



Meningitis Environmental Risk Information Technologies

4th MERIT Technical Meeting

Synthesis Report

School of Medicine, Addis Ababa University and United Nations
Conference Center

Addis Ababa, November 18-20, 2010



CHWG Ethiopia

Climate and Health Working Group

4th MERIT Technical Meeting

Synthesis Report

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Acknowledgements and Team Member

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Acronyms

ACMAD	African Centre of Meteorological Application for Development
ADCEM	Impacts of Dust Aerosols and Climate on Meningitis Epidemics in the Sahel project
AEMET	Spanish Meteorological Agency
AfDB	African Development Bank
AHRI	Armauer Hansen Research Institute
AMMA	African Monsoon Multidisciplinary Analyses
CHWG	Climate and Health Working Group
CIESIN	Center for International Earth Science Information Network
CIPH	Climate Information for Public Health
CIPHAN	Climate Information for Public Health Action Network
CRM	Climate Risk Management
FMoH	Federal Ministry of Health
GEO	Group on Earth Observations
GRUMP	Global Rural Urban Mapping Project
GPW	Gridded Population of the World
HCF	Health and Climate Foundation
IES	Institute for Environment and Sustainability at the Joint Research Council
IHR	International Health Regulations
IPCC	Intergovernmental Panel on Climate Change
IRI	International Research Institute for Climate and Society
IT	Information Technology
JRC	European Commission Joint Research Centre
Men A	<i>Neisseria Meningitidis</i> serogroup A
MERIT	Meningitis Environmental Risk Information Technologies
MoH	Ministry of Health
MoU	Memorandum of Understanding
NCAR	The National Center for Atmospheric Research
Nm	<i>Neisseria Meningitidis</i>
NMA	National Meteorological Agency
NOAA	National Oceanic and Atmospheric Administration
NGO	Non Governmental Organization
PAHO-WHO	Pan-American Health Organization – World Health Organization
SI	Summer Institute on Climate Information for Public Health
UCAR	University Corporation for Atmospheric Research

UN	United Nations
UNECA	United Nations Economic Commission for Africa
UNEP	United Nations Environment Program
UNICEF	United Nations Children's Fund
WCC-3	World Climate Conference-3
WHO	World Health Organization
WMO	World Meteorological Organization

Executive Summary

Background

As established in 2007 and lead by the World Health organization (WHO), the Meningitis Environmental Risk Information Technologies (MERIT) project is a collaborative initiative between the public health, environmental and research communities. MERIT partners work to combine environmental and social, economic and demographic information with public health data to strengthen decision-making and preparedness for epidemic meningococcal meningitis in Africa.

Conducting such an effort is increasingly important, as both the on-going introduction of the new conjugate vaccine against *Neisseria Meningitidis* serogroup A (Men A) and some environmental and climate changes are expected to shape the dynamics of meningococcal meningitis in the African Meningitis Belt.

Organization and Sponsorship

Every year since its implementation, the MERIT Steering Committee¹ holds an international technical meeting that enables member of the MERIT Community to review the status and achievements of MERIT based on the recommendations of the previous technical meetings, and to plan the way forward.

The 4th MERIT Technical Meeting was organized by the MERIT Steering Committee in partnership with the Ethiopian Climate and Health Working Group (CHWG)/Anti-Malaria Association (AMA) , November 19-20, 2010. Hosted for the second time by the CHWG/AMA at the United Nations Economic Commission for Africa (UNECA) compound at the United Nations (UN) Conference Centre, in Addis Ababa, Ethiopia, the meeting was sponsored by the European Commission Joint Research Centre (JRC), Google.org, the Group on Earth Observations (GEO), the Health and Climate Foundation (HCF) and the Spanish Ministry of Foreign Affairs and Cooperation.

Outcomes

Following opening addresses by the Federal Ministry of Health (FMoH) of Ethiopia and the WHO Representative in Ethiopia, 73 participants from the public health,

¹For more information on MERIT and its steering committee, please visit: <http://merit.hcfoundation.org/index.html>

environmental and social sciences communities, involved through a wide range of international and national institutions, attended the meeting.

Through presentations, discussions and working group sessions, they addressed the ways to ensure the public health relevance of MERIT activities in the context of the changing epidemiology and nature of the Meningitis Belt region in Africa, identified potential new partnerships and opportunities with regards to investigating the role of environmental, social, epidemiological and biological risk factors on meningitis epidemics in Africa. Efforts further focused on the ways to develop an operational decision support tool which will help inform reactive vaccination strategies in districts in epidemic as well as preventive strategies in line with the introduction of the new conjugate Men A vaccine, through (but not limited to) the near real-time monitoring of the next meningitis epidemic season. The means to develop, to advance and to support country-led MERIT activities were also discussed, with emphasis on Ethiopia and Nigeria.

Recommendations

At the time the 4th MERIT Technical Meeting was closed, (i) priority research areas had been identified; (ii) detailed suggestions had been made on the next steps to further the development of an enhanced decision support tool; and (iii) some synergies and collaborative potential between MERIT partners had been recognized.

More specifically, it was recommended that:

(i) Research efforts should focus on four main areas:

- Estimating and accounting for immunity.
- Understanding the microbiological response of meningococcal strains to the vaccine pressure on serogroup Men A across the Meningitis Belt.
- Defining the impact and accounting for societal and community-related factors.
- Furthering the knowledge on the impact of dust on the dynamics of meningitis.

While, if understanding the response of meningococcal strains to the vaccine pressure on Men A is a very important element to explore in the coming years, it will not be considered a MERIT research objective at the moment, as the efforts of the MERIT community should currently remain focused on informing preventive and reactive immunization strategies.

Yet, this microbiological issue, combined with the fact that large epidemic waves are usually associated with the emergence of new meningococcal strains (rather than serogroups), urges the MERIT community to deepen its microbiological expertise.

(ii) **Efforts to translate research outputs into decision-making should be strengthened**, building on, in particular:

- The prospective field test of a new decision tree, involving, in addition to the incidence of meningitis, variables such as: “crossing the epidemic threshold before epidemiological week 10”, “the proportion of children under 15”, and “no history of outbreaks or immunization with the same serogroup, in the last two years, at the sub-district level”.
- The experience of country-led MERIT activities, where the collaboration between the public health and climate communities might be closer and more capacity-driven than at the international level.

(iii) **The research community should deliver a clear and unique message to public health decision makers**

As highlighted during the working group session, this improvement would be possible if MERIT partners from the same community develop MERIT sub-groups, based on the area of expertise, and convene small MERIT meetings where, together, they would state on the questions relevant to their field of expertise and the objectives of MERIT, keeping in mind how these research outcomes could be translated into operational procedures. The conclusions of these interim meetings could be presented at the following annual MERIT technical meeting and discussed, in a multidisciplinary context, with the decision-makers as well as MERIT partners from other fields.

National Seminar on Public Health and Climate

In collaboration with the School of Public Health, Addis Ababa University, and the IRI, Columbia University, the Ethiopian CHWG organized a half day National Seminar on Public Health and Climate, prior to the beginning of the MERIT Technical Meeting itself.

Hosted in the School of Medicine, Addis Ababa University, this seminar enabled national and international meteorological staff, public health practitioners and students to better understand the importance, challenges and ways to characterize and manage climate risk in public health in general, and in Ethiopia in particular, in addition to engaging with MERIT partners.

Introduction

The MERIT Initiative

As created in 2007, the MERIT project is a collaborative effort of the WHO and members of the environmental, public health and social sciences communities. It provides a framework to facilitate collaboration between (but not limited to) the public health, epidemiological and environmental communities in the development of effective decision-making tools and enhanced prevention and response control strategies to help reduce the burden of meningococcal meningitis epidemics in the African Meningitis Belt.

In particular, the MERIT initiative aims to support current polysaccharide reactive vaccine activities and the introduction of the conjugate meningococcal A vaccine by improving the risk assessment and management of the disease and by informing both reactive and preventive vaccination strategies. For more information on the activities conducted under the umbrella of MERIT to date, please refer to Appendix 1: Outcomes of Previous MERIT Technical Meetings.

The Ethiopian Climate and Health Working Group

The Ethiopian CHWG was established in February 2008. The CHWG aims at fostering stronger collaboration between the climate and health community so that climate information is effectively used for protecting the Ethiopian people from climate-related health problems such as malaria, meningitis and acute watery diarrhea. Developing effective and functional means for the health sectors to routinely use appropriate climate information for prevention and control of climate-sensitive diseases is among its primary objectives.

Since its establishment, the Ethiopian CHWG has accomplished activities ranging from the organization of technical meetings and workshops (e.g., MERIT workshop in December, 2008; Stakeholders workshop on Weather and Climate Impact on Community Health and Public Health Services in June 2010), the implementation of trainings (e.g., Google Earth/Maps Training in November 2009; Training of Professionals on Climate and Health in November-December 2009), the support of a Masters student's thesis from Jimma University on climate and malaria, February 2010), to the establishment of the MERIT-Ethiopia Case Study and the associated development of four project proposals (Risk assessments for meningitis epidemics, assessment of the socio-economic burden of meningococcal meningitis in Ethiopia, education, training and research on meningitis, and strengthening surveillance and database system of meningitis).

