Appendix
Analysis of impacts of climate variability on malaria transmission in Sri Lanka and the development of an early warning system

International Research Institute for Climate and Society
Earth Institute at Columbia University

Sponsors: NOAA, NSF, EPA and EPRI Joint Program on Climate Variability and Human Health

Collaborators: AMC, FECT and IWMI
APPENDICES

Analysis of impacts of climate variability on malaria transmission in Sri Lanka and the development of an early warning system

Report on International Research Institute for Climate and Society component of the Collaborative Project under: the NOAA, NSF, EPA and EPRI Joint Program on Climate Variability and Human Health Program


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Citation:
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The annual summaries provide details and a chronology of the work.

**Summary Year 1 (October 2003 - June 2004)**

The project has progressed well in its first 8 months. There was a delay of two months until the confirmation regarding the grant award reached the PI’s. Since, then we have progressed rapidly and now are nearly back on the original schedule as presented in our proposal.

During this initial period, we put in place various administrative arrangements. For the IRI component, most of the needs of the projects are in place – purchases of a computer, two field visits to engage with Sri Lankan partners, engagement of a research assistant, and arrangements for data collection in Sri Lanka. We have already completed some of the processing of data, such as assembly of a database; quality control and climatological analysis.

A user needs survey was undertaken in the Uva province and the results have been compiled into a report. In summary, the respondents identified a need for an early warning system incorporating climate. Climate, river flow, land use changes, population dynamics, rural development and control programs were identified as key factors affecting malaria dynamics.

A successful project inception workshop was held bringing together officials from the Uva Proviceal Directorate of Health, Uva Resource Managers, Sri Lanka Anti-Malaria Campaign, Sri Lanka Department of Meteorology, the Natural Resources Management Services and the University of Peradeniya. The majority of Regional Medical Officers in Sri Lanka were able to attend this workshop. We were privileged to have Ms. Aurelia Micko of NOAA/OGP attend and address the workshop. Here, the participants agreed on the need for and utility of an early warning system for malaria. They also reiterated the need to incorporate rural development, land-use, irrigation, and above all malaria control programs in addition to weather and climate in attributing malaria epidemiology.

A consultant from the Anti-Malaria Campaign, Dr. Gawrie Galapaththy has joined the project team at IWMI and has helped with data acquisition. She participated in the Climate and Health Principal Investigators meeting in Atlanta, Georgia along with Dr. Lareef Zubair of the IRI and also visited the IRI. Her entry mitigates the reduced role of one of Project Investigators, Dr. D.M. Gunawardena, who has been engaged to advise the National Malaria Control Program in Eritrea. Several posters regarding the project were displayed during the PI’s meeting of the Climate and Health Program in Atlanta.

Ms. Janaki Chandimala, a research assistant for the project visits IRI for 4 months and operational zed the downscaling protocols. In collaboration with IRI partners, she has built the archive of downscaled predictions for Sri Lanka in the relevant climatic and hydrological variables. Dr. Jeffrey Shaman (Project Investigator from Columbia University who is now at Harvard University) met with Dr. Lareef Zubair to plan for hydrological modeling. During the latter part of Ms. Chandimala’s visit (Fall 2004) we tried to implement the hydrological model with the support of Dr. Jeffrey Shaman.

Thus the tasks that we set for the first year in the proposal (project inception workshop, a users needs survey, data collection in the province of interest (Uva) and in Sri Lanka in general, downscaling of climate predictions and hydrological modeling) have either been completed or are well in hand in general.
Summary Year 2 (October 2004 - June 2005)

The IRI team and collaborators progressed in several directions: data collection, quality control, climate analysis, hydrological analysis and statistical analysis of malaria epidemics with climatic and hydrological precursors.

The key weather, climate, hydrological and environmental data have been collected, quality controlled, and been subject to exploratory data analysis. Climatologies have been constructed, trends have been quantified and primary modes of seasonal variability have been identified.

The methodology for fine scale gridded rainfall prediction was refined.

A hydrological model that incorporates climate information is being developed and the calibration of this model is reported on here. This model shall be subjected to sensitivity studies and shall then be run incorporating climate variability. The potential of this hydrological model to produce intermediate indicators of epidemic risk, such as streamflow, water pooling and soil moisture shall be investigated.

Early results from an analysis of climatic and hydrological relationships with spatio-temporal variation of epidemic risk, the relationship between malaria epidemics and El Nino episodes are considerably nuanced.

We have early results on the relationship between streamflow anomalies and epidemic prevalence for two rivers. We see an association between streamflow deficiencies in the October to December period and malaria epidemics in the next year.

These studies convince us that the association between epidemic and environmental variables are quite complex and both analysis techniques and prediction scheme shall have to be suitably sophisticated.

The project management at IRI involved organizing office support for our work in Sri Lanka, visits to the project site and meetings in New York in addition to continued communication by email and telephone. The Natural Resources Management Services continued to provide support in Sri Lanka for data collection, GIS work, documentation and research. The PI at the IRI, Lareef Zubair, visited with the Department of Meteorology, the Uva Provincial Office and the National Headquarters of the Anti-Malaria Campaign, the Meteorological Office in Uva and its National Headquarters in Colombo in November and also met with Olivier Briët of IWMI. Dr. Jeffrey Shaman visited the IRI for project discussions.

The tasks that we set for the second year in the proposal (climate & malaria relationships, development of statistical model, hydrological modeling, development & establishment of early warning system) are largely in hand. We shall endeavor to complete these tasks in the three months that remain in the second year.

