

Final Report on Activities of the IRI-Google.org project:
“*Building Capacity to Produce and Use Climate and Environmental Information for Improving Health in East Africa*”



‘Climate and Health in Africa –10 Years On’ workshop participants in front of the UNECA Conference Center, Addis Ababa, Ethiopia, April 4-7, 2011; Photo credit Dayan Berhe

Sixth Report (Months 31-40)

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Acronyms

ACMAD	African Centre of Meteorological Applications for Development
ACPC	African Climate Policy Centre
AEWACS	African Early Warning and Advisory Climate Services Project
AfDB	African Development Bank
AfRPC	Africa Regional Program Coordinator
AMA	Anti-Malaria Association, Ethiopia
AUC	Africa Union Commission
CCDA	Climate Change and Development in Africa
CHWG	Climate and Health Working Group
CIESIN	Center for International Earth Science Information Network
CIPHA	Climate Information for Public Health Action
CIPHAN	Climate Information for Public Health Action Network
ClimDev-Africa	Climate for Development in Africa Programme
COP	Conference of Parties
CPT	Climate Predictability Tool
CSMT	Climate Suitability for Malaria Transmission
DfID	Department for International Development, UK
EHNRI	Ethiopian Health and Nutrition Research Institute
ENACT	Enhanced National Climate Time Series
FSSDD	Food Security and Sustainable Development Division
GBMF	Gordon and Betty Moore Foundation
GFCs	Global Framework for Climate Services
GHACOF	Greater Horn of Africa Climate Outlook Forum
GHO	Global Health Observatory
HCF	Health and Climate Foundation
ICPAC	IGAD Climate Prediction and Applications Centre
IFRC	International Federation of Red Cross and Red Crescent Societies
IFPRI	International Food Policy Research Institute
IGAD	Inter-Governmental Authority on Development
IHR	International Health Regulations
IRI	International Research Institute for Climate and Society, Columbia University
KOICO	Korea International Cooperation Agency
MERIT	Meningitis Environmental Risk Information Technologies
MoH	Ministry of Health
NASA	National Aeronautics and Space Administration
NCAR/DC	Centers for Disease Control/National Center for Atmospheric Research
NIEHS	National Institute of Environmental Health Sciences, USA
NMA	National Meteorological Agency
NOAA	National Oceanic and Atmospheric Administration, USA
MODIS	Moderate Resolution Imaging Spectroradiometer
NTD	Neglected Tropical Diseases
PMI	President's Malaria Initiative
RCOF	Regional Climate Outlook Forums

ROSES	Research Opportunities in Space and Earth Science
SADC	Southern Africa Development Community
SI	Summer Institute on Climate Information for Public Health
UNDP-AAP	United Nations Development Programme - Africa Adaptation Programme
UNECA	United Nations Economic Commission for Africa
UNEP	United Nations Environment Program
UNICEF	United Nations Children's Fund
USAID	United States Agency for International Development
WHO	World Health Organization
WHO-AFRO	WHO Africa Regional Office
WMO	World Meteorological Organization
WMS	Web Mapping Service

Section I. Final Progress Report: Sixth Report

Building Capacity to Produce and Use Climate and Environmental Information for Improving Health in East Africa

Introduction: March 2011-December 2011 (Months 31-40)

This is the sixth, and final, issue of the progress reports for this project. It recognizes changes in the project amendment agreements: the first on January 1, 2009, which removed any reliance on the expected 50% joint project funding from the Gordon and Betty Moore Foundation (GBMF), and where, as a result, it was agreed that the geographical scale of the project would be scaled back from regional to national with a focus on Ethiopia; the second on March 30, 2010 following required shifts in effort to IRI and University of Reading staff given the repeated failures to secure both UK and US visas for some Ethiopian trainees that lead to greater emphasis on training in region. While the primary geographical focus of activity has centered on Ethiopia the final months of the project have placed additional emphasis on travel in order to ensure project completion, maximum visibility and dissemination of project outcomes., to maximize regional awareness/impact where available.

Please note, activities are reported on for the period, March-December 2011. A no cost extension was requested and approved in July 2011, due in part to the late arrival of the final tranche of funding and recent changes in staff, including the project Principal Investigator. As the project has now come to a close, we have successfully reached and reported on all of the agreed upon target activities and milestones, within the funding allotment.

As agreed in the amendments, the successful outcome of this project required significant effort in awareness-raising, greater dialogue on climate and health issues as well as research and capacity building among the agencies that support the main players (i.e. the National Ministries of Health and Meteorological Services). As previously reported, awareness and network-building has been achieved in part through the establishment of multi-agency Climate and Health Working Groups. Stakeholders from across Africa were also engaged through the “Climate and Health in Africa: 10 Years On” workshop, a forum to present, debate and evaluate lessons learned, to elaborate on newly emerging perspectives and opportunities for managing climate and health risks in Africa and to establish key recommendations for priority areas for the next ten years.

Research foci have been identified through the resulting dialogue. Research strengthening and operational capacity building has been achieved through the development of appropriate cross-disciplinary training mechanisms.

This reporting period has continued the efforts to train/engage significant numbers of agency staff from both climate and health communities, including capacity building and concerted technical support provided to stakeholders at an Ethiopian data analysis

workshop on the use of climate information in impact assessment for malaria interventions, as well as with staff of the Ethiopian National Meteorology Agency (NMA). The project ended with the official launch NMA's Web-based services, which incorporates IRI Data Library technology and the Enhanced National Climate Time Series (ENACT) developed under the IRI-Google.org project. The new Web-based service disseminates freely a wide range of products

The Ethiopian Climate and Health Working Group (CHWG) have provided critical support in the organization and facilitation of many of these training initiatives in Addis.

Activities under the agreed project outcome headings for this period are summarized in more detail in Section I, below. In Section II, a summary of the overall project and impacts, as well as an appendix of publications/fliers is provided.

Outcome 1: Capacity built to provide information about climate as it impacts on public health

-Development of combined satellite-station climate time series for Ethiopia (browser based/online maps of high-resolution rainfall and temperature time series) and the launch of improved web-based services at NMA.

In Addis Ababa, Ethiopia in December 2011 the efforts towards achieving the previous milestones set out in Outcome 1, culminated with the launch of the web-based services based on the Enhanced National Climate Time Series (ENACT) and other NMA products. The Ethiopia NMA and IRI, with funding from Google.org, have worked to create ENACT products by using a combination of locally calibrated satellite rainfall estimates and all available quality controlled ground-based station data (more than 600 stations). The new climate time series also includes minimum and maximum temperature generated by combining station measurements (from about 300 stations) with NASA's MODIS land surface temperature estimates data and digital elevation model. Both ENACT, derived products, and the web-based services are unprecedented in Africa and many parts of the world. The resulting ENACT components include:

1. Enhanced national climatology time series based on 30 years of good quality 10-daily rainfall and temperature for every 10-km by 10-km grid through combining all relevant data from the national observation network with the satellite proxies;
2. New monitoring products based on observed differences to long-term averages that outcompete all currently available alternative products;
3. An online mapping service (built using IRI Data Library capacity/tools) installed at the NMA providing user-friendly tools for visualization, querying, and accessing information products. The web page of the NMA (<http://www.ethiomet.gov.et/>) has been redesigned for better presentation of its existing products and services, and for the delivery of product derived from the new data set. The Climate Analyses and Applications Map Room (<http://213.55.84.78:8082/maproom/.NMA/>) has five parts: Climate Analysis, Climate Monitoring, Climate and Agriculture, Climate and Water, and Climate and Health. The Climate Analysis and Climate Monitoring Map Rooms have been completed, while the others are still under construction. The Climate Analysis Map Room provides information on the mean climate (in terms of