Meeting Objectives

Main goal of the meeting

Through presentations, discussions and working group sessions, the main goal of this two-day meeting was to review the current status of MERIT based on the recommendations of the preceding of the three previous technical MERIT meetings and to plan the way forward. The detailed agenda of the meeting is available in Appendix 2: Meeting Agenda

Objectives of the meeting

The objectives of the 4th MERIT technical meeting were stated as follows:

1. Provide a forum for the exchange of information between MERIT partners and to identify potential new partnerships and opportunities
2. Ensure the ongoing public health relevance of MERIT activities in the context of the changing epidemiology and nature of the Meningitis Belt region in Africa
3. Assess existing and new research projects investigating the role of environmental, social, epidemiological and biological risk factors on meningitis epidemics in Africa
4. Identify priority research areas and methodologies for developing an operational decision support tool which will help inform:
 - Reactive vaccination strategies in districts in epidemic
 - Preventive strategies in line with the introduction of the new conjugate A vaccine
 - Other research topics related to the longer-term extension of the Meningitis Belt
5. Identify the means and funding support for country-led MERIT activities, including:
 - Advancing the MERIT-Ethiopia case study

- Continuing the near real-time monitoring of the next epidemic season
- Introduction of a MERIT-Nigeria case study

Desired meeting outcomes

Agreement on the next steps based on identified achievements, gaps and opportunities to date. This includes:

- Clarification of the role of MERIT partners in informing public health decisions for reactive and preventive meningitis vaccination campaigns
- Priority research areas identified and agreement on next steps for further development of a decision support tool
- Identification of synergies and collaborative potential between MERIT partners
- Requirements and next steps agreed to for country-led activities

Opening Addresses

The 4th MERIT meeting was honored by an opening message from MrsMihret Hiluf, from the Federal Ministry of Health, and a key note address by Dr. Fatoumata Nafotraoré, WHO Representative for Ethiopia. The full texts of these addresses are available below.

Opening address by Mrs. Mihret Hiluf

Distinguished guests,

Ladies and Gentlemen,

It gives me a great pleasure to officially open the 4th MERIT Technical Meeting.

I would like to commend the Climate and Health Working Group, under the secretariat ship of the Anti-Malaria Association, that is hosting the 4th MERIT meeting here in Addis. As you may also know, the Federal Ministry of Health chairs the Climate and Health Working Group, which is basically a collaboration between the Federal Ministry of Health and the National Meteorological Agency to share and exchange data. It is repeatedly being told now in various platforms that climate information (products and services) is essential for the development of Africa. The establishment of the Health and Climate Working Group in 2008 seems to have been a foresight to what is being forwarded as recommendations of deliberations of gathering these days: access to and utilization of climate products both by providers and users. It seems that the Climate and Health Working Group understanding this has been attempting to do its level best in this regard. The Climate and Health Working Group is an exemplary collaboration which should be taken up by other sectors as well.

The Federal Ministry of Health understands the importance of climate products for the health sector. Because of this, it has provided approximately USD 500,000 to the National Meteorological Agency from the Global Fund to Fight AIDS, TB and Malaria grant for activities related to malaria early warning activities. These include: upgrading the capacity of meteorological stations to monitor additional weather parameters; build the capacity of 14 sentinel service stations in 14 target districts; provisions of meteorological data and information products for malaria early warning and detection of anomalous case trends and other indicators of epidemics. Consequently, the Federal Ministry of Health supports the Climate and Health Working Group initiative as it is built on the existing foundation of the experience between the Federal Ministry of Health and the National Meteorological Agency.

As a platform that was established in 2008, the Climate and Health Working Group has been involved in various activities, some of which include:

- Conducting workshops and meetings to raise the level of awareness of the impacts of climate and health;
- Organizing capacity building trainings;
- Providing support for a master's thesis on malaria and climate;
- Establishing a Meningitis Environmental Risk Information Technologies-Ethiopia case study;
- Formation of study teams in the Meningitis Environmental Risk Information Technologies- Ethiopia case study comprising of volunteer experts who developed proposals on identification of disease determinants, risk factors, and socio-economic impact as well as strengthening surveillance of meningitis epidemic outbreaks.

Coming to the issue which has brought us all today, meningitis is one of the twenty priority diseases under Public Health Emergency Management which is reported on a weekly basis. Outbreaks of meningococcal meningitis have swept over Ethiopia at various times. Before 1988, the endemic areas of meningococcal meningitis in Ethiopia were the northern and western parts of the country (Tigray, Amhara, Afar, Benshangul-Gumuz and Gambella). However, the 1988/89 epidemic affected all regions. Its onset is generally in the middle of the dry season (December to February) Ethiopia is also one of the case study countries, which I am told, that has designed projects under the Climate and Health Working Group and currently under resource mobilization to:

- Understand the socioeconomic impact of meningitis
- Identify risk and determinant factors of meningitis transmission
- Undertake education and training on meningitis
- Strengthen the surveillance and database system.

I am also informed that these projects were developed voluntarily by professionals drawn from the Federal Ministry of Health, the National Meteorological Agency, UN agencies, research institutes like AHRI, MACEPA, academic institutions, etc. The outcomes of these projects will no doubt serve as input to the Federal Ministry of Health's prevention and control strategy of meningitis. This is the kind of support that the Federal Ministry of Health would like to see from the Climate and Health Working Group and other like minded institutions and organizations. The Federal Ministry of Health is willing to extend the necessary support for the realization of

these projects. We hope to secure support from the Meningitis Environmental Risk Information Technologies to implement these projects.

Distinguished guests,

On behalf of the Federal Ministry of Health, I now declare the 4th MERIT meeting officially open, I wish you successful deliberations.

Thank you.



From left to right: from Mrs Mihret Hiluf, from the Federal Ministry of Health, addressing the audience, Dr Fatoumata Nafu-Traoré, fromWHO, and Mr Abere Mihretie, from AMA/CHWG of Ethiopia.

Opening address by Dr. Fatoumata Najo-Traoré

Dr Eric Bertherat, chair of the MERIT Steering Committee,

Mrs Mirhet Hiluf, Director of the Agrarian Health Promotion and Disease Prevention Directorate, Federal Ministry of Health,

Colleagues from partner organizations,

Distinguished guests,

Ladies and Gentlemen,

It is a great honor and pleasure for me to be with you today on the occasion of the 4th MERIT working group meeting in Addis Ababa.

Although effective vaccines and treatment are available, meningococcal meningitis continues to claim hundreds and thousands of human lives, most notably in Africa. The largest burden of meningococcal disease occurs in sub-Saharan Africa in the area known as the meningitis belt, which stretches from Senegal in the west to Ethiopia in the east, constituting a huge public health burden. During the dry season, dusty winds, cold nights and upper respiratory tract infections combine to damage the nasopharyngeal mucosa, increasing the risk of meningococcal disease. At the same time, transmission of *N. meningitides* may be facilitated by overcrowded housing and by large population displacements, pilgrimages, internal and external conflicts and gatherings during traditional markets.

Statistics show that in the 2009 epidemic season, 14 African countries implementing enhanced surveillance reported a total of 78,416 suspected cases, including 4,053 deaths, the largest number since the 1996 epidemic.

Since Ethiopia is one of the countries in the sub-Saharan meningitis belt, it is a risk of meningococcal meningitis epidemics. WHO Country Office is actively involved in all Government's efforts to prevent and control meningitis by providing technical support to strengthen the surveillance system, build health workforce capacity, create awareness among health staff and the communities as well through procurements of vaccines, drugs, and supplies.

Supporting countries to have capabilities in epidemic preparedness and response so as to be in a position to combat epidemic-prone diseases like meningitis at all times is a critical and important function of WHO. This can't be done without accurate, complete and timely data and information, comprehensive enough to help us predicting and pre-empting crises situations.

The MERIT Ethiopia case study is a much welcome initiative which if funded will improve our understanding of patterns, determinants, risk factors of the outbreaks,

the socio economic impact of the disease as well as strengthening the capacity of health workers and other stakeholders.

Dear colleagues, participants,

As you know, we have another challenge ahead, the impact of climate variability on health. How can we collectively, as technical experts, donors and decision-makers help countries to get prepared?

We are delighted and extremely thankful that the MenAfriVac conjugate meningitis A vaccine (which offers immunity for 10 years unlike the polysaccharide vaccine that confers immunity for about 2 years) is being introduced in some West African countries (thanks to a great public-private partnership), Ethiopia will benefit later on.

A lot of work has also been done with regard to the mapping of the malaria and meningitis.

We have improved our knowledge with the past H1N1 pandemic and the country capacity assessment towards a proper implementation of the International Health Regulations (IHR).

How can we build on those experiences in order to get a proper system in place that can predict outbreaks, support the preparedness and rapid response? Can the available tools be used and for what levels? How can we improve the capacity at community level for greater participation and life saving?