Summary Year 3 (October 2004 - June 2005)

The highlights of the progress in the period under review were:

- Collaboration with regional malaria officers
- The development of data sets for epidemiological, hydrological, meteorological and societal analysis
- The development of GIS system for malaria analysis
• Collaboration with NASA land surface modeling group and the implementation of a state of the art land surface model for the project region
• The development of climate analysis for the project region particularly relating to ENSO impacts
• The identification of anomalies patterns in rainfall and stream flow in the project region associated with epidemic conditions
• The identification of epochal changes in the ENSO-malaria relationship around 1940’s and 1980’s
• The publication of discoveries of epochal changes in the ENSO influence on regional climate around 1940’s and 1980’s
• The development of capacity to undertake malaria-climate analysis in project region through joint research, publication and development of infrastructure
• Provision of educational support for three Columbia University students by mentoring on malaria-climate analysis via thesis projects
• Development of relationship with World Health Organization officials

The setbacks from last year which were the relocation of the offices for work in Sri Lanka from Polgolla to Digana and the dispersing of majority of team members in the International Water Management Institute were partially mitigated. The staff members are settled in and better appointed even if more distant offices at the Foundation for Environment, Climate and Technology in the Mahaweli Authority complex. We also undertook epidemiological data gathering and developing relationships with malaria control officers, and with other experts on malaria in Sri Lanka. Overcoming these setbacks was facilitated by three visits by the PI to the project region during the course of the year.

This year saw the publication of two papers related to the project, along with the submission of two other papers. Several manuscripts and a report are in preparation. Two undergraduate thesis projects were completed and one masters level thesis project is in progress. The progress has been presented this year in Sri Lanka and at the annual meetings of the American Meteorological Society (Atlanta, GA), the Climate Predictions and Applications Science workshop (Tucson, AZ) and at the Association of the Environmental Engineering and Science Professors (Potsdam, NY).

Summary Year 4 (October 2004 - September 2005)

We have progressed well on several fronts in a manner that leaves us positioned to complete our project tasks in a satisfactory manner. A concluding workshop is planned for mid-September hosted by our collaborating institution, the International Water Management Institute.

The highlights of the progress in the period under review were:
• Revived collaboration with International Water Management Institute,
• Continued collaboration with regional malaria officers in the project region,
• The establishment of databases for epidemiological, hydrological and meteorological analysis,
• Mapping and analysis using GIS of malaria prevalence,
• Analysis of seasonal and inter-annual features of the malaria and climate relationship,
• Incorporation of GIS data sets into IRI data library to enable time series analysis,
• Development of monthly rainfall data monitoring system at district and sub-district scale,
• Submission of work with NASA land surface modeling group for publication.
• Publication of a paper on the ENSO impacts on rainfall in Sri Lanka with another drafted on ENSO impacts on temperature,
• Publication of findings of epochal changes in the ENSO influence on regional climate around 1940’s and 1980’s,
• Drafting of manuscript on the epochal changes in the ENSO-malaria relationship around 1940’s and 1980’s,
• Development of infrastructure in Sri Lanka to undertake malaria-climate analysis in project region through joint research, publication and training of personnel. Staff associated with this project worked towards degrees in Sri Lanka at the Open University (BA), Post-Graduate Institute of Science (MS) and University of Moratuwa (BS),
• Provision of educational support for five Columbia University students via thesis projects and the NSF Research Experiences for Undergraduate program,
• Collaboration with World Health Organization officials in Geneva and Colombo,
• Development of joint proposals with officials of the Anti-Malaria Campaign,
• Presentation of results and lessons learned from Sri Lanka at the First Malaria Outlook Forum in Nairobi following the 19th GHA Climate Outlook Forum.
• Identification of relationships between malaria incidence and temperature at seasonal, inter-annual and long-term time scales.
• Development of prediction system for malaria incidence based on climatic suitability.
• Project conclusion workshop at the International Water Management Institute with participation of Ministry of Health staff.
• Visit by Stephen Connor, Hyemin Yang and Lareef Zubair to Provincial malaria control programs and regional officers in Uva and other provinces.
• Training Workshop on Climate and Malaria Analysis at the Post-Graduate Institute of Science, University of Peradeniya, Sri Lanka.
• Publications on analysis of seasonal and inter-annual features of the malaria and climate relationship.
• In-service research training for junior Sri Lankan scientists leading to undergraduate degrees and several publications.
• Two regional malaria officers visited the IRI in November 2007 for two weeks based on the nomination of the Director of the AMC sponsored by the global fund on aids, TB and malaria.
Details of the project team members and their role is provided in this section.

**International Research Institute for Climate and Society**

Stephen Connor, Neil Ward and Lareef Zubair continued with work throughout this project. The IRI team had significant assistance from the IRI data library team, Michael Bell, John Del Corral and Benno Blumenthal in data management and database development. Michael Bell and Alessandra Giannini undertook analysis of the climate and malaria data. Project financial management was undertaken by Lori Scally and Ann Binder. The IT team of Leo Ostwald, Sara Barone, Brian Falk and Jeff Turmelle has assisted us many times over.

Janaki Chandimala, Research Assistant, working at the FECT visited the IRI for four months from June to October, 2004 and the arrangements were funded through the grant. A portable computer needed for this work was purchased for her work.

**Anti Malaria Campaign**

Dr. Gawrie Galappaththy, Consultant Community Physician to the Anti Malaria Campaign Head Office, became an official collaborator to the project. In this capacity, she co-presented the project at the PIs’ meeting of the Climate Variability and Health program in Atlanta. Her active involvement in the project has strengthened its prospects for future implementation of its findings. At the national level, she has been involved in data gathering and supervising data entry.

Dr. Dissanayake Gunawardena, Regional Malaria Officer Badulla, has taken temporary leave in order to take up a USAID sponsored position as resident advisor / senior epidemiologist at the National Malaria Control Program (NMCP) in Eritrea. He continues to contribute to the project although his remote location is not ideal for the present project phase of data collection for Uva Province. This is somewhat compensated by the engagement of Dr. Gawrie Galappaththy.