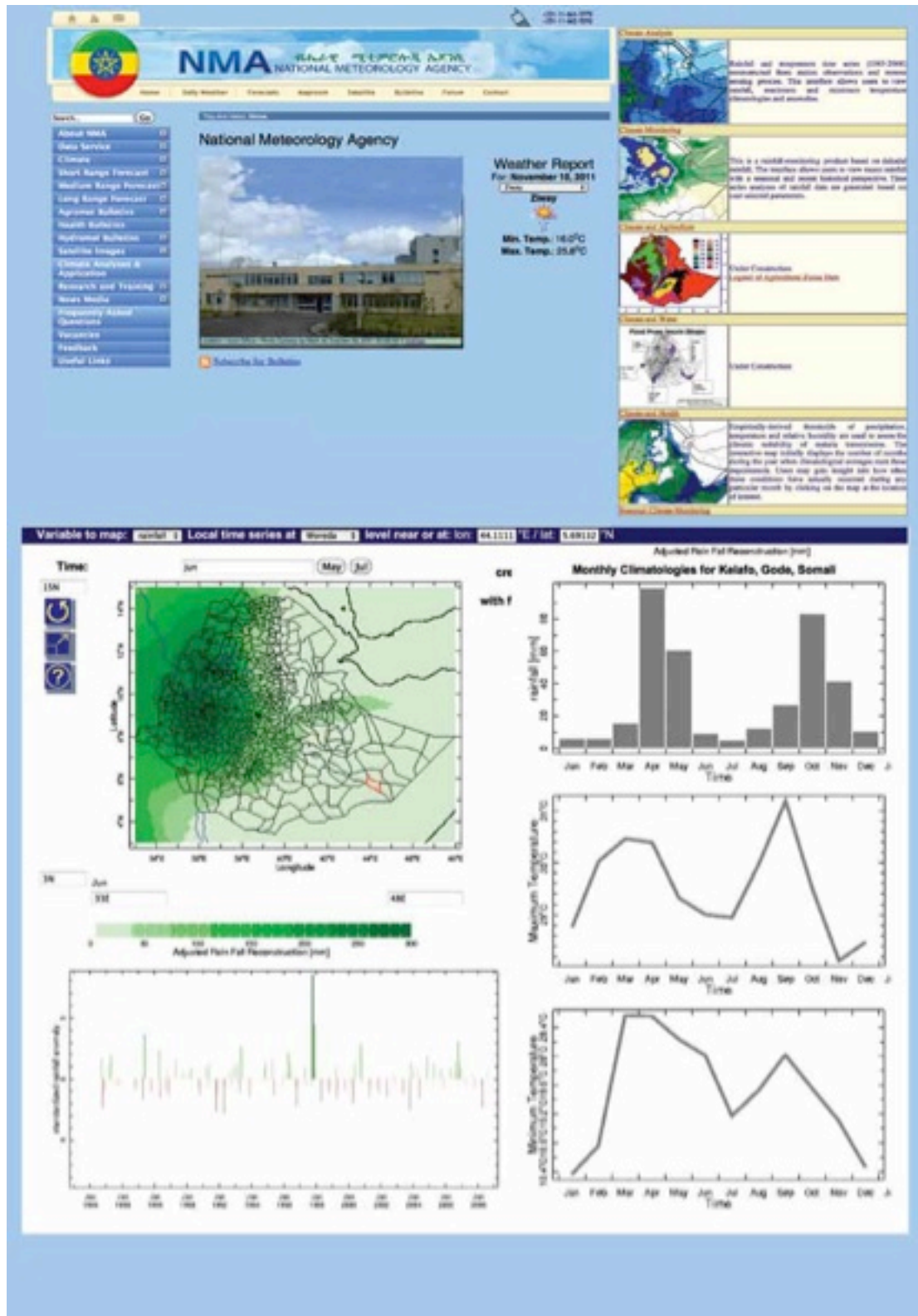
rainfall and temperatures) at any point or for any administrative boundary. It also shows the performance of the rainfall seasons over the years as compared to the mean. The Climate Monitoring Map Room enables monitoring of the current season. Different maps and graphs compare the current season with the mean or recent years. This information could be extracted at any point or for any administrative boundary. Data is updated every ten days, thus enabling close monitoring of the season. Extracting and presenting information at any administrative level enables focusing on specific area of interest.

4. Capacity built at NMA so that the work is sustainable. A number of NMA staff have been trained on different aspects the work. In fact most of the work was done at NMA by NMA staff with technical support from IRI and the University of Reading.

These ENACT product overcomes widely recognized barriers: 1) climate data quantity, quality and dissemination; 2) creation of appropriate and accessible climate services; 3) uptake and use of climate information by development decision-makers; 4) appropriate policy changes that enable better climate risk management (IRI Gap analysis). Thus, the above outcomes have significantly improved the availability, access and use of climate information in Ethiopia.



Participants at the launch of ENACT and other NMA products in Addis Ababa, Ethiopia, December 20, 2011; photo credit: Tufa Dinku



The above images highlight NMA's improved website, designed by IRI and developed by a local company, It is designed in such a way that the user can find information easily. It presents existing and new products from simple station history to more sophisticated maps. It also makes locating and ordering data sets easier. The sector-specific Map Rooms on the right facilitate the use of climate information.

Outcome 2: Capacity built to use and request climate information

Activities agreed to for months 31-end of project (from amendment):

- Regional workshop involving CHWGs with report on project results, products and experiences (April 2011) and dissemination of the Ethiopian experience to the IGAD regional level.

The “Climate and Health in Africa: 10 Years On” workshop was planned as a forum to present, debate and evaluate the lessons learned and to elaborate on newly emerging perspectives and opportunities for managing climate and health risks in Africa. The workshop was held at the United Nations Economic Commission for Africa (UNECA) in Addis Ababa, Ethiopia from April 4-6, 2011. Over 110 stakeholders, representing critical thinkers from multiple disciplines, participated in the 3-day meeting. Participants examined examples of best practices in climate change adaptation in health and deliberated on how to bring key African partners in adaptation together to focus on common demand-driven objectives around an African led agenda. Key outcomes for the workshop include a consensus agreement on priorities for policies, practice, services and data and research and education for the integration of Climate Risk Management into Africa’s health sector. With this as a first step, it was underscored that Africa will be taking the lead in Climate and Health in the future.

The Ethiopian Climate and Health Working Group (CHWG) convened the workshop, along with a steering committee comprised of the United Nations Economic Commission for African Climate Policy Center (UNECA-ACPC), the World Health Organization-Africa Regional Office (WHO-AFRO), the United Nations Development Programme’s Africa Adaptation Programme (UNDP-AAP), the UK Met Office, University of Exeter, UK and the IRI. Google.org, in addition to Columbia University, Health and Climate Foundation (HCF), National Oceanic and Atmospheric Administration (NOAA), National Institute of Environmental Health Sciences (NIEHS) and the Government of Japan, provided sponsorship for the meeting.

The main goal of “Climate and Health in Africa: 10 Years On” was to reduce societal vulnerabilities to climate variability and change in Africa, with a particular focus on implications for public health policy and practice. The workshop was organized around four themes: Policy, Practice, Services and Data, Research and Education. The agenda included panel presentations, discussion and parallel working groups on each of the four themes.

In addition to the three-day workshop, the steering committee met on April 7 to convene a targeted partnership meeting that included representation from the donor community and Ethiopian based foreign embassies. The partnership meeting, presided over by Dr Youba Sokona (UNECA-ACPC) and facilitated by Dr. Michel Jancloes (HCF), aimed to review recommendations from the meeting and to agree on contributions towards a ‘Road Map’ for relevant climate services in support of health development in

Africa. The meeting also defined consensus next steps leading to COP17 in Durban, South Africa and beyond. Following are the key areas of discussion:

- Overview of the workshop recommendations and issues raised;
- Discussion on how to move forward on or implement the recommendations of the “10 Years On” Workshop;
- Opportunities within Africa to present the workshop outputs (including key messages for delivery at COP17 and other regional meetings);
- How to ensure that concrete actions for implementation of the recommendations are obtained;
- Defining the level of participant and steering committee commitment in the future either individually or *via* the institutions represented.



Participants at the opening session of the 'Climate and Health in Africa -10 Years On' in Addis Ababa, Ethiopia, April 4-7, 2011; Photo credit Dayan Berhe

Outcomes and Recommendations

Following an opening address by Food Security and Sustainable Development Division (FSSDD)-UNECA and keynote addresses by WHO-AFRO, the Ethiopian NMA and the Africa Union Commission (AUC), over 100 participants engaged in presentations and discussions of experiences to date, as well as opportunities and challenges in climate and health in Africa. Participants were both providers and users of climate information, including a wide range of policy-makers, practitioners, researchers, donors, advocacy groups, development organizations, and members of the media.

Following are the consensus recommendations of the participants at the workshop:

Theme 1: Policy

Support effective implementation of the Joint Statement on Climate Change and Health in Africa adopted by African Ministers of Health and Environment in Luanda, 2010, as an overarching platform for addressing climate and health issues to:

- **Bridge the gap between policies and practices** through legislation and guidelines, appropriate planning, including relevant vulnerability assessments, programmatic support and multi-sectoral and participatory processes that are gender sensitive.
- Support countries to establish **integrated health surveillance and climate observation and processing systems**.
- **Strengthen health systems** using climate information tailored to decision needs at all relevant levels and time scales.
- Make evidence-based, sound climate-informed decisions to implement a set of **preventive actions** to reduce population vulnerability and lessen the additional burden imposed by **climate-sensitive diseases and health issues** according to their respective epidemiological circumstances.
- **Anticipate, prepare for and respond** to the health consequences of **extreme weather events**, particularly by strengthening the functioning of health systems and other relevant sectors.
- **Multilateral partners** to consider the significant co-benefits of environment integrity, population health and consequent economic development that can result from mitigation and adaptation policies in the climate and health sectors and to support African countries in gaining **access to resources under the various climate-related funds**.

Theme 2: Practice

- Integrate climate health risk management into **cross-sector planning and practice for adaptation** to climate variability and change by developing climate services and products that address disease prevention at end-user level.
- **Create a human resource center/virtual hub** where expertise is shared in order to develop the capacity of African health and climate communities, institutions, practitioners and negotiators to understand/integrate climate change challenges into policy, socio-economics, planning and programming by identifying institutions and organisations in Africa that can deliver **training courses and conduct research on “Climate, Health and Prevention”**.
- **Strengthen community-based organisations** by liaising, in a gender-sensitive fashion, with their leaders to develop locally owned **sustainable strategies for adaptation to climate change and/or variability** in their communities taking account of local knowledge rooted in social history and disseminated by appropriate channels, including the mass media.
- **Define the different levels and needs (including learning outcomes) of health practitioners and stakeholders** across different geographic scales, specifically researchers and teachers, graduate and undergraduate students, practitioners in the public health system, community opinion leaders, traditional healers, impacted communities and other special interest groups and **develop appropriate curricula for adaptation to climate change and/or variability** in the health sector.
- **Promote a gender-sensitive approach to interventions** on climate and health in cross-sectoral disaster risk reduction and preventive health strategies.