Dear colleagues and participants,

I look at this meeting as an important forum for information and knowledge sharing to enrich and sharpen our skills for a more effective control and prevention of meningitis in our respective countries. I know that WHO at all levels (HQ, Regional and Country levels) is an active member of Climate and Health Working Groups and will continue to participate in this endeavor. I understand that the Climate and Health Working Group / Anti-Malaria Association is hosting this scientific meeting with the thought that it will benefit the experts and partners in the country.

I would like to assure you that the WHO Country Office will continue to support and work with the Climate and Health Working Group/MERIT- Ethiopia in all endeavors in this regard.

At this juncture, I wish to express my appreciation to the hosts, organizers and sponsors for holding this fourth meeting in Ethiopia.

Finally, I wish you all a very thought-provoking and fruitful deliberation while awaiting your constructive, creative and useful recommendations on how to move to the next level.

Thank you!

Profile of the Participants

Seventy-three participants, contributing expertise and knowledge from the public health, environmental and social sciences communities, attended the 4th technical MERIT meeting. They spanned from the USA to Ethiopia from where about 58% of the participants originated. While most of the Ethiopian representatives were involved in operational activities, either on the climate or the public health side, the majority of the international participants were researchers involved in climate and/or meningitis projects and based in UK, France and USA, among others. More details on the institutions and participants involved in this meeting may be found in Appendixes 4 and 5.

Summaries of Presentations and Discussions

National Seminar on Public Health and Climate

Climate Risk Management in Health: Lessons Learned **Madeleine Thomson, IRI**

Relying on real instances and case studies relevant for Ethiopia, this presentation described the rationale and current range of climate challenges for public health, with emphasis on outbreak-prone and vector-borne diseases, as well as their complex interactions with other determinants of public health outcomes such as drug resistance. Understand climate and health regardless of the climate change, which recently became an international scientific and political great concern.

This presentation also highlighted the need to make public health decisions despite uncertainty and the ways to reduce it when possible, in particular through the use of climate and environmental data.

Finally, this lecture emphasized the importance of good quality data, long time series, critical thinking and cross-disciplinary interaction and training while using climate and health datasets in order to better understand the relationship between climate and some public health outcomes, as well as for assessing the impact of public health interventions.

During the discussion generated by this presentation, the curriculum on climate information for public health (CIPH) recently developed by the IRI was identified as an important tool to standardize and maximize practices addressing issues at the nexus of climate and public health.

For more information, see:

>> <http://ciphan.iri.columbia.edu/>

Malaria and Climate: Ethiopia in Case **Aduugna Woyessa, Ethiopian Health and Nutrition Research Institute (EHNRI)**

Building on the long-existing awareness of the various relationships between climate and public health and the different ways the variability and changes of climate may affect health and impact vulnerability in the current global context, this presentation addressed concerns relevant to Ethiopia related to climate-sensitive diseases, with emphasis on malaria.

As based on an extended review of the literature, including the experience of the presenter, this talk described the heterogeneity in malaria's patterns across the country and the importance of geo-locating malaria data, especially in the Highlands where malaria is emerging. It also stressed out the importance of multidisciplinary initiatives to document and address this possibly changing epidemiology of malaria in Ethiopia, in particular through enhanced early warning and climate-informed control strategies.

Building Capacity at National Meteorological Agency (NMA) Kinfe Hailemariam, NMA



Mr Hailemariam, from NMA, is answering questions from the audience.

This presentation detailed the current status of the NMA on climate and weather data acquisition, processing and access, as well as the associated challenges. Some of these challenges included the manual processing of un-digitalized data, the manual and un-standardized data quality control, the lack of metadata, limited satellite datasets, the reduced spatial and temporal resolution of the data available, as well as the lack of representativeness in the distribution of the 1,000 existing meteorological stations - while the WMO recommends 5,000 exist for the country.

This presentation also described the on-going capacity building efforts underway to improve the

quality and availability of these data. These efforts, in part conducted in partnership with the IRI, included strengthening data interpolation and quality control, improved access to satellite estimates and validation using ground data, as well as trainings and knowledge transfer activities.

Associated discussions insisted on the importance of following the guidelines developed by the World Meteorological Organization (WMO) when building capacity, despite the challenge of complying with standard procedures given limited resources.

**Building Sustainable Partnerships to Improve Meningitis Surveillance and Response:
The MERIT Initiative
Emily Firth, WHO**

The current WHO strategy for the control of meningitis outbreaks relies on standard treatment and reactive mass vaccination, which, unfortunately, has strong limitations. Improving our understanding of the natural history of the disease and its relation to the environment would help detect meningitis outbreaks at an earlier stage, and/or anticipate their occurrence, resulting in optimized disease control strategies.

These opportunities led to members from the public health and climate communities coming together and creating in 2007 the MERIT project, which relies on multidisciplinary partnerships, involving “doers” (decision-makers) and “thinkers” (researchers) working at the national and international levels. Case studies are being implemented, various models are being produced, and decision tools are being developed with the aim of applying these findings as soon as possible to support the decision-making process for improved meningitis epidemic control.



Participants to the national public and climate seminar.

Technical Meeting

Session 1: Opening Remarks and Introductions

MERIT objectives and expected outcomes

Eric Bertherat, WHO, Chair of the MERIT Steering Committee



Dr Eric Bertherat, from WHO and Chair of MERIT, is presenting during the technical meeting.

Drawing on the burden of meningococcal meningitis in the African Meningitis Belt, where 400,000 cases were reported in the past 10 years over the 21 countries and 300 million people at risk of meningitis, this presentation underlined the importance of improving the current strategy for meningitis control and addressing the immunity and carriage issues now, while the development of a new conjugate vaccine against Men. A paves new ways for meningitis prevention.

This presentation also highlighted the achievements and challenges faced by the MERIT initiative. These challenges included: (i) ensuring the ongoing public health relevance of MERIT activities in the context of the changing epidemiology and nature of the Meningitis Belt, (ii) assess existing and new research projects investigating the role of environmental, social, epidemiological and biological risk factors on meningitis epidemics in Africa, (iii) identify priority research areas and methodologies for developing an operational decision support tool which will help to inform reactive and preventative vaccination strategies, as well as (iv) identify the means and funding support for country-led MERIT activities.

GEO Health Services Video

Masami Onoda, GEO Secretariat

As developed by the US Environmental Protection Agency for GEO, this video clip on how Earth observations can serve public health needs by delivering information on the impact of climate on public health (e.g., air pollution and respiratory diseases, dust and meningitis) was broadcasted at the GEO Ministerial Summit, held in Beijing on November 5, 2010 that brought together Ministerial-level representatives from across the globe. GEO also developed a book “Crafting Geoinformation”, which includes a full chapter on meningitis in Africa, in its section on “Information for Decision Making: Health”. These two outputs may be used by MERIT members to raise awareness and seek supports.

The video is available from:

>> ftp://ftp.earthobservations.org/EXCHANGE/2010_Ministerial_Videos/

The book “Crafting Geoinformation” may be accessed from:

>>http://www.earthobservations.org/documents/geo_vii/geo7_crafting_geoinformation.pdf

New opportunities in the context of climate and health in Africa

Madeleine Thomson, IRI



Dr Madeleine Thomson, from the IRI, is presenting during the technical meeting.

The arrival of climate on the global health centre stage was marked by the address on climate change and global public health in 2007 by Margaret Chan, Director-General of WHO: "Climate change will affect, in profoundly adverse ways, some of the most fundamental determinants of health: food, air, water."

Going beyond the issue of climate change itself, the Declaration of Libreville was signed in August 2008 by African Ministers responsible for health

and environment issues to reaffirm their commitment to implement all the existing policies “that bear on health and environment linkages” and to develop “health-and-environment strategic alliance, as the basis for plans of joint action”. The importance of such type of initiative was further underlined during the 2009 World Climate Conference-3 (WCC-3), where the Global Framework for Climate Services was established to “enhance climate observations and monitoring, transform that information into sector-specific products and applications, and disseminate those products widely,” said Alexander Bedritsky, President of the WMO.

This presentation highlighted how closely the MERIT initiative aligns with this global political and scientific momentum. It emphasized the importance of sustaining efforts and resources to: (i) improve the quality and availability of climate and public health data, with regards, in particular, to spatial and temporal resolution, (ii) develop relevant analytical tools and (iii) build capacity through tailored trainings developed by the countries.

Session 2: Ensuring the Relevance of MERIT in a Changing Environment

Overview of the 2010 epidemic season

Eric Bertherat, WHO

Overall, the 2010 meningitis epidemic season (Nov. 09-May 10), was of mild intensity. Outbreaks, as defined by the epidemic threshold being crossed at the district level, were recorded in Burkina Faso, Niger, Nigeria, Ghana and Chad. About 20,000 cases were notified across the Meningitis Belt, with an average case-fatality ratio of 11% (similar to developed countries), triggering the distribution of four millions doses of vaccine. As usual, Men A was responsible for the vast majority of cases but outbreaks of NmW135 and NmX were recorded, respectively, in Niger and Burkina Faso. Compared to 2009, the 2010 epidemic season was overall of much smaller magnitude (80,000 cases in 2009).