We were supported by H.M. Faizal, Regional Malaria Officer for Moneragala district in the Uva. We have had discussions with the Regional Malaria Officers in the Central Province (Ms. P. Kusumawathie) and North-Western Provinces (Ms. Devika Perera and Mr. H.R.M.S. Bandara).

**International Water Management Institute**

Principal Investigator Dr Felix Amerasinghe passed away on June 7, 2005 after almost a year long struggle with his health. Dr Amerasinghe was IWMI’s Theme Leader water, health and environment, and was involved in the conception, design and implementation of this study. Subsequently, Dr. Priyanie Amarasinghe assumed the role of Principal Investigator. Mr. Olivier Briet remained the lead technical analyst on this project registering for a PhD with Dr. Priyanie Amerasinghe as the internal supervisor.

**Columbia University**

One of our investigators, Dr. Jeffrey Shaman, took up an appointment at Harvard University during the initial two years. Nevertheless, we remained engaged through email, telephone and occasional meetings. After Dr. Shaman took up a posting at Oregon State University in the fall of 2006, we continued the hydrological work in collaboration with the NASA GSFC Land Surface Group. Another of our collaborators, Dr. Marc Stieglitz took up an appointment as Associate Professor in the School of Earth and Environmental Science at Georgia Institute of Technology in Atlanta.
Stacey Hirsh who had been an intern funded by the Earth Institute at Columbia University during 2005 completed the analysis of NDVI. A proposal for a summer internship to the Columbia University Summer Internship program was funded by the Cooperative Institute for Climate Applications and Research (CICAR) and enabled the work of Hyemin Yang of Columbia University during the summer of 2006 with support from Cooperative Institute for Climate Applications and Research. Hyemin Yang also attended the project conclusion workshop in Sri Lanka.

In 2006, Columbia University undergraduate Lindsay Kaye Warren and Barnard University undergraduate Lady Vanessa Reyes undertook their senior projects on the predictability of malaria and the influence of vulnerability factors in the Uva Province. Nelun Fernando (Lecturer in Geography at University of Colombo) completed her M.A. thesis under the Climate and Society course on water scarcity in the Kurunegala and Puttalam district in the North-Western province. These three thesis projects were mentored by the PI and made possible from the resources of the project.

Joseph Simonson, a senior, undertook work in support of this project during the summer of 2007 with support form the Earth Institute at Columbia University in the NSF funded Research Experiences for Undergraduates program. Syd Partridge of Columbia University undertook work under this project to fulfill his internship requirements for his Masters in Climate and Society at Columbia University during the summer of 2007.Arron Layns and Daniel Bader, who are all undertaking the M.A. in climate and society, joined in the work starting in September 2007.

**Foundation for Environment, Climate and Technology**

Vidhura Ralapanawe put in place rainfall data sets, prepared brochures and the project website. Janaki Chandimala has been working on this project from its inception undertaking hydrometeorological and associated research. Manjula Siriwardhana too contributed to climate analysis and malaria analysis under this project from the beginning until August 2007 when she commenced her post-graduate work over seas. Upamala Tennakoon and Champika Jayatillake have provided GIS support through the course of the project. Zeenas Yahiya has handled the Documentation, Project Management and vulnerability analysis for this project through its duration, Siraj Razick (IT) and Amila Karunaratne (IT) have provided technical support between them through the course of the project. Yoosuf Ashraj, Wishvanath Tillakaratne, Saman Ratnayake and Champika Jayatillake have assisted in data management. Badra Nawarathna (Civil Engineer) who was seconded by the Mahaweli Authority of Sri Lanka has undertaken analysis of evaporation and validation studies on satellite based rainfall estimates. This team is developing a near-real-time rainfall monitoring system and much of the mapping work for Sri Lanka which shall assist in predictions.

**National Aeronautical and Space Agency**

Dr. Sarith Mahanama and his colleagues, Randy Koster and Rolf Riechle, collaborated with us to develop a Land Surface Model for the project region.

**University of Sri Jayawardhenapura / University of Kelaniya**

Dr. A.R. Wickremasinghe joined the Faculty of Medicine of the University of Kelaniya as the Professor and Head of Community Medicine.
Project Meetings

Year 1

- L. Zubair, visited Sri Lanka from May 1 – June 6th for the purposes of organizing work related to the project. He visited the Anti-Malaria Campaign (AMC) of the Sri Lanka Ministry of Health and Sri Lanka Department of Meteorology. At the AMC, he met with the Director, Dr. Luxman Siyambalagoda, Director of the Anti-Malaria Campaign and Drs. Ravi Abeysundera and Gawrie Galappaththy, Consultant Physicians. He was given an overview of the Malaria recording system in operation in Sri Lanka and an exposure to the record keeping and the digitization work under the present project. He also had discussions with Olivier Briët of the International Water Management Institute.

- L. Zubair’s visit to the Natural Resources Management Services (NRMS), Sri Lanka was useful in organizing the support needed in Sri Lanka for IRI work such as data collection, literature collection, web programming and documentation.

- Olivier Briët of the International Water Management Institute’s project team for this project visited the IRI and Columbia University on January 12th and 13th, 2004 for planning and coordination of the project. He had substantive meetings with Dr. Neil Ward, Dr. Steve Connor, Dr. Jeffrey Shaman and the L. Zubair at the IRI and presented the IWMI work on malaria.

- Dr. Gawrie Galapaththy, Consultant Community Physician of the Anti-Malaria Campaign of the Sri Lanka Ministry of Health visited IRI from March 1-2. She made a presentation to the IRI staff and other invitees from Columbia University regarding the status of Malaria and its control in Sri Lanka. She met with the project investigators for a roundtable discussion. Her visit was sponsored by the NOAA/OGP and expenses in New York were borne by the project grant.