Theme 3: Services and Data

- **Develop tailored services** in partnerships with weather/climate and health organisations. These should recognise that health forecasts, which are different from weather forecasts, should be well designed and understood by all. They should act as early warnings to users of differing types, that assist in the prediction of future health outcomes.
- **Improve existing data**, for example through: the digitisation of historical health and climatic data; the increased use of metadata analyses and validation tools; the inclusion of aggregated health data at appropriate spatial and temporal scales; and the enhanced awareness of, and use of, observational and processed data, appropriate satellite, and climate model data sources.
- **Access and use data in a systematic manner** in order to identify vulnerable groups and areas. This needs to involve: employing data strategically within and across sectors; considering trend and seasonality issues; using data to evaluate the success of interventions; and, importantly, understanding how communities cope.
- **Incorporating other data into these health forecast services**, for example population, rural vs. urban residence, migration, nutritional status, environmental and poverty data.
- **Collaboration +: new, multi-disciplinary initiatives** that involve communities beyond health and climate/ weather; build upon existing initiatives and progress; aim to meet emerging challenges; and communicate with end-users in appropriate ways.
- **Commitment at all levels** that brings climate and health communities together, clarifies responsibilities, builds capacity in the climate and health sectors to achieve these services, facilitates joint initiatives and ensures resources such as data are shared in a suitable way.

Theme 4: Research and Education

- **Understand the relationships between climate and climate-sensitive diseases and health issues** under different environmental conditions through interdisciplinary, multi-sectoral and multi-centre research.
- **Ensure that climate change mitigation and adaptation strategies are informed by multi-disciplinary research.**
- **Develop capacity within Africa** for the generation, interpretation and use of climate, health and other interdisciplinary data enabling informed, evidence-based decision making.
- **Standardise and quality control** data collection and storage, ensuring data are available on relevant temporal and spatial scales.
- **Enhance knowledge transfer and communication** of information across disciplines and communities through existing networks, encouraging the introduction of climate and health into the curriculum at all levels of education.
- **Strengthen existing partnerships and collaborations** while developing new groups and building links across disciplines.

During the workshop, a five-year memorandum of understanding was signed between the Ethiopian CHWG and ACMAD with the aim to combat and mitigate the effects of climate variability and change on climate sensitive diseases, extend lessons learned, best practices and training.

The Ethiopian CHWG also proposed a Pan-African Climate and Health Working Group and solicited initial membership from workshop participants.

Judy Omumbo presented the results of the workshop at the Climate Change and Development in Africa – 1 (CCDA) meeting in Addis on the 17th of October 2011. Follow-up from 10 Years On workshop also includes the development of two African based research capacity building initiatives on vector-borne diseases and climate.

For more information on the above activities, please see the April 2011 *Climate and Health in Africa: '10 Years On' Workshop* report available at the link below:

<http://iri.columbia.edu/publications/id=1090>

From Amendment, Outcome 2 Milestones:

The resulting tools and deliverables and demonstration of their uptake and use in Ethiopia will be highlighted in a regional workshop aimed at launching demand for greater up-take within the IGAD region of East Africa (and elsewhere).

-Malaria and climate data analysis workshop in Addis Ababa, December 2011

The workshop, 'Use of Climate information in Impact Assessment for Malaria Interventions', was held with support from the Federal Ministry of Health and the National Meteorological Services Agency of Ethiopia, at the UNECA Conference Center, in Addis Ababa, Ethiopia from December 12-14, 2011. This data analysis workshop directly built upon the detailed list of recommendations, outlined at the recent 'Climate and Health in Africa: 10 Years on' workshop, for improving the management of climate sensitive health outcomes through the better provision of climate services, and building capacity in the health community to use climate information in routine decision-making.

The December 2011 workshop was planned as a platform for "hands-on" data analysis, whereby participants reviewed malaria indicators and climate data generated from the new, Google.org funded, ENACT products (discussed in Outcome 1, above). The data was used to explore the impacts of climate on disease trends, and test methodologies for impact evaluation for malaria interventions in Ethiopia. The workshop sought to establish data and methods whereby the confounding effect of climate variability on malaria impact assessment could be removed.

The main objectives of the workshop were to: 1. Introduce the ENACT products to the Ethiopian Malaria community, 2. Investigate possible associations between climate variability and trends, and malaria transmission in Ethiopia between July 2004 and June 2009 at sub-national levels, using the comprehensive IDSR data set made available by the Ministry of Health, and 3. Establish a methodology for removing the confounding effect of climate on impact evaluation for malaria interventions in Ethiopia using a range of local malaria data sets and the ENACT product.

The workshop included presentations and practical analysis sessions. Participants were introduced to health and climate (ENACT) data, methodologies for how the data was

obtained/recorded, and various group exercise conducted in Excel and using mapping tools available in the IRI Data Library. Each session ended with a discussion of the usefulness of the analysis and implications for Ethiopia’s national malaria control program. Participants were also encouraged to propose further analyses.

A total of 28 participants took part in the workshop. They came from a wide range of backgrounds: health practitioners from federal and regional health bureaus, researchers from universities, development organizations, donors, and the NMA of Ethiopia.



Participants of the workshop on “The use of Climate Information in Impact Assessment for Malaria Interventions” held in Addis Ababa, Ethiopia December, 2011

Outcomes and Recommendations

At the end of the workshop, participants had achieved the following outcomes:

- Demonstrative capability for accessing, querying and using the NMA MapRoom for malaria analysis.
- Familiarity with specific descriptive and statistical tools used to analyze malaria and climate relationships.
- An initial assessment of the relative importance of climate as a determinant of malaria incidence in different ecological zones.
- Those individuals who brought their own data to the workshop were able to use the tools developed (including an excel spreadsheet designed to assess the degree of association between anomalies in climate and anomalies in malaria incidence) to assess the climate sensitivity of their own data and to explore in more detail impacts of climate on malaria outcomes.

- Participants from NMA were able to report on the different climates of the 8 regions of Ethiopia and the climate anomalies that have occurred in these regions over the last 28 years.

Following are the key areas of discussion and recommendation:

Multi-disciplinary and integrated approach

- Malaria is a complex disease so a multi disciplinary and integrated approach is needed including information on climate, environment, vectors, epidemiology, as well as an understanding of local social factors.
- The 30 years of quality controlled climate data recently made available for Ethiopia by the NMA via the MapRoom is a great first step, however this data needs to be integrated with other data of relevance to malaria, as indicated above.

Data sharing platform

- **The efforts the Climate and Health Working Group/AMA Ethiopia should be reinitiated and strengthened** to help solve gaps in awareness, quality control malaria data and tools. This workshop provides a key opportunity to do this.
- A technical team from the CHWG should prepare a proposal for obtaining data by clearly justifying the purpose and importance of the data to the concerned decision makers.
- Although the recent decline in malaria could be strongly attributed to interventions, **there should be a mechanism where by we can determine that the decline is due to the intervention or other factors like climate.** A statistical tool that can integrate different information (surveillance, prevalence, quality time series facility data, climate and interventions, etc.) to explore change over time will be of value.
- **Data collected historically for research purposes should be accessed where possible** to ensure that consistent and quality data sets can be made available for new analysis, through contacting authors and made available for further analysis.

Climate Suitability for Malaria Transmission (CSMT)

The results achieved indicate that the tool is good at capturing the uni-modal or bi-model seasons and indicating where temperature, rainfall or humidity may be a limiting factor; however, it could be greatly improved if:

- the relationship between CSMT and cases could be quantified across the country
- if the lag time between the malaria transmission, suitability and expected cases was defined

- if the temperature threshold (currently set for *P.falciparum* at 18° c- 32° c) was also set for *P.vivax* 16° c- 30° c).

MapRoom

- It was recommended that a **drop down menu for individual woredas** might help the user identify the right administrative boundary in the woreda NMA MapRoom interface.

Malaria and Climate Analysis

- The malaria and climate concordance tool was very however the level of concordance does not imply significance in the relationship and **other statistical tools need to be developed to help further explore the data sets.**

For more information on the above activities, please see the December 2011 ‘*Use of Climate information in Impact Assessment for Malaria Interventions*’ Workshop report available at the following link: <http://iri.columbia.edu/publications/download=1136>

Outcome 4: Project coordination, implementation, assessment and reporting

Activities agreed to for months 31-end of project (from amendment):

-Advisory and implementation visits to the region (both Ethiopia and Kenya) and partners (e.g. University of Reading, Google and OpenHealth).

The project provided travel support for Barbara Platzer to participate in and organize the IRI co-hosted “Climate and Health in Africa: 10 Years On” workshop in Addis Ababa, Ethiopia. This trip was taken from March 3rd to April 9th, 2011. Katikiti, an in-region partner, was also sponsored to attend this meeting from April 2nd to the 7th.

Judy Omumbo also traveled to Addis Ababa for the “10 Years On” workshop from March 3rd to April 9th, 2011 to participate and provide organizational support. From May 21st to the 24th Judy traveled to Geneva, Switzerland. The purpose of this trip was to attend the 16th Congress of the World Meteorological Organizations (WMO) and to participate in a side meeting on “Climate and Health in Africa: Outcomes from Ethiopia”.