The overview of the season, put in perspective with historical data, highlighted the existence of a cyclic pattern but the current inability to predict the magnitude of the next epidemic season based on epidemiological information.

Monitoring the 2010 meningitis season by ACMAD, IRI and WHO

Sylwia Trzaska, IRI

Building on the recommendations of the 3rd MERIT meeting, climate professionals from ACMAD and the IRI and meningitis experts from the WHO developed a near real-time experimental monitoring of the environmental conditions and the epidemic situation at the regional/Meningitis Belt level. Together, they tried to link some of the epidemiological and environmental patterns they noticed, as a first step in the development of outbreak risk forecast methods.

Through teleconference calls held every 10 days between Dec. 09 and April 10, the localization and intensity of the meningitis outbreaks were put in parallel with the most recent climate and environmental information at the sub-seasonal scale (weekly-10-day averages), such as sea surface temperature, humidity, current position of the wind convergence and dust conditions, as well as the forecast of location of the wind convergence zone and of dust storms. The climate indices were defined at a large-scale, therefore enabling predictions to be made.

Overall, despite the consistency between the observed mild dry season and the relatively calm meningitis epidemic season, no clear environmental trigger for meningitis outbreaks could be identified at the regional level. Looking more closely at the situation of Burkina Faso and Niger, however, it seems like a 5-7 days average of humidity and wind conditions could potentially be good predictors of incidence increase within the season.

The ViGIRisC Implication for Climate and Public Health Activities²

Lazreg Benaïchata, ACMAD (summary presented by Sylwia Trzaska, IRI)

As lead by ACMAD, the pan-African ViGiRisc/African Early Warning and Advisory Climate Services project arose from the 2006 « Climate information and needs of development » (ClimDevAfrica) initiative launched in part by the UN Economic Commission for Africa and supported by the African Development Bank (AfDB).

The main objective of ViGiRisc is to strengthen the capacity of African countries to adapt and cope with increasing climate variability through the development of relevant tools and services for climate risk assessment and early warning for five sectors, including public health.

Re-orientation of research needs in response to the introduction of the conjugate meningitis A vaccine

Eric Bertherat, WHO

Introduction plan of the Men A Vaccine in the Meningitis Belt

This presentation described the 2009-2015 MenAfriVac project for the introduction of the new Conjugate-A vaccine, superior to the polysaccharide vaccine thanks to the herd and prolonged (10-year) individual immunity it is expected to provide. As pre-qualified by the WHO and manufactured in India at less than USD 0.50 per dose, this vaccine is first targeted to most at risk populations pending broad and routine distribution to the entire Meningitis Belt, with an expected 250 million persons protected at the completion of the project.

Production of the vaccine started in February 2009, with an expected 23 million doses available by the end of the year. Since 2010, a pilot introduction phase is underway in two districts in each of the three hyperendemic countries (Burkina Faso, Mali, Niger), with initial very good results in terms of vaccine coverage and safety. Nigeria and Chad are the next targeted countries for vaccination. Though highly promising, these mass immunization efforts will be sustained if GAVI, who provided the fund for the first phase of the project, the countries and other partners secure sufficient funds to cover both for the cost of the vaccines and the training of the staff who will deliver it.

In the meantime, however, it is important to ensure adequate epidemic-response through establishing stockpiles of meningococcal polysaccharide vaccines and improving timeliness of response, as well as to strengthen meningitis surveillance systems as outbreaks will still need to be responded to.

² *This presentation could not be delivered during the conference*

Implication for research needs

The introduction of the new Men A vaccine as well as the changes in the environment within and/or at the fringes of the Meningitis Belt will undoubtedly change the epidemiology of meningitis in sub-Saharan Africa. Whether new serogroups emerge, or new areas become hyperendemic, these changes are likely to occur rapidly and urge the MERIT community to address these questions at the district, national and regional levels.

In particular, the MERIT community should support the introduction of the conjugate A vaccine, by forecasting the future pattern of Men A cases in the Belt, and exploring the impact the large-scaled and long-lasting immunization against Men A might have on the dynamic of other strains. As a consequence, the vaccine needs for both preventive and reactive strategies after the conjugate A vaccine is introduced should be estimated, based on the identification the areas and populations most at risk, either for environmental (e.g., drying conditions at the fringes of the Belt) or epidemiological reasons (e.g, immunity and carriage).

Additionally, the current response thresholds might need to be redefined or/and re-characterized. In particular, the MERIT community is requested to define which variables may help shortening the decision process in the period between the alert and epidemic thresholds and trigger preemptive/reactive immunization against Men A and/or, as importantly, other serogroups.

These issues were specifically addressed during the break out sessions.

MERIT-Ethiopia case study Abere Mihretie, CHWG



Mr Abere Mihretie from AMA/CHWG of Ethiopia is presenting during the technical meeting.

Established in 2008, the Ethiopian Climate and Health Working Group involves the Federal Ministry of Health, the National Meteorological Agency, UN agencies such as the WHO, the United Nations Children's Fund (UNICEF), the United Nations Environment Program (UNEP), academia such as School of Public Health, Addis Ababa University, as well as NGOs such as the Anti-Malaria Association and humanitarian non-governmental organizations (NGOs) such as the Ethiopian Red Cross Society. The group creates a framework for collaboration between the climate and public health communities in Ethiopia.

Following the 2nd MERIT meeting and the associated capacity building workshop, the CHWG decided to launch a MERIT Ethiopia case-study that would help (i) characterize the determinants of meningitis epidemics in Ethiopia; (ii) better understand the environmental, social and economic impacts of meningitis in the country; (iii) promote education programs and (iv) strengthen meningitis surveillance systems in Ethiopia. Detailed proposals covering these four key areas have been developed by voluntary teams, but funds are yet to be raised to support these projects.

Overview of meningitis epidemics in Ethiopia
Tadesse Seda, Oromia Regional Health Bureau

Further to the introduction to the MERIT Ethiopia case-study, this presentation detailed the surveillance system for meningitis in Ethiopia from a regional health bureau perspective, as well as outcomes of this surveillance such as the number of meningitis cases and fatalities reported between 2000 and 2008. This presentation also highlighted the will of this regional health bureau to work with partners like MERIT and the WHO country office to handle the capacity building challenges associated with the surveillance (data quality in particular) and control of meningitis in Ethiopia.

Establishing a State MERIT Committee in Nigeria
Mansur Matazu, Federal University of Technology Minna, Nigeria

Inspired by the 3rd MERIT meeting and the functioning of the Ethiopian CHWG, the Federal University of Technology Minna, in Katsina State, Nigeria, partnered with the State Ministry of Health and state representatives of WHO, UNICEF, UNFPA and NIMET to implement a Katsina State MERIT Committee.

With an initial financial support from the State Focal Office on MDGs, this committee aims to reduce the suffering and death from meningitis in the state. In particular, this committee seeks to (i) engage further in meningitis research, (ii) identify gaps and accelerate new warning and intervention strategies for meningitis and (iii) build capacity within the public health and climate/environment communities.

Currently, the State MERIT Committee is looking for technical partnership to address the socio-economic impact of meningitis in Katsina, as well as defining performance indicators for their activities, such as a significant improvement and availability of meningitis vaccine.

The discussion that followed the description of country-led MERIT activities insisted in part on the need to improve both the quality and the availability of the public health and climate data.

Session 3: Overview of MERIT research activities - achievements and new opportunities

Brief reports on research meetings in 2010

New York meeting, Madeleine Thomson, IRI

The small MERIT Meeting on Meningococcal Meningitis Modeling, held in New York in May 2010, was designed to enable MERIT partners, such as IRI, WHO, CERMES, UCAR, Lancaster University and the Burkina Faso and Niger Meteorological offices, to share technical information on current modeling projects and recent findings, in parallel with the IRI Summer Institute on Climate Information for Public Health (SI).

The meeting enabled new collaborative opportunities between existing and new partnerships to be identified, helped highlight gaps in current research activities, and addressed new requirements in relation to the changing nature of meningitis epidemics across the Meningitis Belt region in line with the development of new vaccination strategies.

The full report on the meeting is available from:

>> <http://merit.hc-foundation.org/>

Lancaster meeting, Michelle Stanton, University of Lancaster

Another small MERIT meeting on meningitis spatio-temporal modeling was hosted by Lancaster University in early November 2010. This meeting brought together MERIT partners, such as IRI, CERMES and Lancaster University, to refine the objectives of spatio-temporal research and the selection of climate variables to be included in the models being developed.

Demographic and Environmental Factors in Meningococcal Meningitis Frequency in Niger

Sylwia Trzaska, IRI (poster presentation)

Demographic and environmental factors have been mentioned in the literature as potential determinants of meningococcal meningitis outbreaks. As conducted within the NASA/ROSES feasibility study, this poster presented a preliminary analysis of the relative contribution of environmental and demographic factors to the frequency of meningitis epidemics in Niger based on the weekly case record at district level for the period 1986-2008, compiled by WHO.