- Dr. Lareef Zubair, Dr. Dissanayake Gunawardena and Olivier Briët attended the Synthesis Workshop on the Health Impacts of Climate Variability and Climate Change in Small Island States at Bandos Island, Maldives, November 30- December 5, 2003 at the invitation of the Ms. Juli Trtanj. Local expenses in Maldives were borne by NOAA/OGP. Here, Lareef presented an introductory address to the conference on Weather, Climate Variability and Climate Change. Ms. Aurelia Micko, Olivier Briët and Lareef Zubair provided a second address on the work of the OGP in climate and health in general using the Sri Lanka climate and malaria case as an example.

- Dr. Gawrie Galappaththy of the Anti-Malaria Campaign and L. Zubair of the IRI participated in the PI’s meeting of the Climate Variability and Health program in Atlanta, Georgia between March 3 and 5th, 2004. Here, 6 posters showing the climate analysis work were presented. In addition, the two representatives made a joint presentation at this meeting on the Sri Lanka project “Analysis of Impacts of Climate Variability on Malaria Transmission in Sri Lanka and the Development of an Early Warning System”.

Year 2

- L. Zubair, visited the Anti-Malaria Campaign (AMC) of the Sri Lanka Ministry of Health, the Provincial Regional Malaria Officer in the Uva Province and the Sri Lanka Department of Meteorology. He had discussion with Dr. Gawrie Galapaththy of the AMC and Olivier Briët of IWMI.

- L. Zubair’s visit to Sri Lanka in November 2004 was useful in organizing the support needed for IRI work such as data collection, literature collection, web programming and documentation.

- Jeffrey Shaman visited the IRI for a planning meeting on developing the hydrological modeling tool on January 12th.
• L. Zubair presented outcomes from this project at the Congresses of the American Geophysical Union (San Francisco), the Association of Environmental Engineering and Science Professors (Potsdam, NY) and the United Nations University meeting on Sustainable water resources management in a changing monsoon environment (Colombo).

• L. Zubair undertook a private visit for Tsunami relief work in January 2005. During this period, he was able to facilitate data collection, provide guidance and organize and communicate scientific knowledge and expertise including material developed through this project. The websites developed by a group under his loose leadership continue to provide services (see http://www.recoverlanka.net/, http://www.geolanka.net and http://lareef.blogspot.com/).

Year 3

• August 2005: L. Zubair undertook a project visit to Sri Lanka and had
○ meetings with Dr. Gawrie Galapaththy of the Anti-Malaria Campaign on project progress
○ meeting with Olivier Briet (IWMI), Dr. D.M. Gunawardene and Dr. Gawrie Galapaththy (AMC) on the progress of the project
○ Meeting with Olivier Briet (IWMI)
○ Visit to Regional Malaria Office in Badulla and discussions with staff.
○ Project supervision and research guidance of work conducted by FECT team, The FECT offices had to be shifted at short notice from Polgolla and it was reestablished 12 miles East at Digana.
○ October 2005: L. Zubair visited National Oceanic and Atmospheric Administration, Climate Program Office, Silver Spring, MD,
○ October 2005: L. Zubair visited National Aeronautial and Space Agency, Global Modeling and Assimilation Office, Greenbelt, Maryland,
○ L. Zubair held meetings regarding collaborative Land Surface Modeling with Sarith Mahanama, Randy Koster, Max Suarez and Rolf Riehle.
○ Presentation on Predictability of Climate and Climate Applications in and around Sri Lanka.
○ December 2005- January 2006: L. Zubair undertook a project visit to Sri Lanka
○ Meeting with Dr. Gawrie Galapaththy of the Anti-Malaria Campaign (AMC)
○ Meeting with the Regional Malaria Officer for the Moneragala District in the Uva Province, H.M. Faizal, the Regional Epidemiologist and Deputy Director of Health.
○ Tour of health facilities, control sites, and treatment facilities within Uva Province and meetings with staff.
○ Meetings with Dean of the Faculty of Natural Sciences and the Head and Professor of Environmental Sciences of Sabragamuwa University which is located in the Uva Province.
○ Visit by H.M. Faizal (Regional Malaria Officer, Moneragala, Uva) to FECT. He presented the current status of work in the Moneragala district and we developed plans for research collaboration.
○ March 2005: L. Zubair at the Climate Predictions and Applications Science Workshop at Tucson, Arizona
○ Presentation on the progress of the project at the workshop session on health.
○ Meetings with Ms. Nancy Beller-Simms, Program Manager of the Sectoral Applications Research Program,
○ Meetings with Joshua Foster of the NOAA Climate Transition Program among others of the Climate Program Office of NOAA.
○ May 2005: Dr. Sarith Mahanama of the Land Surface Modeling group at NASA visited IRI for establishment of Land Surface Model at IRI.
○ May 2005: L. Zubair visited Sri Lanka and
○ met with Dr. Gawrie Galapaththy of Anti-Malaria-Campaign to review project progress.
○ met with Mr. H.M. Faizal (Regional Malaria Officer, Moneragala, Uva Province) to continue research collaboration.
• met with Ms. Kusumawathie (Regional Malaria Officer, Kandy and Nuwara Eliya Districts, Central Province) with intention of research collaboration for her districts and on the rise in malaria in high-altitude regions.
• met with Ms. Devika Perera and Mr. H.R.M. S Bandara who are the RMO’s in the Kurunegala District on research collaboration in their districts.
• met with Dr. Laksmi de Silva, Coordinator of the National Dengue Control Program.
• Dr. Steve Connor met with WHO officials who are undertaking work in Sri Lanka - in particular, Dr. Mika Kawano and Dr. Shiva Murugasampillay of WHO. Consequent to the WHO meetings in Geneva, L. Zubair met with Dilip Hensman at the WHO office in Colombo.