The project also provided support for Steve Connor to attend the “10 Years On” conference. Here he participated in and helped to organize the workshop. From May 16th to the 23rd, Steve participated in discussions with UK DFID: Climate, Environment, Health and followed up with partners from the “10 Years On” conference. These meetings occurred in London, UK. In addition, Steve was funded to participate in the 4th Centers for Disease Control/National Center for Atmospheric Research (NCAR/DC) Biannual

Colloquium on Climate and Health in Denver, CO. This conference took place from July 10th to the 16th.

Additionally, Tufa Dink was partially funded to travel to Tanzania and Ethiopia to participate in the African Climate Policy Centre workshop (ACPC). He also had discussions with the Tanzania Meteorology Agency and furthered the Google.org-IRI project in Ethiopia. This trip was from April 11th to the 27th. From June 19th to July 31st he was working on project activities (in Ethiopia) and attending a USAID Workshop in Senegal. This also included a trip to Tanzania to discuss proposal plans for replicating the Ethiopian climatology work. From October 15th to the 31st Tufa traveled to Addis Ababa to attend the Climate Change and Development in Africa (CCDA) Conference, work on project activities and meet with project partners. He traveled back to Addis from the 29th of November to the 22nd of December to participate in the Malaria Climate Workshop and prepare and launch the NMA's new services.

The project provided support for John del Corral to travel to Addis from June 11th to the 23rd in order to install the portable IRI data Library for the NMA. From October 9th to the 16th Remi Cousin traveled to Addis to provide training on MapRoom use at the NMA. Remi also traveled to Addis in December to update the NMA's Analysis and Applications Maprooms, and participate in the workshop on the use of Climate Information in Impact Assessment for Malaria Intervention.

Madeleine Thomson was funded by the project to complete CCDA-1 visits to PMI and participate in the Healthy Futures Expert Review Panel. She visited Kampala, Uganda and Addis in October. From December 8th to January 9th Madeleine was in Addis to facilitate a workshop titled, "Use of Climate Information in impact assessment for Malaria interventions", and to launch the Enhanced National Climate Time Series (ENACT) products.

-Report coordinated by Ethiopian CHWG.

The Ethiopian Climate and Health Working Group (CHWG) is a collaborator on this final report, on the activities of the IRI-Google.org project: *"Building Capacity to Produce and Use Climate and Environmental Information for Improving Health in East Africa"*

-Sixth and final consolidated report on project activities and findings.

This report serves as the sixth and final consolidation report on the project activities and findings of the IRI-Google.org project: *"Building Capacity to Produce and Use Climate and Environmental Information for Improving Health in East Africa"*.

-Potential next steps beyond the project cycle.

Broad dissemination of the projects results through the Global Framework for Climate Services (GFCS), USAID and CLIM-Dev Africa.

From Amendment, Outcome 4 Milestones:

Finalizing dialogue with partners and beneficiaries. Project activity supervision, monitoring, evaluation and reporting. Elaboration of lessons learned and potential next steps beyond the project cycle. Project completion.

Section II. Consolidation Report on Project Activities and Findings

A. Context and development focus of the Google project

Prior to this project, health practitioners in Eastern Africa had little opportunity to explore the potential value of climate information in health decision-making. In addition climate scientists had little understanding of what information might be relevant for the health field, as well as how to produce it and make it available. A review commissioned in support of the Global Climate Observing System Climate for Development in Africa (IRI 2006) attributed this gap to “Market Atrophy”; no effective supply of useful climate information and consequently no informed demand. This project has attempted to deal with the full spectrum of key issues that needed to be addressed, including improvements in policy, practice, services and data.

After three years of effort, the situation in Ethiopia is radically different:

1) Policy

Health policy makers are seeking out climate information to improve their decision-making, most notably in the areas of early warning for epidemics and impact assessment for malaria interventions. For instance, WHO and partners used the products developed through this project to assess the risk of malaria in the Somali Refugee Camps in the Horn of Africa. In addition, the Presidents Malaria Initiative (PMI) partnered with the project in a training on the use of climate information in health impact assessments, and subsequently resourced a pilot study on the use of climate information in impact assessments in Ethiopia and Tanzania. The rich knowledge gained through the intensive work in Ethiopia has been shared within the region and across the continent. The 100 person-plus stakeholder workshop, ‘Climate and Health in Africa – 10 Years On’, was a milestone in terms of the development of clear recommendations for the creation of climate services for the health community across Africa.

2) Practice

A broad health research and practitioner community has been engaged in dialogue, under the auspices of a new interfacing institution the Climate and Health Working Group (CHWG) of Ethiopia. Through this process, and many hands-on training workshops, a new and ever improving knowledge base on when and how to consider climate information in health decision-making has been shared. The Ethiopian CHWG has gone on to inspire others in Madagascar, Kenya, Burkina, Mali, Niger and elsewhere. Likewise, trainees have gone on to train others. A key outcome of this has been the emergence of a practitioner community across Africa and a curriculum designed to bring climate and health specialists together to focus on reducing climate sensitive health challenges. Evidence of local ownership of this process and products of the training can be seen in the training reports, as well as in the publications led by our partners and funded students.

3) Services

The creation of new and improved climate products, including better quality forecasts for the region, and greatly improved historical and monitoring products encapsulated in the newly released Enhanced National Climate Time Series (ENACTS) product, are having a dramatic impact on the way climate information is perceived and used. As the Deputy Director of the Ethiopian National Meteorological Agency said when launching the new NMA website, now incorporating IRI Data Library technology, “We have moved from a one desk NMA, to a one click NMA”. ENACT products are designed to aid in the creation, dissemination and use of climate information for health and other sectors (including agriculture and disasters). As a result of this success, similar products are in development in Madagascar and Uganda, with plans for similar activities in Tanzania, Mali, Burkina and other countries. Donor interest in support of these activities has been committed or expressed by the World Bank, USAID, the World Meteorological Organization, as well as African based sources including ClimDev-Africa.

4) Data

This project has enabled the development of cutting edge blended satellite and rainfall products (ENACT), leveraging critical 21st century technology in a region traditionally assumed to be data poor. Using these enhanced products, an extensive community of African meteorologists has been trained in the creation and delivery of improved climate services to the health and other sectors. In particular, the project’s focus on access to and creation of quality-controlled data has helped to create evidence-based services, aligning the outcomes with the newly established Global Framework on Climate Services (GFCS).

B. Summary of main activities and findings

(Further details regarding the below activities can be found in the individual funding milestone progress reports, already provided to Google.org.)

Outcome 1: Capacity built to provide information about climate as it impacts on public health

The efforts and activities of Outcome 1 culminated with the launch of the web-based services based on the Enhanced National Climate Time Series (ENACT) and other NMA products, in Addis Ababa, Ethiopia in December 2011. The Ethiopia NMA and IRI have worked to create ENACT products by using a combination of locally calibrated satellite rainfall estimates and all available quality controlled ground-based station data (more than 600 stations). The new climate time series also includes minimum and maximum temperature generated by combining station measurements (from about 300 stations) with NASA’s MODIS land surface temperature estimates data and digital elevation. Both ENACT, derived products, and the web-based services are unprecedented in Africa and many parts of the world.

These ENACT product overcomes widely recognized barriers: 1) climate data quantity, quality and dissemination; 2) creation of appropriate and accessible climate services; 3) uptake and use of climate information by development decision-makers; 4) appropriate policy changes that enable better climate risk management (IRI Gap analysis). Thus, the

above outcomes have significantly improved the availability, access and use of climate information in Ethiopia.

The launch of these tools, product training, the ENACT products and other NMA products, are further described in detail in Section I of this report.

NMA staff trained and competent in development of verifiable seasonal climate forecasts for Ethiopia (rainfall and temperature) and in routine operational production of blended satellite-ground station monitoring products. These are of direct use to health services in Ethiopia in dynamic mapping and monitoring of climate sensitive diseases.

However, the use of the new products and tools goes beyond the health community. Thus, maximizing the benefits of the developed products and tools will require training more users from different disciplines on accessing and using the products. NMA has plans to offer training workshops for different users.