Using a multiple linear regression analysis and stepwise procedure the most relevant predictors for epidemic frequency at district level were selected among: district population density, total district population, district area, fraction of urban population, fraction of urban area, latitude and longitude of district centroid, and

seasonal (January to March) mean zonal and meridional wind, humidity and temperature at district level. The final model included three predictors (population density, low level meridional wind and total district population) and correlated with the observed epidemic frequency at $r=0.85$. However, the improvement over a model using a single predictor (population density) was very small suggesting that in Niger mean climatic conditions are not a limiting factor of epidemic outbreaks.

Future analyzes will include: validation of the model on independent data, investigation of the role of mean climatic conditions in the (humid) margins of the belt where they could have a stronger impact, investigation of the role of environmental condition on interannual variability of meningitis occurrence.

Spatio-temporal Cluster Analysis of Meningococcal Meningitis Epidemics in Niger from 2003 to 2009

Juliette Paireau, Pasteur Institute (poster presentation)

Meningococcal meningitis severely affects populations of the African Meningitis Belt, causing a high burden especially in Niger. Case fatality rates reach in average 10% and severe sequelae occur in 10 – 30% of cases. Emergence and diffusion patterns of epidemics have to be better understood to improve control strategies of the disease.

An analysis of the spatio-temporal distribution of confirmed cases of meningococcal meningitis was performed between years 2003 and 2009, using health care centers areas as spatial units. Two cluster detection methods, Anselin's local Moran's I test for spatial autocorrelation and Kulldorff's spatial scan statistic, were used to identify spatial and spatio-temporal clusters.

Significant spatial or spatio-temporal clusters in twenty health care centers areas were at risk mostly near Nigeria border and less near Burkina Faso border. A strong inter-annual variability in the occurrence of the clusters was shown. The epidemics did not seem to spread from a unique source, constant from year to year, but to emerge from scattered sources in southern Niger and diffuse step by step. The allocation of resources (antibiotics, vaccines, rapid diagnostic tests, medical staff...) should target the highlighted health care centers areas. These fine-scale spatial analyses could also help to respond more efficiently to the epidemics and suggest coupling the epidemiological and environmental surveillance systems.

Towards Real-time Spatio-temporal Monitoring and Forecasting of Meningitis Incidence in Sub-Saharan Africa

Lydiane Agier and Michele Stanton, University of Lancaster (poster presentation)

In order to anticipate meningitis epidemics and gain time to launch vaccination campaigns, the study presented in this poster focused on predicting the risk of exceeding the epidemic threshold at a district level in Niger up to 5 weeks in advance.

Two models were fitted based solely on the intrinsic dynamics of district-level weekly incidence data, and have obtained preliminary results for their predictive capabilities: (i) modeling and predicting the weekly incidence rate, and computing the risk of exceeding the epidemic threshold, and (ii) discretizing the weekly incidence rates into states defined from the alert and epidemic threshold, and modeling and predicting the probability of being in each state. The output of both models is the probability of exceeding the epidemic threshold. A cut-off value is selected through establishing an appropriate balance between sensitivity, specificity, positive predictive value, and negative predictive value. These four criteria are evaluated by comparing predictions to the current reactive strategy, i.e. to the fact of exceeding the epidemic threshold.

The preliminary results presented were deemed satisfactory from a statistical modeler's point of view, but it is currently unclear how useful they might be to the policy maker for the purpose of improving the current meningitis control strategy. Further, these models need to be tested on the most recent data (2008-2010) to establish their validity (data not available until now). Among future complementary studies, the Lancaster group is working with colleagues from the IRI to incorporate district-level meteorological variables and to assess whether or not this improves the predictive performance of their models.

Spatio-temporal Modeling of Meningitis in Ethiopia using GIS and Remote Sensing **Asnakew K Yeshiwondim, Boston University**

It is hypothesized that the transmission of meningitis varies greatly in time and space due to variations in climatic, environmental, demographic, and socio-economic factors. Consequently, the study described in this presentation aimed to (i) explore the spatial patterns of meningitis incidence and identify hotspots in at risk regions in Ethiopia over 2001-2010, (ii) examine the relationship between meningitis epidemic and environmental risk factors using remotely-sensed data and historical meningitis morbidity and mortality data routinely reported at the district level through the surveillance system, (iii) develop area-based operational predictive models to enhance epidemic early warning system with enough lead-time and (iv) produce predicted and uncertainty meningitis risk maps to enhance evidence-based policy decision making and strengthen existing surveillance system.

The preliminary results presented spanned over 611 districts of Ethiopia, linking all attribute data with geo-referenced database using ArcGIS 9.3®. Local Moran's I or LISA and Gi* statistics were used to examine, respectively, significant clusters and hotspots.

The study found that 87% of the cases occur from January to June, with high variations existing between years, with particularly high incidences being observed in 2001-2004. The recent decreasing trend, it was suggested, could be due to extended cyclic periods. Over the period, most of the cases occurred in the Northern and South-Western regions, with hotspots of cases varying between seasons, and being localized in the fringe regions of the southern part of the Northern area, and the northern part of the Southern area.

Overview of the MenAfriCar Carriage Study

Maria Nascimento, London School of Hygiene and Tropical Medicine

As funded by the Wellcome Trust and the Bill and Melinda Gates Foundation, the MenAfriCar project aims to investigate the epidemiology and dynamics (including seasonal) of meningococcal carriage in countries of the meningitis belt and to evaluate the impact of the new conjugate vaccine on carriage and transmission of serogroup A meningococci.

Prospective, community-based studies are under way in Senegal, Mali, Ghana, Niger, Nigeria, Chad and Ethiopia. Two study designs are used to distinguish between countries where the new Conjugate-A vaccine is and is not about to be introduced via mass vaccination campaigns. Both designs rely on regular cross-sectional surveys and household contact studies, conducted between 2009 and 2012, in both rural and urban settings.

As of October 2010, preliminary results indicated a 1.3% overall carriage rate observed among the 7,828 subjects recruited in seven countries, with higher prevalence observed for serogroups A (ranging from 2.8% in Senegal to 1% in Chad). If the four *N. meningitis* serogroups (A, W135, X, Y) were found in Chad, Ethiopia and Niger, serogroups A, W135 and X were found in Mali, W135 and X in Nigeria, while Men A was the only serogroup found in Senegal, and W135 the only one in Ghana.

This presentation also described the recent efforts being conducted in partnership with the IRI to assess the impact of seasonality, humidity and dust on meningitis carriage rates across the Belt.

What can Dynamical Models Tell us about the Epidemiology of Meningococcal Disease in the Meningitis Belt?

Tom Irving, University of Bristol

The epidemiology of meningococcal meningitis in the African meningitis belt is seasonal, peaking up during the dry season. The magnitude of these seasonal peaks can vary substantially from year to year, with large epidemics occurring unpredictably every 6-14 years. Climatic factors may contribute by increasing the transmissibility of the infection and/or by increasing the likelihood that carriers or newly infected individuals develop meningitis.

Deterministic compartmental models were used to investigate the importance of seasonal changes in transmission rates compared to changes in the risk of disease given infection. Furthermore model with no immune state was examined and compared to models where individuals became temporarily immune following carriage.

Models without immunity produced annual peaks of similar magnitude. In comparison models with immunity allowed much greater variation in disease incidence between dry seasons, with epidemics magnitude following the accumulation of susceptibles. Models where only the risk of disease given infection varied seasonally did not result in sufficient variability in incidence, whereas forcing the transmission rates allows greater variation in population immunity, which can lead to aperiodic epidemics of varying magnitude as seen in the meningitis belt. Finally, models that included a period of temporary immunity following carriage, coupled with seasonal changes in transmissibility, were best able to explain the observed patterns of disease.

As a result, fluctuations in the transmissibility of the meningococcus rather than in the likelihood of disease given carriage might drive the seasonal variations. Accounting for population immunity, in addition to environmental variables, was deemed critical to develop forecasting models.

A 30-year High Resolution Model Reanalysis of Dust and Climate for the Meningitis Belt

Carlos Perez, NASA Goddard Institute for Space Studies (GISS) and IRI

Meningitis outbreaks have been associated with dry and dusty conditions since the seminal work of Lapeyssonie in 1965. While some studies have explored the relationship between meningitis outbreaks and climate/environmental factors, very few focus specifically on quantifying the role of dust aerosols. This is partly due to the very scarce quantitative information about surface level dust available in the Meningitis Belt. Further, existing remote-sensing data do not provide necessary

information since they may only partially capture surface conditions, and satellite retrievals have several limitations.

This presentation examined the relation between meningitis outbreaks recorded in sub-Saharan Africa and dust aerosol concentrations over the Meningitis Belt as generated by a 30-year simulation model (1979-2010) recently developed with a $0.5^\circ \times 0.5^\circ$ resolution at NASA/GISS and the IRI. In addition to dust concentration, this model provides simulations of dust turbulence, dust sources, travel and deposition and wind speed.

The outputs of the simulations are yet to be validated at the daily, seasonal, annual, inter-annual and trend scales using in situ and satellite dust data, when existing. Ongoing work further includes a preliminary analysis of the relationship between weekly cases of meningitis in Niger between 1986 and 2008 and some of these model outputs.