Year 4

• December 2006: L. Zubair undertook a project visit to Sri Lanka and had
• Discussions with Dr. Gawrie Galappaththy of the Anti-Malaria Campaign on project progress
• Phone discussions with Dr. Priyanie Amerasinghe (IWMI)
• Presentation at Man and Biosphere Conference.
• Visit with Regional Malaria Officer for Moneragala.
• Project supervision and research guidance of work conducted by FECT team,
• February 2007: L. Zubair visited University of Maryland, Earth System Sciences (ESSIC) offices
• L. Zubair held meetings regarding collaborative Land Surface Modeling with Sarith Mahanama.
• Invited Presentation by L. Zubair on Data management for Applications at the ESSIC seminar.
• March 2007: L. Zubair undertook a project visit to Sri Lanka,
• Meeting with Olivier Briet (IWMI) and phone discussions with Dr. Priyanie Amerasinghe (IWMI)
• Visit to Anti-Malaria Campaign Headquarters for interaction. Discussion with Dr. Gawrie Galapaththy.
• Discussions with Regional Malaria Officers for Moneragala, Kandy and Kurunegala.
• Presentation at International Conference on Hazards Mitigation at Peradeniya, Sri Lanka on Land Surface Modeling.
• Project supervision and research guidance of FECT team.
• September 2006: Lareef Zubair, Stephen Connor and Hyemin Yang undertook a project visit to Sri Lanka and had
• Discussions with Dr. Rabindra Abeyasinghe, Director and Dr. Gawrie Galapaththy Consultant Physician of the Anti-Malaria Campaign.
• Discussions with Dr. Julie Van der Bliek, Dr. Priyanie Amerasinghe (IWMI)
• Visit of Dr. Stephen Connor and Hyemin Yang to Uva Province sites with the ex-Regional Malaria Officer for Moneragala, H.M. Faizal.
• Project supervision and research guidance of work conducted by FECT team
• Training Workshop at the Post-Graduate Institute of Science, University of Peradeniya.
Project Inception Workshop

Agenda

Tuesday 9 December 2003
Uva Management Development Training Institute,
7 Mile Post, Passara Road, Pelgahathenna (Badulla).
Telephone: 055 22 88071, 055 22 88072,
Fax: 055 22 88073, E-mail: mdti@slt.net.lk

08.45 AM Registration
09.00 AM Welcome address By OjT Briët (MSc), IWMI
09.10 AM Ceremonial opening
09.15 AM Current and future control strategies of malaria in Sri Lanka, and the possible use
of an early warning system - By Dr. RRMLR Siyambalagoda (MBBS MSc), director AMC, presented
by Dr G.N.L. Galappaththy (MD), AMC
09.45 AM Management of historical and new surveillance data at the Anti Malaria
Campaign. - By Dr G.N.L. Galappaththy (MD), AMC
10.15 AM Tea and cake
10.30 AM Spatio-temporal malaria risk factors in Uva province and options for control.- By
Dr. DM Gunawardena (PhD), AMC
10.45 AM Discussion on spatio-temporal malaria risk factors Facilitator: Dr. DM
Gunawardena (PhD), AMC
11.15 AM Weather forecasting in Sri Lanka By Mr. L. Chandrapala (MSc), Meteorological
Department
11.35 AM Synthesis of a Workshop on the Health Impacts of Climate Variability and Climate
Change in Small Island States, Bandos Island, Maldives, December 1-4, 2003 - By Dr. Aurelia
Micko, NOAA
11.50 AM Introduction to the Project - By Mr. OjT Briët (MSc), IWMI
12.20 PM Applications of climate information - By Dr. L. Zubair (PhD), IRI
12.35 PM Discussion (facilitator: Dr. DM Gunawardena (PhD), AMC)
02.00 PM Lunch
Participants