The following activities supported the above project outcome:

- ***Meteorological staff trained in statistical techniques in seasonal forecasting. Training at IRI of NMA staff in statistical tools for seasonal forecasting - rainfall, temperature, extremes – and in verification techniques:*** Google funds supported the training of Kassa Fekadu from the Ethiopian NMA, for three months at the IRI.
- ***Climate Predictability Tool (CPT) training at Ethiopian NMA, May 23-June 1, 2009.***
- ***Forecast verification workshop at ICPAC, February 23-28, 2009.*** In February 2009 a one-week capacity building workshop was held in Nairobi, Kenya, immediately prior to the Greater Horn of Africa Climate Outlook Forum (GHACOF). The aim was to improve the quality of the seasonal climate outlook forums produced by GHACOF, by identifying and correcting for any systematic errors in the way the forecast are made. Earlier results conducted through a collaborative project with the African Center of Meteorological Applications for Development (ACMAD) had indicated a noticeable tendency for forecasters at all the African Regional Climate Outlook Forums (RCOF) to hedge the forecasts towards high probabilities on the normal category. This hedging tendency is an almost inevitable outcome of the large subjective component that is permitted in the construction of the RCOF forecasts, but it is problematic because it reduces the quality of the forecasts and makes it harder for users of the forecasts to assess the actual risks of anomalous rainfall. However, the ACMAD results were obtained using satellite-based estimates of observed rainfall, and the results were not perceived to have any detectable impact on the forecast production. The objectives in the Nairobi workshop were to recalculate the verification results using gauge-based data, and to have the forecasters perform the verification analyses themselves to increase the likelihood of effecting a change to the forecast process. The verification results did confirm the conclusions from the ACMAD analyses, but more specifically, a correction was made to the GHACOF forecast that was about to be released in order to reduce the hedging

that was clearly evident in the initial draft. The conclusions drawn at the capacity building workshop were clearly taken on board, since hedging in subsequent GHACOF forecasts has been reduced. Similar independent workshops have been conducted in West Africa in an attempt to improve the forecast quality in that region too. Although it is far too early to perform a rigorous assessment of changes in forecast quality as a result of these workshops, simple inspection of the forecasts themselves can demonstrate the changes that have been made. Further work is required to reinforce these results and to extend the impact to other regions in Africa and beyond, but the Nairobi workshop marks a significant turning point in the process of improving the forecast quality of the RCOFs.

Work shop report: Mason, S. J. 2009. Recommended Procedures for the Verification of Operational Seasonal Climate Forecasts, World Meteorological Organization, Commission for Climatology XIV Expert Team on CLIPS Operations, Verification, and Application Service. WMO Geneva.

- ***Training at University of Reading of NMA staff in creation of satellite-station climatology for Ethiopia to produce 30-year time series of temperature and rainfall.*** Following unsuccessful applications, appeals and final refusals for UK visas for the Ethiopian trainees by the British Government - many of the training components of this work had to be carried out in Ethiopia instead of at the University of Reading as originally planned. Ultimately, this proved to be a positive development as many more NMA staff were trained. Tufa Dinku and three scientists from the University of Reading's Department of Meteorology conduct a training program on "Satellite rainfall estimation for long term rainfall time series for Ethiopia" held at NMA, December 7-11, 2009. The general objective of the training was to enhance NMA's capacity to provide its users, including the health sector, with quality-controlled historical and real-time data for the whole country.
- ***Data acquisition/NMA web development and training.*** Tony Barnston, Ousmane Ndiaye and Tufa Dinku (from IRI) conducted a training workshop on "Seasonal Prediction and the Use of the Climate Predictability Tool", from November 30 to December 4, 2009. The 25 participants explored the climate predictability tool as a means for understanding principles of seasonal prediction, the statistical techniques that can be used in seasonal prediction, the preparation of seasonal forecasts, and the verification methods which measure forecast skill. As a result of this training (and the May 2009 training at IRI of Mr. Kassa Fekadu), the NMA has started using CPT operationally for its seasonal predictions.
- ***Training of Ethiopian meteorologist at NMA in satellite temperature blending techniques and use of MODIS for estimation of night-time temperatures.*** The Ethiopian meteorologist, Mr. Zerihun Bikila, was refused a US entry visa in August 2009. Alternate plans were made to train Mr. Bikila in Ethiopia. IRI's Pietro Ceccato and Tufa Dinku led a workshop, held February 2-4, 2010, at NMA headquarters in Addis Ababa, Ethiopia. It focused primarily on land surface temperature retrieval from satellites and interpolation of station temperature observations.
- ***Assessment of the temperature monitoring capabilities of MODIS for Ethiopia.*** Following the methodology developed by Vancutsem, et al. (2010), comparisons MODIS Land Surface Temperature (Ts) and station measurements (Ta) were made over different ecosystems and seasonal periods in Ethiopia. This was also done during the training session above, station measurements collected by NMA for the

two years 2005 and 2006 were compared with data extracted from MODIS. Comparisons demonstrated good correspondence between Ts and Ta for minimum temperature but less agreement for maximum temperature.

- ***Visit of Kinfe Hailemariam Beyene, Head of the Data Management and Dissemination Department, Ethiopian NMA, to IRI, November 16-20, 2009.***
- ***Development of satellite-station climate time series for Ethiopia (browser based/online maps of high-resolution rainfall and temperature time series) and the launch of improved web-based services at NMA.*** In Addis Ababa, Ethiopia in December 2011 the previous efforts towards achieving this millstone culminated with the launch of the web-based services based on ENACT and other NMA products (discussed in further detail in Section I above). The web page of the National Meteorology Agency (<http://www.ethiomet.gov.et/>) has been redesigned for better presentation of its existing products and services, and for the delivery of product derived from the new data set. The Climate Analyses and Applications Map Room can be found here: <http://213.55.84.78:8082/maproom/.NMA/> and has five parts: Climate Analysis, Climate Monitoring, Climate and Agriculture, Climate and Water, and Climate and Health.
- ***CPT and Verification Training in Ethiopia, August 23-28, 2010.*** A short summary report on the seasonal forecasting, verification and use of IRI's Climate Predictability Tool (CPT) workshop held at NMA in Addis, Ethiopia can be found at: http://iri.columbia.edu/docs/114/NMATrainingSummaryReport_CPT.pdf

Outcome 2: Capacity built to use and request climate information

In the final year of the Google.org-IRI project the "Climate and Health in Africa: 10 Years On" workshop was held as a forum to present, debate and evaluate the lessons learned and to elaborate on newly emerging perspectives and opportunities for managing climate and health risks in Africa. This workshop in Addis Ababa, Ethiopia from April 4-6, 2011 brought together 110 stakeholders, representing critical thinkers from multiple disciplines, to reduce societal vulnerabilities to climate variability and change in Africa, with a particular focus on implications for public health policy and practice. The workshop was organized around four themes: Policy, Practice, Services and Data, Research and Education. The agenda included panel presentations, discussion and parallel working groups on each of the four themes. This conference served as a major culmination of much of the capacity building and stakeholder engagement activities over the course of this project. Further details regarding the "Climate and Health in Africa: 10 Years On" workshop can be found in Section 1 of this report.

Another major achievement, resulting from the activities in Outcome 2, is the development and testing of training curricula, as well as the creation of a network of engaged public health and climate professionals. A key outcome of the summer was the creation of the 'Climate Information for Public Health Action' (CIPHA) Standard Core Curriculum, which builds heavily on the 2008, 2009 and 2010 Summer Institute curricula. This has been developed in partnership with the Center for International Earth Science Information Network (CIESIN) and the Mailman School of Public Health. It also captures lessons and experiences from the tailored trainings on CIPHA that have

been implemented in Ethiopia and Madagascar in 2009 and 2010, some with project support and all of which relied on inputs from SI alumni and local partnerships. SI alumni have been involved in leading these in regional climate and health training initiatives in Africa. This established training material cuts across the six ways we use climate information (spatial risk, seasonal risk, year-to-year variability, long-term trends, impact evaluation and understanding the mechanisms of climate sensitive diseases) and will be a critical way to engage more stakeholders in capacity building activities in the future. Alumni also regularly contribute content to and participate in the dissemination of the CIPHA newsletter, which provides updates on the latest developments within the CIPHA network. For links regarding educational material and contributions from SI alumni, see the SI, capacity building and workshops activity summaries below.

Reinforcement of awareness raising and practical demonstration of the value of using climate/environmental information to understand climate-health linkages and guide improved and more timely control of climate sensitive disease in Ethiopia (and elsewhere). Information needs elaborated – development and demonstration of service in response to expressed needs.

The resulting tools and deliverables and demonstration of their uptake and use in Ethiopia will be highlighted in a regional workshop aimed at launching demand for greater uptake within the IGAD region of East Africa (and elsewhere).

The following activities supported the above project outcome:

- ***Project participants trained in use of climate information for public health. Climate Matters workshops – Ethiopia.*** Following the establishment of the Ethiopian CHWG, the group organized and hosted a three-day “*Science and Technical Workshop*” in Addis Ababa in September 2008. The workshop attracted over 60 participants from national and sub-national level offices across the disciplines and agencies interested in Climate and Health issues in Ethiopia. Priorities were identified and recommendations were made on moving forward on these issues, including the development of appropriate training of practitioners in relation to using climate and environmental information to guide more effective health interventions. In addition, strategic issues relating to the function and sustainability of the CHWG itself were raised. Following publicity surrounding the Ethiopian CHWG, the WMO and WHO decided to sponsor the establishment of a similar CHWG in Madagascar. IRI was invited to participate at no expense to the project.
- ***Training of partner personnel in use of climate information for public health at the Summer Institute.*** The Summer Institute is an annual two-week training course that exposes participants to data, methods and tools for integrating climate information into public health decision-making processes. The second annual Summer Institute on Climate Information for Public Health was held June 1-12, 2009 on the Lamont campus of Columbia University. This project’s funds supported four participants, three from Ethiopia and one from Kenya. The 2009 Summer Institute report can be found here: <http://iri.columbia.edu/publications/id=909>.

The third annual Summer Institute on CIPHA was held May 17-28, 2010 in New York. The IRI-Google project supported the tuition and travel of three participants from Ethiopia. A complete report of the 2010 Summer Institute can be found online at: <http://iri.columbia.edu/publications/id=1011>. In 2010, for the first time since the implementation of the Summer Institute, the Climate Information for Public Health Action Network (CIPHAN) web platform supported all course materials, available online at: <http://ciphan.iri.columbia.edu>.