The Use of Remote Sensing Datasets for Health Impacts Studies in the Frame of the ADCEM Project

Adrien Deroubaix, University of Bourgogne

The 2009-2012 “Impacts of Dust Aerosols and Climate on Meningitis Epidemics in the Sahel” (ADCEM) project is supported by the French “Climate-Environment-Society” Scientific Interest Group and relies on preliminary research conducted within the African Monsoon Multidisciplinary Analyses (AMMA) program. ADCEM aims to analyze the relationships between dust, climate and meningitis to contribute to the elaboration of a prediction system for meningitis outbreaks.

During the first phase of ADCEM, multi-scale epidemiological and geophysical parameters, including a quantitative dust occurrence indicator, will be collected and validated. All parameters have to be qualified to respond to a clear need of the health impact scientific communities, as stated in previous MERIT meetings.

This presentation detailed the validation of the aerosol satellite data sets, available at a daily scale from 1996 to present over Africa. This validation aimed to assess if this dataset correctly matches with ground data, and could be used for health impact studies. Preliminary results highlighted the potential of using recent and validated fine-scale satellite data sets over Burkina Faso, Mali and Niger, which are among the countries most burdened by meningitis epidemics in semi-arid West Africa.

An update on the Google-funded UCAR Meningitis Weather Project
Mary Hayden, UCAR/NCAR

As led by UCAR and funded by Google.org, this three-year project brings together an international team of meteorologists, economists, and epidemiologists – as well as local community members – with the goal of using the observed link between the decline in meningitis and the onset of seasonal rains. If the onset of rains can be predicted with appropriate spatial and temporal resolution 1-14 days ahead, health officials can prioritize allocation of vaccines to those districts likely to remain dry.

The project team is currently analyzing the rain-disease link in the context of other geophysical and socio-demographic factors. International and regional public health decision-makers were interviewed to understand how meteorological and other data can be most effectively introduced into the decision process, and developed algorithms to predict relevant meteorological variables using probabilistic global and regional models.

Most recently, as detailed in this presentation, members of the Google project launched case-control surveys in Navrongo, Ghana to understand (i) local knowledge, attitudes, and practices (KAP) associated with the experience of meningitis outbreaks at a household level, and (ii) the socio-demographic factors associated to them. The team is also conducting cost-of-illness survey among cases. Together, these efforts are expected to provide a framework to measure the economic and social benefit of any intervention, including improved weather prediction.

Session 4: Identifying priority areas for research

The four main areas of research identified through a plenary discussion involving the participants to the 4th MERIT meeting are detailed below. Although these issues span over different areas of expertise and hypotheses that the MERIT Steering Committee would like to see answered, it was agreed that researchers of each given area should converge on common opinions and deliver a clear unique message to public health decision makers. Building on the recommendations of the 3rd MERIT meeting, it was suggested to list the points the community agrees on/disagrees on/doesn't know yet.

1. Estimating and accounting for immunity

The participants of the 4th MERIT meeting deemed immunity as an important factor to be taken into account, since cases report data are believed to reflect the natural history of the disease but are broadly biased by the immunity component. Measuring immunity, however, is challenging, given that only minimal information is easily available at the relevant scale on previous immunization or outbreaks at a given serotype. To overcome this challenge, field studies could be helpful to retrospectively back-calculate what immunity might have been in the past. It was also mentioned that designs such as the carriage MenAfriCar study, combined to some sera surveys, could improve our current knowledge in this domain. Retrospective studies could also be undertaken at a small scale and repeated after the introduction of the new vaccine to characterize the before/after immunization patterns of the population immunity.

Biologists should be more broadly involved in these studies on immunity. Results from the blood tests conducted in WHO collaborative centers, and which should be accessible, might give some indications for the pre-vaccination period, pending further studies.

Better understanding immunity would be a step forward which will remain a key element for predicting and responding to outbreaks even after immunization with the new vaccine. Yet, we should keep in mind that immunity does vary with age.

2. Understanding the microbiological response of meningococcal strains to the vaccine pressure on serogroup Men A across the Meningitis Belt

Strains dynamics should be investigated simultaneously with immunity since they are two complex but closely linked systems.

In particular, it is feared, that the pressure on the serogroup A by the wide introduction of the new vaccine might prompt some strains to express themselves in non-A serogroups, including serogroup X, for which no vaccine exists and outbreak control measures would rely only on case management, with an overall poor efficiency at the population level.

However, if understanding the response of meningococcal strains to the vaccine pressure on Men A is a very important element to explore in the coming years, it shall not be considered a MERIT research objective at the moment, as the efforts of the MERIT community should currently remain focused on informing preventive and reactive immunization strategies.

This issue, combined to the fact that large epidemic waves are usually associated with the emergence of new meningococcal strains (rather than serogroups), urges

the MERIT community to deepen its microbiological expertise before the introduction of the new vaccine has any significant impact on strain dynamics.

3. Defining the impact and accounting for societal and community-related factors

Societal and community-related factors, associated with economical and physical constraints, are also to be considered. The discussion also insisted on the importance of investigating the local knowledge (how health workers engage with the community) in order to more efficiently react to outbreaks.

4. Furthering the knowledge on the impact of dust on the dynamics of meningitis

Concerning dust estimates, remote sensing data and model outputs, the discussants concluded that these estimated or simulated data should be validated using ground level data. This task, complex but feasible, is critical to pursue further efforts to clarify the relationship between dust and meningococcal meningitis. Size of dust particles and their respective impact on the body should also be investigated.

These issues, combined to the emerging research needs discussed in Session 2: Ensuring the Relevance of MERIT in a Changing Environment, were addressed during the working group session. For more details, refer to: Session 7: Closing Session.

Session 5: Data sharing, visualization and tool developments

Contribution of the Joint Research Council (JRC) to Monitoring Environment for Public Health in Africa

Andreas Skouloudis, JRC

In support to large scale assessment of the health effects of environmental conditions, the Italy-based Institute for Environment and Sustainability (IES) of the European Union Joint Research Council (IES/JRC) address issues such as environmental risks and natural hazards, and environmental information systems. Their environmental research infrastructures include large facilities such as field mission vehicles, portable laboratories, reference laboratories for air pollution and other tools for climate monitoring. These tools include (but are not limited to) new

satellites with downward and horizontal spectra, air composition sensors coupled with mobile positioning GPS or “Lab-on-a-chip” portable device to detect bacteria.

Further, IES/JRC is implementing an Environment and Health action plan developed in 2004 to improve coordination between the health, environment, and research sectors around activities of (i) environmental health monitoring, such as the development of indicators to measure the link between environment and health and understand the routes pollutants take from their source to the human body, (ii) research, as well as (ii) communication and training of health professionals for identifying environment and health interactions.

This presentation described how advance sensor technologies coupled with new telecommunication systems can revolutionize environmental monitoring, how real time relaying of information is possible for crisis prevention and operational preparedness, and how shared information management tools can facilitate new concepts on the integration of environment and health data. It also highlighted the need for research to develop diagnostic tools and methodologies for to address environmental health issues, to standardize spatial and temporal elements and re-analyze forecasts, and described how technology will change significantly the perceptions about vulnerable population, the severity of specific locations (hot spots) and the significance of episodes for which dispersion modeling is required.

Demographic Data in Support to Improved Meningitis Research and Operational Activities

Greg Yetman, CIESIN

In the contexts of meningitis surveillance and forecasting, demographic factors may act as drivers for predicting occurrence, and as indicators of vulnerability and risk. This presentation detailed how quality controlled census data and gridded population estimates at the district level can be used for this purpose, and how migration flows may (or may not) be documented.

CIESIN’s Gridded Population of the World (GPW) version 3 and Global Rural Urban Mapping Project (GRUMP) are two global population surfaces (at 2.5’ and 30” respectively) developed for integration of demographic data with remote sensing products. GPW and GRUMP data can be made available on a yearly basis since 1990 at the district level. Building on these datasets, this presentation described how these counts and density population surfaces were refined with the incorporation of age and sex structure for rural and urban populations, and partially integrated to the IRI Data Library. While the population counts provide the denominators for calculating the incidence of the disease, the incorporation of age may improve the calculation of incidence by age groups in addition to providing an estimate of the population at risk.

Across the Meningitis Belt, new strains tend to move westward, from the eastern part of the Sahel. More information on the timing and magnitude of the internal and international migrations, which both have a seasonal pattern, in relation to the Meningitis Belt would be most helpful to anticipate these dynamics. However, if internal migration flows are well documented, the information is available at the region, rather than district, level. Similarly, most of the information on international migration to and from countries of the Meningitis Belt is available at the national level only, with little information on the magnitude of the migrations.

IRI Data Library Meningitis Maproom

John del Corral, IRI (poster presentation)

The IRI Climate Data Library has assembled a web-accessible maproom for climate and public health variables that are related to meningitis. The maps in the maproom are interactive, and have functions to spatially and temporally analyze the data represented in the maps. The maproom contains regional maps for precipitation, specific humidity, wind, temperature, aerosols, observed epidemics, and predicted probability of meningitis.