Dr. M.R.S.S. Bandara, Regional Malaria Officer, Anti Malaria Campaign, Kurunegala
Mr. I. Bandara, Junior Research Engineer, Natural Resources Management Services, Mahaweli Authority, Dam Site, Polgolla
Mr. O.J.T. Briët, Associate Expert Medical Entomology, International Water Management Institute, PO Box 2075, Colombo
Ms. J. Chandimala, Junior Research Engineer, Natural Resources Management Services, Mahaweli Authority, Dam Site, Polgolla
Dr. K. Chandrakumar, Regional Medical Officer, Anti Malaria Campaign, Vavunia
Mr. L. Chandrapala, Senior Meteorologist, Department of Meteorology, Baudhhaloka Mw, Colombo 7
Dr. K.W.S. Chandrasiri, Provincial Director of Health (Uva), Bandaranayake Mawatha, Badulla
Mr. W.J.M. Dayarathna, Land Use Policy Planning Officer, Kachcheri Complex, Monaragala
Prof M. de S. Wijesundara, Prof. Of Parasitology, Department of Parasitology, Faculty of Medicine, University of Peradeniya, Peradeniya
Mr. G.H.P. Dharmaratne, Deputy Director, Department of Meteorology, Baudhhaloka Mw, Colombo
Dr. A.M. Dissanayake, District Medical Officer, Base Hospital, Mahiyangana
Mr. H.M. Faizal, Regional Malaria Officer, DPDHS Office, Town Hall Road, Monaragala
Dr. G.N.L. Galappaththy, Consultant Community Physician, Anti Malaria Campaign, No 555/5, Alvitigala Mawatha, Colombo 5
Dr. D.M. Gunawardena, Regional Malaria Officer, 56 A, Mahiyangana Road, Badulla
Mr. R. Hensman, GIS consultant, N0. 226, Baudhhaloka Mawatha, Colombo 7
Dr. A.M. Hussain, Technical Officer, 226, Baudhhaloka Mw, Colombo 7.
Dr. T. Indramathie, Regional Medical Officer, Anti Malaria Campaign, Trincomalee
Mr. S.R. Jayaneththi, Regional Malaria Officer, Anti Malaria Campaign, DPDHS Office, Anuradhapura
Dr. K.S.A. Kumarasiri, Regional Epidemiologist, DPDHS Office, Mahiyangana Road, Badulla
Mrs. P.H.D. Kusumawathie, Regional Medical Officer, Anti Malaria Campaign, No.40, Hewaheta Road, Talwatta, Kandy
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Mr. N.B. Munasinghe, Regional Malaria Officer, Anti Malaria Campaign, Yodagama, Embilipitiya
Dr. K.P. Pattiyawattage, Regional Medical Officer, Anti Malaria Campaign, Ampara
Mrs. D.B. Perera, Regional Malaria Officer, Anti Malaria Campaign, Kurunegala
Mrs. B.S.L. Peris, Regional Medical Officer, Anti Malaria Campaign, Hambantota
Dr. R. Premalal de Silva, Department of Agricultural Engineering, Faculty of Agriculture, University Park, Peradeniya
Mr. D.A.R Premasiri, Regional Malaria Officer, Anti Malaria Campaign, Puttalam
Dr. A.L.F. Rahuman, Regional Medical Officer, Anti Malaria Campaign, Kalmune
Mr. S.B. Rajakaruna, Manager, Natural Resources Management Services, Mahaweli Authority, Dam Site, Polgolla
Dr. D.B. Rubasinghe, Medical Officer of Health, MOH Office, Giradurukotta
Dr. K. Sijathan, Regional Medical Officer, Anti Malaria Campaign, Ministry of Health Office, Kilinochchi
Mr. M.R.A. Siraj, Web Designer, Natural Resources Management Services, Mahaweli Authority, Dam Site, Polgolla
Dr. A., Sumanasekara, Medical Officer (Planning), Provincial Health Office, Bandaranayake Mawatha, Badulla
Ms. K.B.N. Surangika, Post Graduate Student, PGIA, Old Galaha Road, Peradeniya
Summary of Project Conclusion Workshop

Invitation

The International Water Management Institute,
International Research Institute for Climate and Society
&
Anti Malaria Campaign, Sri Lanka

Kindly request your participation at the

Workshop on: Analysis of impacts of climate variability on malaria transmission in Sri Lanka and development of an early warning system

Date: Monday, 17th September 2007
Time: 0830 – 1700 hr
Venue: Yellow River Auditorium, IWMI

RSVP: Nazreen - 2880000 by 5th Sept

Email: nazreen.silva@cgiar.org
Program

Agenda

0830 - Registration

0930 – Welcome address – Dr. David Molden – Acting Director General/IWMI

0945 – The NOAA Project - Dr. Gawrie Galappaththy, Dr. Dissanayake Gunawardena, Dr. Priyanie Amerasinghe and Dr. Lareef Zubair

1000 – Malaria situation in Sri Lanka – Dr. Rabindra Abeysinghe – Acting Director/AMC

1020 – Malaria Early Warning Systems: Recent Progress, Constraints Challenges and Future Actions – A Global Perspective – Dr. Stephen Connor

1100 - Some Climate and Malaria Linkages in Sri Lanka - Dr. Lareef Zubair, Hyemin Yang, Zeenas Yahiya, Janaki Chandimala, Manjula Siriwardhana, Upamala Tennakoon, Champika Jayatillaka, Joseph Simonson, Neil Ward, Dr. Stephen Connor

Climate and Hydrological Monitoring and Prediction for Sri Lanka
Janaki Chandimala, Dr. Lareef Zubair, Dr. Neil Ward, Badra Nawarathna, Dr. Sarith Mahanama, Syd Partridge, Michael Bell, Dr. John del Corral, Dr. Benno Blumenthal

12 00– Models for short term malaria prediction in Sri Lanka
Olivier Briët, Dr. Penelope Vounatsou, Dr. Dissanayake Gunawardena, Dr. Gawrie Galappaththy and Dr. Priyanie Amerasinghe

12 30–1330 Lunch

13 30– Spatio-Temporal Variation of Malaria Incidence in the Moneragala District in Sri Lanka - Anputhas Markandu, Susitha Wanigaratne, Olivier Briët, Dr. Dissanayake Gunawardena and Dr. Priyanie Amerasinghe

Economic Burden of Malaria - Deeptha Wijerathna, Olivier Briët, Dr. Gawrie Galappaththy and Dr. Priyanie Amerasinghe

Project Progress – IWMI - Olivier Briët and Dr. Priyanie Amerasinghe
Project Progress – IRI - Dr. Lareef Zubair, Dr. Stephen Connor and Dr. Neil Ward

1500 – Discussion, feed back (AMC) and dissemination of project findings

1700 – Concluding remarks – Julie van der Bliek – Director/Global Research Division/IWMI
## Participants

### Participants List (* Non-Attendees)

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<td>Zubair, Lareef</td>
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SUMMARY OF TRAINING WORKSHOP

PUBLIC ANNOUNCEMENT

POSTGRADUATE INSTITUTE OF SCIENCE
UNIVERSITY OF PERADENIYA

Workshop on
MALARIA RISK MANAGEMENT
using Climate Information

(Friday 21st September 2007)

The workshop will focus on: the relationship between climate and malaria and is suited for researchers in the field of malaria, infectious diseases, climatology, medical geography, community medicine, public health and environmental engineering.

Key Note Address:
Dr. Rabindra Abeysinghe, Acting Director, Anti-Malaria Campaign, Sri Lanka.

Principal Resource Persons:
Dr. Stephen Connor, Director, PAHO/WHO Collaborating Centre on Climate Sensitive Diseases, International Research Institute for Climate and Society, U.S.A.
Dr. Lareef Zubair, Associate Research Scientist, International Research Institute for Climate and Society, U.S.A.