Alumni of the Summer Institute regularly contribute content to and participate in the dissemination of the CIPHA newsletter, which provides updates on the latest developments within the CIPHAN. The CIPHA newsletter is available at:

<http://iri.columbia.edu/education/ciphnews>.

- **CHWG workshop- Ethiopia (scheduled for September/October 2009).** With support from this project, the Ethiopian CHWG held its General Assembly, October 30-31 in Addis Ababa with the key objectives of increasing awareness amongst stakeholders on the linkages between climate and health, reporting on the year's activities, reporting on its five year strategic plan developed with UNICEF support, evaluating the current achievements of the CHWG, disseminating new research findings on climate sensitive diseases and strengthening the collaboration between existing members of the working group. The CHWG also used the General Assembly as a means of seeking new opportunities for outreach, partnership and resourcing. A full report can be found online at: [http://iri.columbia.edu/~bplatzer/Google 3rd report Feb10/CHWG Oct09 GA report](http://iri.columbia.edu/~bplatzer/Google%203rd%20report%20Feb10/CHWG_Oct09_GA_report)
- **CHWG workshop/MALOF – Kenya.** On November 4, 2009, with support from the project, IRI held a symposium on "Building Capacity to Use Climate and Environmental Information for Improving Health Outcomes" at the 5th MIM Pan-African Malaria Conference, the premiere malaria conference targeting experts in infectious disease research and control from both Africa and the international community. For a full report on all associated activities around the MIM, please see: [http://iri.columbia.edu/~bplatzer/Google 3rd report Feb10/IRI Report on MIM symposium and joint CHWG meeting Nov04.09.pdf](http://iri.columbia.edu/~bplatzer/Google%203rd%20report%20Feb10/IRI%20Report%20on%20MIM%20symposium%20and%20joint%20CHWG%20meeting%20Nov04.09.pdf).
The MIM symposium was also reported on at: <http://www.tropika.net/svc/specials/mim2009/session-reports/symposium-29>.
- **Implementation of Climate and Health training.** This project supported a training workshop on Climate Information for Public Health in Ethiopia, November 30-December 5 at UNECA in Addis Ababa. The workshop was a 6-day training course for health professionals, with a curriculum based on the 2008 and 2009 Summer Institutes and further tailored to local conditions. A full report on the workshop can be found online at: <http://iri.columbia.edu/publications/id=981>.
- **Support of Masters in Public Health student summer projects (health data collection and analysis).** A full report by the CHWG on this activity can be found at: [http://iri.columbia.edu/~bplatzer/Google 4th report Aug10/CHWG Report student support.doc](http://iri.columbia.edu/~bplatzer/Google%204th%20report%20Aug10/CHWG%20Report%20student%20support.doc).
- **Survey of participants in Ethiopian CHWG meetings plus institutions and partners.** The baseline report on the capacity of the NMA for providing climate information to the health sector can be found at:

[http://iri.columbia.edu/~bplatzer/Google 4th report Aug10/NMA Survey Report DraftFeb.10.doc](http://iri.columbia.edu/~bplatzer/Google%204th%20report%20Aug10/NMA%20Survey%20Report%20DraftFeb.10.doc).

A team supervised by Mr. Adugna Ayantu of the Ethiopian Health and Nutrition Research Institute (EHNRI) has completed a baseline survey to assess the awareness of and use of climate information for managing disease in the Ethiopian Federal Ministry of Health (MoH). **The final report can be found at:**

<http://iri.columbia.edu/docs/114/DraftReportPublicHealthSurvey.pdf>

- **National Ethiopian CHWG workshop- Demonstration/service delivery of Health Map Room products (around October/November 2010).** Leading up to August 2010 the Ethiopian CHWG was engaged in many national and international fora relating to climate and health, including those listed below. As a consequence, project support for national CHWG workshops, initially proposed for March and October/November 2010, was postponed to later in the project cycle. Examples of CHWG engagements at the national and regional scale leading up to August 2010 include, at no cost to the project:
 - The African Early Warning and Advisory Climate Services Project (AEWACS – ViGIRisC), launched in Addis Ababa, March 25-26, 2010.
 - The First Conference of Ministers responsible for Meteorology in Africa, organized by the World Meteorological Organization (WMO) in partnership with African Union Commission, held under the theme “Investing in weather and climate services for development” in Nairobi, Kenya from April 15-16, 2010.
 - A conference held at the UN Conference Centre in Addis Ababa to celebrate Earth Day on April 22, organized by the newly formed Climate Change Forum for Ethiopia (CCC-E).

For more information on the above activities, please see the June and July 2010 CHWG newsletters and August 2010 CHWG Highlights linked to below:

[http://iri.columbia.edu/~bplatzer/Google 4th report Aug10/CHWG newsletter June10.pdf](http://iri.columbia.edu/~bplatzer/Google%204th%20report%20Aug10/CHWG%20newsletter%20June10.pdf)

[http://iri.columbia.edu/~bplatzer/Google 4th report Aug10/CHWG newsletter July10.pdf](http://iri.columbia.edu/~bplatzer/Google%204th%20report%20Aug10/CHWG%20newsletter%20July10.pdf)

[http://iri.columbia.edu/~bplatzer/Google 4th report Aug10/CHWG highlights Aug10.pdf](http://iri.columbia.edu/~bplatzer/Google%204th%20report%20Aug10/CHWG%20highlights%20Aug10.pdf)

- **Regional workshop involving CHWGs with report on project results, products and experiences (around May/June 2011) and dissemination of the Ethiopian experience to the IGAD regional level.** Project funding was provided to the CHWG to host three significant initiatives in November. These kicked off with a National Seminar on Public Health and Climate held at the School of Medicine at Addis Ababa University, followed by the 4th International/National MERIT meeting and a two-day Climate & Malaria workshop. The latter was a localized response to needs arising out of the Global Malaria Report process expressed by both WHO and the President's Malaria Initiative.

The 4th MERIT Technical Meeting was organized by the MERIT Steering Committee in partnership with the CHWG and was held November 19-20, 2010. A full report can be found at: <http://iri.columbia.edu/publications/id=1064>

The Climate and Malaria workshop, from November 22-24, was designed with a hands-on approach to analyze malaria and climate datasets to explore the associations between climate variability and malaria trends in Ethiopia between 2004 and 2009. A draft report on the workshop can be found at:

<http://iri.columbia.edu/docs/114/DraftReportClimateMalariaWorkshop.pdf>

The WHO Global Malaria Report 2010 can be found at:

http://www.who.int/malaria/world_malaria_report_2010

A link to the Summer Institute 2010 video with alumni that contributed to Climate and Malaria workshop can be found at: <http://vimeo.com/19037641>

- **Regional workshop involving CHWGs with report on project results, products and experiences (April 2011) and dissemination of the Ethiopian experience to the IGAD regional level.** The “Climate and Health in Africa: 10 Years On” workshop was planned as a forum to present, debate and evaluate the lessons learned and to elaborate on newly emerging perspectives and opportunities for managing climate and health risks in Africa. The workshop was held at the United Nations Economic Commission for Africa (UNECA) in Addis Ababa, Ethiopia from April 4-6, 2011. For more information on the above activities, please see the April 2011 *Climate and Health in Africa: ‘10 Years On’ Workshop* report available at the link below: <http://iri.columbia.edu/publications/id=1090>
- **Malaria and climate data analysis workshop in Addis Ababa, December 2011.** The workshop, ‘Use of Climate information in Impact Assessment for Malaria Interventions’, was held in collaboration with the Federal Ministry of Health and the National Meteorological Services Agency of Ethiopia, at the UNECA Conference Center, in Addis Ababa, Ethiopia from December 12-14, 2011. For more information on the above activities, please see the December 2011 ‘*Use of Climate information in Impact Assessment for Malaria Interventions’ Workshop* report available at the following link: <http://iri.columbia.edu/publications/download=1136>

Outcome 3: Global dissemination of products, tools, and knowledge

The efforts and activities of Outcome 3 culminated with the launch of the web-based services based on the ENACT and other NMA products, in Addis Ababa, Ethiopia in December 2011. As described in Section 1 and under Section 2 Outcome 1, of this report, these tools can now be accessed through an online mapping service (built using IRI Data Library capacity/tools) installed at the NMA, providing user-friendly tools for visualization, querying, and accessing information products. The web page of the NMA (<http://www.ethiomet.gov.et/>) has been redesigned for better presentation of its existing products and services, and for the delivery of products derived from the new data set. The Climate Analyses and Applications Map Room (<http://213.55.84.78:8082/maproom/.NMA/>) has five parts: Climate Analysis, Climate Monitoring, Climate and Agriculture, Climate and Water, and Climate and Health.

In addition, the IRI data library now has the capacity to be used both on and offline to enable easier access when Internet is slow/not available. The IRI has also made significant steps in integrating the IRI Data Library with OpenHealth, SERVIR and Google Earth/Maps. The portable Data Library is now ready to be used around the

world in training courses about the use and understanding of climate data. It can be used as a means of transferring technology to build capacity in developing countries. New map services are interested in displaying Web Mapping Service (WMS) maps generated by the Data Library. Publications, presentations, peer reviews and reports have also aided in the global dissemination of products, tools and knowledge.

