceeds the historical 95% confidence limit for high rainfall observed since 1982.

Ethiopian malaria and past ENSO events

In additional to heavy and unseasonal rainfall, unusually high temperatures that occur across the tropics during and immediately following an El Niño event pose a significant risk for malaria in Ethiopia where approximately 50% of the population lives in cool highland areas in which malaria is restricted by low temperatures. Epidemic or unstable malaria-prone areas are found between 1,500m and 2,500m and affected by epidemic in varying scales. The escarpments of the Rift Valley and in western,



Images created from NMA Maproom a) cumulative rainfall anomalies from June to September 2015, displaying the severe drought in Ethiopia and b) cumulative rainfall anomalies from September to November 2015, showcasing the unseasonal and extreme rainfall in Ethiopia.

oentral and eastern areas are especially prone to periodic epidemics (Abeku, van Oocrtmarssen et al. 2003).

A recent systematic search of peer reviewed publications and unpublished reports of malaria epidemics in Ethiopia for the period 1963-2010 revealed that most of the 22 malaria epidemics/ outbreaks identified were associated with ENSO events. During the El Nino years, the largest Regional States including Tigray, Amhara, Oromia and SNNPR were affected; Oromia was the most frequently affected among those regions.

2015-16 El Nino and malaria transmission in Ethiopia

Thus, the current ENSO state and forecasts indicate a substantive increase to transmission potential in Ethiopia, over the coming season due to a wetter, unseasonal short rains in the south of the country and substantively warmer minimum temperatures at higher altitudes across the highland region. This poses a real short-term risk to current control and elimination programs (Disease Prevention and Control Directorate 2014). In Ethiopia, malaria is highly climate sensitive, but the regions differ in their response to El Niño. Understanding this complexity at scales for local decision-making is only possible with high-resolution locally enhanced climate products such as those now available from NMA along with, knowledge of the local climate system and local knowledge of malaria risks.

We recommend:

- The National Malaria Control and Elimination Program should take advantage of the information forecasting service at NMA Maproom for engaging the most at risk regional states.
- The health sector could also strengthen its case-based surveillance to timely detect in areas of probabilistic risk of malaria outbreak.

References

Abeku, T. A., G. J. van Oortmarssen, G. Borsboom, S. J. de Vlas and J. D. F. Habbema (2003). "Spatial and Temporal Variations of Malaria Epidemic Risk in Ethiopia: Factors Involved and Implications." Acta Tropica 87(3): 331-340.

Disease Prevention and Control Directorate (2014). National Malaria Strategic Plan 2014 – 2020. Addis Ababa, Federal Ministry of Health.

Thomson, M.C. Muhammed, A., Woyessa, A., Kebede A, Jimma D, Diriku, T., Koreche, D., Cousin, R., Bernston, T., Lyon, B. (submitted) "The 2015 El Niño – Implications for malaria in Eastern Africa"

Footnotes

[1] http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/enso_advisory/ensodisc.html2

[2] http://www.wmo.int/pages/prog/wcp/wcasp/gpc/gpc.php

[3] http://www.ethiometmaproom.gov.et:8080/maproom/Climatology/index.html#tabs-3

Appendix 5: Training Materials

All training material PDFs can be found at the following website:
http://iri.columbia.edu/resources/enacts/enacts-training-materials/

Appendix 6: References

1. Dinku, T., Block, P., Sharoff, J., Thmoson, M., (2014a). Bridging Critical Gaps in Climate Services and Applications in Africa. Earth Perspectives. 1(15),
2. Dinku, T., A. Kanemba, B. Platzer and M. C. Thomson (2014b). Leveraging the Climate for Improved Malaria Control in Tanzania." Earthzine.http://www.earthzine.org/2014/02/15/
3. Ghebreyesus TA, Tadese Z, Jima D, et al. Public health and weather services–climate information for the health sector. *Bulletin of the World Meteorological Organisation* 2008; **57**(4): 256–61.
4. Dinku, T., Cousin, R., del Dorral, J., et al., (2016). 'The ENACTS Approach – Transforming Climate Services in Africa One Country at a Time. World Policy Institute.