Workshop Fee: Rs. 500/= 
If interested please visit the PGIS website for further information www.pgis.lk or contact the Conference Division, Postgraduate Institute of Science (PGIS), P.O. Box 25, Peradeniya, (Phone: 081 2394784; 081 2385669, Fax No: 081 2389026) in order to submit applications before the 18th of Sept.

Director

Postgraduate Institute of Science (PGIS)

05 - 09 - 2007
One-Day Workshop on
MALARIA RISK MANAGEMENT USING CLIMATE INFORMATION

Organized by the
POSTGRADUATE INSTITUTE OF SCIENCE (PGIS), UNIVERSITY OF PERADENIYA

Friday, 21st September 2007 (0830 – 1500 hrs)

PROGRAMME

0830 - 0855 hrs  REGISTRATION

0855 - 0900  Welcome Address – Prof. Lakshman Dissanayake – Director PGIS

0900 - 0930  Key Note Address: Forecasting of Malaria: its Importance for Malaria Control in Sri Lanka - Dr. R R Abeyasinghe

0930 - 1000  Malaria Early Warning Systems (MEWS): Recent Progress, Constraints, Challenges and Future Actions - A Global Perspective - Dr. Stephen Connor

1000 - 1030  Climate and Malaria Linkages in Sri Lanka - Dr. Lareef Zubair / Ms. Hyemin Yang

1030 - 1130  TEA

1100 - 1130  Towards Malaria Risk Management: Geographical Distribution and Seasonality of Resistant Plasmodium vivax haplotypes in Sri Lanka - Dr. Rupika Rajakaruna

Influence of Insecticide Resistance on Malaria Risk Management – Prof. S H P P Karunaratne

1130 - 1200  Use of Climate Information for Malaria Risk Management in Africa - Dr. Stephen Connor

1200 - 1230  Malaria Outbreaks Related to Failure of the Southwest Monsoon -
Prof. Manel Wijesundara

1230 - 1330  LUNCH

1330 - 1350  Remote Sensing and Tools for Climate Sensitive Diseases
- Dr. Stephen Connor

1350 - 1410  Case Study: Malaria Situation in Uva and Climate Linkages -
Mr. H M Faizal/ Dr. Lareef Zubair

1410 - 1430  Climate and Hydrological Monitoring for Sri Lanka -
Ms. Janaki Chandimala / Dr. Lareef Zubair

1430 – 1500 PANEL DISCUSSION - Dr. Priyanie Amerasinghe, Dr. Gawrie
Galappaththy, Mr. Ranjith De Alwis, Dr. RRML Siyambalagoda,
Dr. Stephen Connor, Dr. Lareef Zubair

1500  TEA

RESOURCE PERSONS:

Dr. Rabindra Abeyasinghe, Acting Director, Anti-Malaria Campaign, Colombo

Dr. Stephen Connor, Director, PAHO/WHO Collaborating Centre on Climate Sensitive
Diseases, International Research Institute for Climate and Society (IRI), The Earth
Institute, Columbia University, U.S.A.

Dr. Lareef Zubair, Associate Research Scientist, IRI, Columbia University, U.S.A.

Ms. Hyemin Yang, Research Assistant, Columbia University, U.S.A.

Dr. Rupika Rajakaruna, Department of Zoology, University of Peradeniya

Prof. Parakrama Karunaratne, Department of Zoology, University of Peradeniya

Prof. Manel Wijesundara, Department of Parasitology, University of Peradeniya

Mr. H.M. Faizal, Regional Malaria Officer, Kegalle and former RMO, Uva Province.

Ms. Janaki Chandimala, Intermediate Research Engineer, Foundation for Environment,
Climate and Technology, Digana Village.

Dr. Priyanie Amerasinghe, Senior Scientist, International Water Management Institute,
Hyderabad, India

Dr. Gawrie Galappaththy, Anti-Malaria Campaign, Colombo

Mr. Ranjith De Alwis, Registrar, University of Peradeniya, Formed Epidemiologist, National
Dengue Control Unit and Anti-Malaria Campaign.

Dr. R R M L Siyambalagoda, Deputy Director, Teaching Hospital, Peradeniya, Former Director
of the Anti-Malaria Campaign, Ministry of Health
Dr. Lareef Zubair,
International Research Institute for Climate and Society,
Lamont Campus, 61 Route 9W,
Palisades, NY 10964, USA

Dear Dr. Zubair

I write to express my appreciation for our training on “Climate and Malaria” from 3rd – 16th November 2007 at your institution.

First of all, I am thankful to Director-General of the IRI for issuing permission to visit IRI in spite of the short notice from our country.

The training programme was very well planned. It gave us an opportunity to learn many aspects of climate and malaria including (1) handling climate data and data library, (2) analysis of climatic variable and malaria, (3) presenting and interpretation of data and (4) use of remote sensing in malaria epidemic forecasting. We also had the opportunity of having interactions with other researchers working in the field of climate and malaria and to share their experiences in this field. In this particular exercise, Dr. Michael Bell, Dr. Alessandra Giannini, Dr. Judy Onumbo, Dr. Tufa Dinku, Dr. Pietro Ceccata, Dr. Stephen Connor, Dr. Madeleine Thomson, Mr. Ousmane Ndiave, Mr. Daniel Ruiz, Ms. Gilma Mantilla and others made us aware of the importance of climatic variables in malaria control and showed the potential to use these variables for malaria control in our districts.

During the period of our visit, I tried to finish a document on climatic variable and malaria for the Kandy and Nuwara Eliya districts. But, the short period time of our stay was not sufficient to complete it. However, at present, I am working on this document here. I hope to finish the document within a month or so.