Greater understanding of the roles and responsibilities of interested partners (WHO-OpenHealth, IRI Data Library, Google engineers) and roadmap for integrated developments in browser/online climate/environmental informed disease mapping, monitoring and surveillance tools.

Demonstration of tools and products in response to expressed demand for information products to help improve focused and timely response to disease control in Ethiopia. The products will include joint outputs from the collaborative efforts of WHO-OpenHealth/IRI/Google and be deliverable within a specific problem context browser/online facility of direct relevance to disease control needs in Ethiopia.

The following activities supported the above project outcome:

- **Create Health Map Room for the IGAD region in the IRI data library. Prototypes presented via Google Earth.** During the first funding cycle IRI worked on building a bridge between the Data Library and GoogleEarth, making it possible to deliver IRI Data Library maps on that platform. The connection is currently functional, and examples were made available at http://iri.columbia.edu/~benno/kml_examples.html
- **OpenHealth-IRI-Google interaction/integration.** In June 2009, OpenHealth officially launched the Global Health Observatory (GHO). This is a web-accessible platform for mapping and analysis of national level public health statistics. The IRI provided climate/environmental map layers for GHO and Google Earth. In July 2009, the IRI improved these climate/environmental map layers by generating images with a transparent background where there was little or no data. A prototype ISO 19115 metadata container for the IRI climate map layers was delivered to the OpenHealth GeoNetwork for evaluation.

IRI has continued to focus on integrating the Data Library with WHO's OpenHealthMapper, which is used to display both health and climate/environmental information on the same OpenSource platform. It was well-received by the CHWG in Ethiopia when it was demonstrated and delivered by WHO in July 2010 at the Korea International Cooperation Agency (KOICA)-funded "Weather and Climate Impact on Community Health and Public Health Services" workshop.

With support from the project, the IRI has improved its WMS catalogue. Another web browser interface was developed to provide a faceted search based on physical terms, location, and projects, of available maps. This facilitates the integration with WHO's OpenHealth Mapper and GoogleEarth. The interface includes thumbnail images and brief descriptions of the available maps.

The IRI has been successful in attracting additional resources to further develop the integration of the IRI Data Library, OpenHealth, SERVIR and Google Earth/Maps. In particular, the IRI led proposal entitled "*Improving Decision-Making Activities for Malaria and Meningitis Risk Mapping-Integration of NASA Products Platforms (SERVIR) and UN-WHO-OpenHealth*" has been funded by NASA's Research Opportunities in Space and Earth Science (ROSES-2010) program. Work on this project is currently ongoing.

- **Prototype range of testable tools and products created for malaria mapping, seasonality, and inter-annual variability analysis.** Prototypes presented via Google Earth and tested on G1 Android phone. As part of the Google Project, we have been restructuring the Data Library web pages so that they are usable from an Android Phone (and iPhone) in both portrait and landscape modes. This was done in such a way as not to handicap the functionality of search and display. The technology is now being incorporated and improved upon in the new Data Library Maproom interfaces.
- **Google Earth Tour.** The IRI has produced a Google Earth tour focused on the role of climate information in the control of meningitis outbreaks in Africa. The tour was submitted to Dr. Karin Tuxen-Bettman at Google Earth Outreach on August 2009 for final review and editing.
- **Ethiopian Web/Software engineer hired as consultant to work on Ethiopia Website and Map Room.** A link to the recommended consultancy requirements can be found here:
<http://iri.columbia.edu/docs/114/NMAConsultancyRequirements.pdf>
A link to the recommended NMA website architecture and navigation can be found here: <http://iri.columbia.edu/docs/114/NMAWebNavigation.pdf>

Outcome 4: Project coordination, implementation, assessment and reporting

In terms of monitoring progress in activities, all of the lead PIs have been engaged in elements of the project with oversight given as appropriate to their specialisms. Barbara Platzer (months 1-35), IRI's Africa Regional Program Coordinator, was heavily engaged in administration of the project within and between IRI, Columbia University's Office of Projects and Grants, regional project partners and Google.org. The PIs, the AfrRPC Coordinator and project scientists have been involved in advisory and supervisory visits to the region as appropriate to the planning, coordination and implementation of the project with details listed above. Project partners were funded to travel to the IRI to participate in training and capacity building exercises, project meetings/discussions. Workshop reports, as mentioned above, have been provided as they have become available

The following activities supported the above project outcome:

- **Project and scientific oversight by the PI and Co-Pis.**
- **Project coordination by Africa Regional Program (AfrRPC) Coordinator.**
- **Advisory and implementation visits to the region (both Ethiopia and Kenya) and partners (e.g. University of Reading, Google and OpenHealth).**
- **Report on monitoring and evaluation activities/findings.**
- **Reports on project progress.**

Appendix: Project Related Publications

- Alemu, A., Abebe, G, Tsegaye, W., and Golassa, L. (2011). Climate variables and malaria transmission dynamics in Jimma town, South West Ethiopia. Vectors & Parasites. 4:30
- Cibrelus, L., R. Cousin, et al. (2009). Building capacity through training: experience from the first Malagasy workshop on integrating climate information into public health decision making, October 2009. 3rd MERIT Technical Meeting. Niamey, Niger, IRI
- Cibrelus, L. and G. Mantilla (2009). Summary of the Climate Information for Public Health Training Course. IRI Technical Report. Palisades, New York.
- Cibrelus, L. and G. Mantilla (2010). Climate Information for Public Health: A Curriculum for Best Practices - Putting Principles to Work. IRI Report. New York, IRI.
- Connor, S. J., J. Omumbo, et al. (2010). "Health and Climate - Needs." Procedia Environmental Sciences Volume 1 1: 27-36.
- Dinku, T., S. J. Connor, et al. (2010). Comparison of CMORPH and TRMM-3B42 over Mountainous Regions of Africa and South America. Satellite Rainfall Applications for Surface Hydrology. M. Gebremichael and F. Hossain, Springer: 193-204.
- Dinku et al. (2012): Combined Use of Satellite Rainfall Estimates and Rain gauge Observations to Produce Rainfall Time Series over Data-Sparse Regions of Africa. In review, Meteorological Applications.
- Dinku, T., K. Hilemariam, et al. (2012). "Improving availability, access and use of climate information " World Meteorological Bulletin.
- Ghebreyesus, T. A., Z. Tadese, et al. (2009). "Using Climate Information in the Health Sector." Field Actions Science Reports 2: 63-67.
- Mason, S. J. (2009). Recommended Procedures for the Verification of Operational Seasonal Climate Forecasts. Commission for Climatology XIV Expert Team on CLIPS Operations, Verification, and Application Service. Geneva, Switzerland, World Meteorological Organization.
- Mason, S. J. and S. Chidzambwa (2008). Verification of RCOF Forecasts. Palisades, New York, International Research Institute for Climate and Society.
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Appendix: Opportunities for engaging ‘Climate Services’ development for improved health outcomes in Africa

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Abstract:

Protecting health and achieving climate resilient development gains in sub-Saharan Africa is a major challenge in the face of climate change and other stressors. Climate change brings both risks and opportunities and how we manage these will be crucial to socio-economic development chances and human security over the coming decades. Part of the international response to the threat of climate change is to promote ‘Climate Services’ to better inform societal needs and allied investments for adaptation. This article outlines our recent experience with climate information in the field of public health and disease prevention and discusses some concerns going forward.

Background:

It is widely recognized that global environmental change has profound implications for human health and well being: and climate change is currently considered by many to be one of the most important issues facing society today. The perceived linkage between climate and health is an old one dating back at least to Hippocrates, who recognized and documented effects of seasonality and unusual weather patterns on disease prevalence. However, the modern health sector has been slow to utilize weather and climate information for health promotion and disease prevention. While this may be understandable given the rise and predominance of the medical model of health over the last century, many opportunities are missed. While climate change is recognized as a major threat to health we must not lose sight of the opportunities presented by the greater

societal concern with managing climate risk and adaptation as well as investments in climate science and observation. There is currently much focus of international attention on the need for development of ‘Climate Services’ able to provide climate sensitive development sectors with useful, science based information, to help protect socio-economic development gains and aid adaptation to climate change in essential development sectors, including: agriculture, water, health and disaster prevention sectors (WMO 2011). The question is, as with most development initiatives, how do we ensure that we adequately identify, understand, negotiate and serve information needs in a pro-poor and sustainable manner – particularly in the developing world and perhaps especially so in sub-Saharan Africa where need is arguably the greatest?

Considerations of climate were largely absent in the drafting of the Millennium Development Goals, many of which are health related, yet 10 years on concerns over ‘Climate Change’ are ubiquitous in related progress reports. For the health sector the first decade of the new millennium was one of fairly slow recognition of the importance of climate both on current health burden as well as future life chances. It was not until 2008 that the current WHO Director General Margaret Chan highlighted the issue as one of the priorities for global public health and selected it as the theme for World Health Day: ‘Protecting Health from Climate Change’ that the impetus increased among high level policy developments. The 193 countries represented at that years World Health Assembly, gave unanimous support for a new resolution calling for greater engagement in this issue (WHO 2008). African Heads of State followed up with the Libreville Declaration on Environment and Health in Africa in which recognition of the climate challenge has become increasingly recognized as needing urgent attention (UNEP and WHO 2010).