This maproom makes climate and health data that is related to meningitis, globally accessible to researchers for free over the internet, in an interactive format. For instance, regional views can be zoomed in to country or district levels, time series of data such as rainfall, specific humidity and aerosol can be compared, averaged etc. The results of analyses and the raw data itself are available for download to the researcher's desktop for further study.

For more information, see:

[>>http://iridl.ldeo.columbia.edu/](http://iridl.ldeo.columbia.edu/)

SERVIR/IRI Data Library

John del Corral, IRI

WHO is working with technical developers and partners to facilitate the implementation of an open source mapping tool for public health, called OpenHealth, to support the collection and analyses of public health data at the global, national and sub-national level. The project also aims to develop an 'environmental risk' module. As a result, one of the initial focuses of OpenHealth has been on the integration of environmental data and information from the IRI Data Library. This web-based platform facilitates the automatic integration of climatic and environmental data from the IRI Data Library into OpenHealthMapper and other platforms such as the NASA WorldWind/SERVIR, Google Earth, ArcGIS,

not to mention some outputs from tools and models developed within the MERIT framework.

How do we Approach Data Interoperability and Sharing?

Rajul Pandya, UCAR

This presentation addressed the importance, ways and challenges associated with implementing and sharing a common and comprehensive database that would support MERIT activities.

With the development of a MERIT decision making system as ultimate goal, this information system would ideally be accessed openly by MERIT partners and gather current, historic, and forecasted epidemiological, environmental, political, and socio-demographic data in a geo-referenced framework. This information system would enable MERIT members to access and integrate different kinds of data, in addition to tools for data analysis.

However, to date, a few of these systems are being developed independently by different MERIT groups. As much as it important for these efforts to be concerted, significant technical (e.g., communication intensive), logistical (e.g., data quality and format) and partnership (e.g., data ownership) issues are associated with designing and running a single MERIT information system. An option to overcome these challenges, this presentation suggested, would be to promote tool and data interoperability using a common repository regulated by a MERIT data policy. It was agreed, though, during the associated discussion, that practicalities of such a system are complex to set.

Session 6: Focus of MERIT in 2011 and beyond

As a preamble to working group activities, the chair of the session insisted on the importance and ways to for the research and decision making processes to be integrated. In particular, the lessons learned from Madagascar could feed the discussions on the integration of research and operational climate and health activities at the national level in Ethiopia for the two countries share a lot of cultural and historical similarities, among others.

An instance of Country-based Climate and Public Health Collaboration: The Climate and Health Working Group of Madagascar
Laurence Cibrelus, on behalf of the Malagasy CHWG

Bridging research and operational efforts in the context of multidisciplinary climate and health activities is a long-lasting process that can be challenging. In Madagascar, the development in 2009 and 2010 of cross-training courses and group pilot projects on the use of climate information for public health facilitated this process.

This initiative was conducted with the frame of the Malagasy CHWG, which was established in 2008 between the General Directorate of Meteorology at the Ministry of Public Works and Meteorology (DGM) and the Ministry of Health (MoH). The CHWG relies on formal agreements that define the terms of reference of the group's activities as well as data sharing, between the two ministries and with their national and international partners.

As funded by the WMO and developed in partnership with the Malagasy CHWG and the IRI, these trainings of key decision-makers from the public health and climate communities were tailored to the local needs, language and data. These pilot projects explored the relationship between climate and the main climate-sensitive diseases of public health importance in Madagascar (malaria, plague, Rift Valley Fever). They paved the way for the development of joint operational products, building on the interaction, skills and knowledge gained during the courses. These courses also enabled the Malagasy public health and climate communities to define together the activities of the CHWG, in terms of research and program, and to set the frame to evaluate these activities.

For more information, see:

>> <http://iri.columbia.edu/publications/id=1034>

Working Groups Sessions

A group of participants to the 4th technical MERIT meeting brainstormed on the ways to inform reactive vaccination strategies today, in particular through the development of an enhanced decision tool for meningitis control. The group discussed (i) the feasibility of testing a new decision tool for the 2011 epidemic season, (ii) which additional criteria might be included in this tool, and (iii) how this tool could be validated using national datasets.

Another group addressed the ways to inform preventive vaccination strategies across the Meningitis Belt after the wide introduction of the conjugate A vaccination is completed, in particular through the definition of research questions relevant to the Belt- including on the issue of immunity.

The third group focused on MERIT country case-studies and operational recommendations to better integrate research and operations in the field, and to develop a plan of action for the next year building on the expertise of the climate and health professionals from Ethiopia and Nigeria who attended the meeting.

Session 7: Closing Session

Informing Reactive Vaccination Strategies Today – Decision Tool

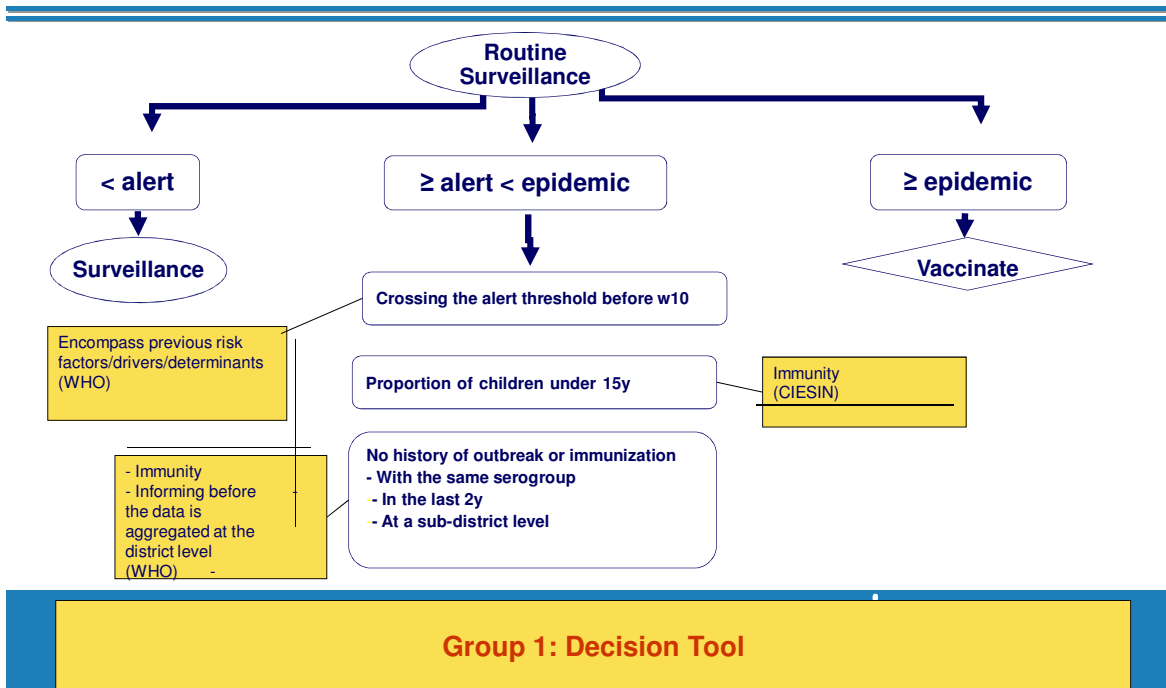
This group discussed the ways to improve the current WHO decision tree by including new variables that would help decrease the time between the alert and epidemiological thresholds (i.e., shall a reactive immunization campaign be launched or not).

The group proposed two approaches to answer the question asked:

- Modify the tree, by introducing variables the group deemed important. The group made its decision based on the experience of the group members, as well as their knowledge of the availability and quality, hence reliability, of the variables considered.
- Including modeling outputs such as those developed by some members of the group.

In consideration of possible options for modifying the decision tree, the group suggested that easily and routinely accessible variables accounting for the level of immunity of the population as well as for a “epidemic risk indicator” be integrated to the decision tree, as indicated in the slide below (with the source of the data indicated in brackets): crossing the epidemic threshold before epidemiological week 10, proportion of children under 15, and no history of outbreaks or immunization with the same serogroup, in the last two years, at a sub-district level.

Hypothetical decision tree adding an “alert+” action threshold



Some of the improvements to the current decision tree suggested by group 1, as integrated to a slide by WHO.

The group, however, suggested that during the next epidemic season this tree is tested against bear real-time data to assess whether the combination of these variables or the occurrence of one, two or all of these elements should trigger reactive immunization. At the other end of the decision process, the group also suggested that, even if one or more of these criteria are met once the alert threshold has been crossed, this situation should not lead to an anticipated immunization if the humidity is above a given threshold (to be determined) – for a high level of humidity, signing the end of the dry season, is known to be associated with the end of the epidemic season.

As for the second approach, the group suggested that some models are used to feed in the tree. In particular, it was suggested that the outputs of the Markov chain model developed by Lancaster University are used. As based on incidence data only, this model accounts for seasonality and spatial dependency and is able to predict the probability to exceed the epidemic threshold 1, 2 or 3 weeks ahead.