Our stay at the IRI was very pleasant. We were free to work at any time of the day in a pleasant and friendly environment with all facilities including computers, e-mail and internet, photocopying and printing. Also, we were looked after well, in every aspect. I am thankful to Ms. Sandy Vitelli, Ms. Thea Marillo and Ms. Ann Binder for making arrangements. Finally, I appreciate the kindness and friendliness of staff at IRI, their motivation to work with other agencies, pleasure of sharing their knowledge and experience with us.

I am specially thankful to you who took much trouble in arranging this training programme, looking after us and for encouraging us to perform meaningful tasks at the IRI. I shall be very happy to participate and collaborate with you in future work on malaria, dengue and climate.

Dr. Mrs. P.H.D.Kusumawathie
Dr. P.H.D. Kusumawathie,
Regional Officer, Anti-Malaria Campaign,
Kandy, Central Province, Sri Lanka.
Tel: +94-81-2210687; Email: kukan_kan@yahoo.com
Dr. Lareef Zubair,
International Research Institute for Climate and Society,
Lamont Campus,
61 Route 9W,
Palisades, NY 10964, USA

Dear Dr. Zubair,

I like to express my gratitude for you and for the International Research Institution, Columbia University, U.S.A. for conducting a training programme for me, on ‘Climatic induced factors on Malaria’ from 3.11.2007 to 16.11.2007. I would also like to thank The Director, and the other staff members of IRI including Ms. Sandy Vitelli and Ms. Ann Binder for their assistance.

The training programme was well organized and we gained a good knowledge on the management of climatic data, maintaining a data library, spatial and temporal analysis of data, data interpretation and risk analysis of disease variables, epidemic forecasting of malaria and the use of remote sensing in epidemic forecasting of malaria. The lectures, discussion and presentations were conducted by Dr. Alessandra Giannini, Dr. Judy Omumbo, Dr. Michael Bell Dr. Pietro Ceccato, Dr. Connor and these were very useful.

I shall use this knowledge on ‘climatic related disease epidemiology’ to control malaria and dengue in my district in Sri Lanka. I shall be very happy to continue to collaborate on further research and development on the climate impact son both malaria and dengue.

Thank you, Sincerely,

Dr. M.R.S.S. Bandara,
Regional Officer, Anti-Malaria Campaign,
Kurunegala,
Tel: +94-37-2222193
Email: mrssbandara@yahoo.com
USING CLIMATE INFORMATION FOR MALARIA RISK MANAGEMENT IN SRI LANKA

In collaboration with the Sri Lanka Ministry of Health and other government research partners, IRI and the International Water Management Institute have undertaken a project to characterize climate and malaria linkages in Sri Lanka, focusing initially on the Uva province in the southeastern part of the island. The goal is to use climate information for early warning of disease risk.

Climate is a major determinant in the distribution and occurrence of malaria epidemics in Sri Lanka. Temperature, rainfall, and humidity affect breeding and survival of vector mosquitoes and the development of malaria parasites within the mosquitoes. IRI, in collaboration with the Anti-Malaria Campaign of the Sri Lanka Ministry of Health, the International Water Management Institute (IWMI), Foundation for Environment, Climate and Technology and other partners, has studied climate-malaria linkages in order to develop an early warning system of climate induced disease risk. The project set goals of characterizing climate and malaria relationships in Uva Province at a fine scale, and to develop early warnings for malaria risk in all of Sri Lanka. The project was supported by NOAA’s Climate Variability and Human Health program starting in December 2003.

Project Outputs
Project accomplishments to date include the development of:

- A database of fine scale climatic hydrological and malaria information
- Fine-scale climate analysis and high resolution prediction techniques
- A climate monitoring system
- A refined land surface model
- Geographic information systems for climatic, hydrological, malaria and societal data
- Methods of identifying linkages between climatic variables and malaria at seasonal, inter-annual, decadal and epochal time-scales
- Methods to identify factors that lead to vulnerability to malaria
Our analysis shows clear evidence of climatic influence on malaria, both spatially and temporally. Malaria is linked to both the El Niño phenomenon and climatic change. As there is considerable spatial and epochal heterogeneity in the climate and malaria linkage, carefully calibrated, fine-scale warning systems are needed.

The project has led to capacity building opportunities for researchers and government officials, as well as educational opportunities for students. For example, in November 2007, IRI hosted two malaria control officers from Sri Lanka, with support from the Global Fund for AIDS, TB and Malaria.

During stakeholder workshops in Sri Lanka in September 2007, Sri Lanka’s Anti-Malaria Campaign and other local partners identified the need to continue this work despite the recent decreases in malaria incidence. During periods of low malaria prevalence, the immunity of the population is lowered, disease surveillance and control measures are relaxed, there is an enhanced risk of epidemics. Under these circumstances, early warning systems based on climate and environmental information can be a cost-effective means of identifying the risk of epidemics.

Left: Annual average malaria incidence (Plasmodium Vivax). Middle: The end of the year malaria incidence was correlated with anomalously high rainfall in the drier regions particularly in the North. This relationship of malaria with rainfall can be used in disease-risk prediction if the current climate is monitored. Right: A rainfall monitoring system has been put in place at fine scales and an estimate of anomalous wetness and dryness for October 2007 as estimated in early November is shown. The lead time of predictions can be extended with seasonal climate forecasts which have also been developed at fine scales.

About the IRI
The IRI works on the development and implementation of strategies to manage climate related risks and opportunities. Building on a multidisciplinary core of expertise, IRI partners with research institutions and local stakeholders to best understand needs, risks and possibilities. The IRI supports sustainable development by bringing the best science to bear on managing climate effects and the impacts of climate change, in agriculture, food security, water resources, and health. By providing practical advancements that enable better management of climate related risks and opportunities in the present, we are creating solutions that will increase adaptability to long term climate change. IRI is a member of the Earth Institute at Columbia University.