Sub-Saharan Africa with its predominant reliance on rain-fed agriculture and water resources, poor food security, and high prevalence of vector-borne and water borne diseases, is clearly a region that could benefit from greater investment in climate services development (IRI 2006). However, what is the experience of the past decade – what lessons have been learned? Here we outline regional and national examples of attempts to use climate information in disease control and health care provision and consider some of the issues involved?

Climate and Health - a regional initiative:

The link between vector-borne diseases, such as malaria, and climate was one of the more immediate concerns in the late 1990s as malaria ‘re-emerged’ and came to be recognized as a disease of major economic as well as public health importance. The newly initiated Roll Back Malaria Partnership (WHO 1998) recognized the potential to use climate information in Malaria Early Warning Systems (MEWS) to help predict and prevent malaria epidemics (WHO 2001). The MEWS approach was designed to include elements of vulnerability assessment, seasonal climate forecasting, weather/environmental monitoring, and improved sentinel case surveillance – within an integrated framework that could inform malaria control planning, enable preparedness, early detection and timely response.

Regional support for MEWS development in the Southern Africa Development Community (SADC) countries was supported by WHO-SAMC (Southern Africa Malaria Control: the RBM Inter-Country Team based at WHO’s Regional Office in Harare, Zimbabwe) in collaboration with SADC’s Drought Monitoring Centre (DMC) also then based in Harare. An initial focus of attention on Botswana with its more robust, laboratory

confirmed epidemiological data, enabled evidence to be produced regarding associations between malaria and rainfall - both forecast and observed (Thomson, Connor et al. 2005; Thomson, Doblas-Reyes et al. 2006). Demonstrated use of MEWS and associated epidemic control in Botswana encouraged neighboring SADC countries to follow suit.

The principal mechanism for awareness raising and information sharing between the climate and malaria control communities in Southern Africa was the Seasonal Malaria Outlook Forum – the ‘MALOF’. This initiative emerged in 2004 as a result of collaboration between the WHO Inter-country Team, the SADC-DMC and their national partners, from both health and climate sectors (DaSilva, Garanganga et al. 2004) with financial support from UK-DFID and AUS-AID. The MALOF garnered great interest in its first two years of operation. The activity was cited in many publications and reports and, while never designed as such, it was suggested to be a practical example of adaptation to climate change and its approach applicable to other climate sensitive sectors (WMO 2007).

The impetus in the regional activity did decline once the funding to WHO-SAMC from DFID and AUSAID ran out. Those funds had enabled the collective regional organization and implementation efforts, once these were gone the health sector could no longer adequately support the initiative and the climate community could not pick up the cost. All was not lost however as national level activities continued in some of the SADC member states and the malaria epidemics of the past have not re-emerged at the scale seen historically. While the regional MALOF is no longer held in Southern Africa there is anecdotal evidence from newspaper reports and statements suggesting that epidemic early warning activities do continue and are associated with greater investment and successful malaria control at the national level. Due to recognition of WHO-SAMC’s perceived ‘comparative advantage’ in support of epidemic and emergency malaria control they were given responsibility for a greater geographical region which included East Africa (ESAMC). Unfortunately this increase in responsibility coincided with declining funds for regional activity as most funding for malaria control was now being directed through the Global Fund for AIDs, TB and Malaria (GFATM) directly to the national programmes.

Climate and Health - a national initiative:

Epidemics of malaria are a major public health issue in East Africa where both desert-fringe and highland fringe epidemics have occurred following unusual rainfall and temperature conditions. The highland areas are a particular concern due to the high concentration of human populations in these economically important regions. Ethiopia, Kenya, Rwanda are all examples where major epidemics occurred during the 1990s. Ethiopia is a striking example given its large population (80 million - second only after Nigeria) and the fact that 75% of the population live in areas of unstable malaria transmission, acquire low-levels of immunity and are therefore at risk of malaria epidemics with severe health outcomes.

In 2008 a multi-agency, cross disciplinary “Climate and Health Working Group“ was formed to elicit and support the development of climate information needs for improved control of climate sensitive diseases in Ethiopia (Ghebreyesus, Tadese et al. 2008). The composition of the CHWG is approximately 12 agency representatives. It is chaired by the Ministry of Health and co-chaired by the National Meteorological Agency

with the remaining membership drawn from the agencies that broadly support public health development in Ethiopia. These include the WHO, UNICEF, IFRC, UNEP, the Ethiopian Health and Nutrition Research Institute, Addis Ababa University and the Association of Schools of Public Health. The function of Secretariat is carried out by a local Community Based-Organization: The Anti-Malaria Association (AMA).

In its three years of operation the Ethiopian CHWG has organized and supported cross disciplinary training and research activities across these agencies at national and sub-national levels. This in turn has led to elaboration of information needs and the development of operational information products designed to serve control needs for a number of climate-sensitive health issues (Teka 2009; Dinku, Hilemariam et al. in press). Research strengthening and operational training has also been supported using malaria (a ‘wet conditions’ disease) and bacterial meningitis (a ‘dry conditions’ disease) as practical operational examples.

This demonstration from Ethiopia stimulated much interest elsewhere and CHWGs (with similar composition to Ethiopia – chaired by the Ministry of Health, co-chaired by the National Meteorological Services and agencies supporting public health systems development) have been established in Madagascar (with the support of WMO), Kenya (with the support of WHO) and in West Africa with the support of ACMAD (African Centre for Meteorological Applications in Development) and AEMET - the Spanish Meteorological Services.

The CHWG model is also gathering interest at the regional level and seeks to engage with regional level developments and investments in Africa’s Climate Change negotiations for Adaptation and the supporting developments emerging from the Clim-Dev Africa process. The Climate Information for Development in Africa Programme (Clim-Dev) is a multilateral initiative managed by a joint secretariat comprising: the African Union, the UN Economic Commission for Africa and the African Development Bank (ECA, AUC et al. 2010).

The Ethiopian CHWG has been prominent in ensuring health has a voice in these developments and was instrumental in the organization of an international meeting held at the UNECA in April 2011. The meeting entitled “Climate and Health in Africa: 10 Years On” was designed to address the changes in perspectives in climate and health priorities over the past decade – recognizing achievements made as well as requirements for the next 10 years (Omumbo, Platzer et al. 2011).

Discussion: what’s needed next:?

The 10 Years on Meeting was a multi-stakeholder process (over 100 participants) which developed a set of recommendations covering four areas: policy; practice; data and services; research, education and training needs. The recommendations were designed to be taken forward to inform discussions on investment needs at related regional processes in the months leading up to Clim-Dev’s 1st Climate Change Adaptation in Africa Conference – organized by UNECA’s Africa Climate Policy Centre in Addis Ababa, October 2011; and COP-17 (the UNFCCC Conference of Parties Conference) in Durban, December 2011.

The successful but limited demonstrations of climate informed health activities outlined above were subject to discreet project funding. Reliance on project funding (typically 3 years) invariably leads to non-sustainable activity, more or less regardless of benefit, because of the insufficient time for the mainstreaming process to occur. Discreet cross disciplinary projects often pose additional problems of extra demand and activities on the

individual disciplinary institutions - where each discipline is often already under-resourced – and at the end of the project its activities quickly cease and lessons are forgotten. How do we rectify this loss of knowledge and development opportunity and enable a process of successful demonstration projects becoming full scale programs fit for mainstreaming purposes?

Many millions of dollars have been pledged by donor countries for the strengthening of climate services in Africa through the Clim-Dev Africa Programme Special Fund (approximately US\$135million for Phase I: 2009-2012 and US\$800million for phase II: 2012-2020). In addition to this the Climate Investment Funds, being negotiated by the international community, aim to channel billions of dollars of investment into climate resilient development initiatives in Africa. This represents huge potential for improved social and economic welfare on the continent. Newly developing Climate Services have a responsibility to inform these investments to the best of their ability – to realize this it is essential that the negotiations around climate information needs and services are developed through rigorous cross disciplinary dialogue, mutual learning and development. It is therefore essential that Climate Services do not develop as merely data and generic information providers but as services that can truly provide negotiated and specific information products that enable improved financial choices and resource allocation across a range of time scales. For the health sector it has been recommended that mutual investment and development needs to occur in 4 areas: data quality and services provision; cross disciplinary research strengthening, education and training; the climate and health policy arena; and climate informed practice. Good data is required for good research – which in turn is required to inform good policy – is required for good practice – and good training is required for all points of the circle. Without this integrated approach the investments in climate services are unlikely to reach the development potential they need to. This is true for health – but also true for other essential related climate sensitive development issues including: agriculture and food security; water resource security and sanitation; energy and air quality.

The challenge of realizing sustainable and resilient development in sub-Saharan Africa in the face of climate change is enormous. However, with the current international focus on climate change and its inequity issues there are real, perhaps once in a generation, opportunities for developing negotiated climate information needs and effective service delivery. Finance is of course an essential but not-sufficient requirement and concerted developments in institutional and social capacity will be essential. Effective services as well as effective demand and effective users must be developed. In the interim phase strong research and technical support will be needed from external partners while domestic policy, practice, data and services are developed – research, education and technical training institutions must be identified early and appropriate curricula developed for a wide ranging (society-wide) education in ‘climate-smart development’.

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Appendix: Health and Climate Experts Must Jointly Tackle Disease

***Appendix: Climate Variables and Malaria Transmission Dynamics in Jimma
Town, South West Ethiopia***