Informing preventive vaccination strategies after the large-scale introduction of the conjugate A vaccination in the next three years – Research Questions

This group discussed which hypotheses and methods shall be prioritized to inform vaccine preventive strategies, in particular with regards to immunity and global research questions across the Belt.

Concerning immunity, the two main questions MERIT currently needs to answer in this area relate to the estimation of the immunity in the population and the integration of this information in both climatic and epidemiological models. Following a group discussion, the team suggested that, as a preliminary step, all research projects use the historical dataset of surveillance data from WHO for Mali, Burkina Faso and Niger to provide a proxy of population immunity, based on epidemics status of districts and vaccination. It was mentioned that the MenAfriCar project could also support these efforts by providing serological profiles in the seven countries where it is implemented.

About the global research across the Belt, the group deemed the four following issues as priorities:

- Relation between environment and carriage
- Biological mechanisms of the impact of dust on infection (experimental studies)
- Extension of the Belt (i) to countries that are not targeted by the new vaccine (e.g. Uganda), and (ii) in the context of climate evolution
- Dynamics of serogroups

In response to these priorities, the group suggested an action plan spanning from January to June 2011. Beginning with the combination of dust samples and Met Station data with carriage data from the MenAfrCar study, this plan includes the organization of a research sub-group meeting on epidemiological modeling (parameters definition, data needs ...) that would be held in Spring 2011 in Montpellier, France, and followed by a general modeling meeting in Summer 2011. Additionally, the group insisted on the importance of identifying and engaging microbiologists in MERIT. It also suggested a case-study is conducted on the climate evolution and the extension of the Belt, at its fringes. UCAR and partners volunteered to conduct this project in Uganda.

Lastly, the group highlighted the need for research to rely on good surveillance and data access, wondering how this would evolve as the new conjugate vaccine is implemented (e.g., surveillance of serotype, epidemiological parameters).

Country Case Studies – Operational Recommendations

The members of the MERIT Ethiopia and MERIT Nigeria working groups discussed ways to address, respectively, their limited funding and the way to move forward in terms of partnerships.

Building on two years of existence, MERIT Ethiopia seeks to focus its activities on three main areas: operational recommendations, link between research and decision-making, and enhancing surveillance. Based on group discussions, they recommended the following:

- A MERIT focal person should be designated at the FMoH and regional health bureaus levels, through a consultation with the decision-makers
- Fund raising activities should be strengthened, notably through the ClimDevAfrica initiative
- The leadership of the government in MERIT-related activities should be enhanced
- The action plan and proposals of the CHWG/MERIT committee should be reviewed, based on an assessment of the local needs and capacities
- Technical assistance should then be sought accordingly to achieve these goals, building on, in particular, the knowledge and skills gained by the Ethiopian professionals trained through the training courses developed by the IRI.

In relation to the integration of research and decision-making activities, the group insisted that the outcomes of research conducted so far are communicated and discussed with the FMoH on a regular basis. It is also hoped that the gaps in meningitis knowledge are identified in conjunction with the regional health offices, building on their field expertise and knowledge.

Communication strategies were deemed important and should be strengthened, with clear channels being identified both at the national and regional levels. It was also suggested that the results of the new developments of MERIT Ethiopia/CHWG should be broadly made available and published.

With regards to enhanced meningitis surveillance, the group suggested that specific trainings are conducted on data collection, management and quality control, and that the computer and laboratory capacities of the health offices are strengthened.

In Nigeria, the MERIT committee developed a state proposal with regards to the MDGs, involving state partners such as the MoH, demographers and research. Together, they designed an action plan to be implemented in January 2011. They will focus their initial activities on the collection of meningitis, climate and

population data over at least the last seven years. The MERIT state committee also seeks to collaborate with research institutes and other partners working at the regional (Meningitis Belt) level. Setting up collaborations with regional and local partners has been the principal challenge to date for MERIT Nigeria, which already received funding from the MDGs state committee and should received additional support from the state MoH. MERIT Nigeria will also publish its activities in the state monthly magazine.

Meeting Outcomes and Recommendations

The 4th MERIT technical meeting brought together 73 participants from the public health, environmental and social sciences communities.

Together, under the direction of the MERIT Steering Committee, they revised the current state of knowledge on the factors associated with epidemics of meningococcal meningitis in the Meningitis Belt. They also addressed the ways to integrate this information into decision making and to develop operational procedures to better respond to meningitis outbreaks in addition to informing the allocation of the new conjugate vaccine.

The ways to ensure the relevance of MERIT in a changing epidemiological and environmental context were also discussed. These interactions lead to the identification of some gaps in knowledge or capacities, as well as to the definition of priorities areas where research, partnership and tool development efforts should be focused to overcome these limitations.

Looking at the next epidemic season and beyond, participants to the 4th MERIT meeting recommended the following:

(i) Research efforts should focus on four main areas:

- Estimating and accounting for immunity.
- Understanding the microbiological response of meningococcal strains to the vaccine pressure on serogroup Men A across the Meningitis Belt.
- Defining the impact and accounting for societal and community-related factors.
- Furthering the knowledge on the impact of dust on the dynamics of meningitis.

(ii) Efforts to translate research outputs into decision-making should be strengthened, building on, in particular:

- The prospective field test of a new decision tree, involving, in addition to the incidence of meningitis, variables such as: “crossing the epidemic threshold before epidemiological week 10”, “the proportion of children under 15”, and “no history of outbreaks or immunization with the same serogroup, in the last two years, at the sub-district level”.

- The experience of country-led MERIT activities, where the collaboration between the public health and climate communities might be closer and more capacity-driven than at the international level.

(iii) ***The research community should deliver a clear and unique message to public health decision makers***

As highlighted during the working group session, this major improvement would be possible if MERIT partners from the same community develop MERIT sub-groups, based on the area of expertise, and convene small MERIT meetings where, together, they would respond to questions relevant to their field of expertise and the objectives of MERIT, keeping in mind how these research outcomes could be translated into operational procedures. The conclusions of these interim meetings could be presented at the following annual MERIT technical meeting and discussed, in a multidisciplinary context, with the decision-makers as well as MERIT partners from other fields.

Appendix

Appendix 1: Outcomes of Previous MERIT Technical Meetings

First MERIT Technical Meeting

The first MERIT Technical Meeting was held in September 26-27, 2007 in Geneva, Switzerland to provide a baseline and guidance for future MERIT activities on the identification and maximized use of meningitis epidemic risk indicators. In addition to providing a forum for information-sharing between the relevant communities, the meeting generated active discussions to define future research parameters and to determine how to transition from research to operations through the use of information systems and technology.

The two-day meeting was considered an important early step in a long-term collaborative process and resulted in the following key recommendations being made³:

- That the recently formed MERIT Project continues to be developed to provide an effective collaborative framework around which the outcomes from the meeting will progress.
- That a comprehensive technical review of existing research surrounding meningitis epidemics and earth observations be conducted.

Second MERIT Technical Meeting

The 2nd MERIT Technical Meeting was held on December 1-2, 2008 in Addis Ababa, Ethiopia, and followed on December 3rd by a national Ethiopian MERIT capacity building workshop. Both of these events were hosted by the Climate Health Working Group of Ethiopia. In its first year, MERIT has helped guide and support the development of research projects investigating the linkages between environmental conditions and epidemic meningitis outbreaks in Africa. The following key recommendations were made during this meeting³:

- Develop and implement an expert opinion model for the next meningitis season in Niger
- Support empirical modeling work using a spatio-temporal approach to implement in for the following season

³ Adapted from the meeting report.

- Carry out socio-economic studies as part of a comparative analysis for different countries of the impact of meningitis on families and the public health sector
- Create a national MERIT Ethiopian Case study.

Third MERIT Technical Meeting

As held in Niamey, Niger, on November 9-11, 2009, the 3rd MERIT meeting was hosted by the African Centre for Meteorological Applications for Development (ACMAD) and the Centre de Recherche Médicale et Sanitaire (CERMES), in partnership with the MERIT Steering Committee. The meeting was followed by a one-day national training workshop which was an opportunity for national meteorological staff, health practitioners and medical students to engage with local MERIT partners and to assess the benefits and applications of MERIT-related activities in Niger.

The following recommendations arose from the meeting3:

- Provide operational support for the next meningitis season, at the country (Niger) and regional (Meningitis Belt) levels
- Develop a decision-support system to be used to shorten the decision-making process in the period lying between the crossing of the alert and epidemic thresholds
- Identify relevant environmental variables for the anticipation of meningitis outbreaks, to be integrated into the decision tool.

For more information on the MERIT Steering Committee and its Terms of Reference, as well as the full reports on the previous MERIT technical meetings, see:

>> <http://merit.hc-foundation.org/>

Appendix 2: Meeting Agenda

Thursday 18th November, 2010
New Building, School of Medicine, Addis Ababa University

Public Health and Climate Seminar

The CHWG in collaboration with School of Public Health and the IRI, Columbia University, organized a half day seminar on Public Health and Climate.

Chair: Dr Wakgari Amente, School Of Public Health, Addis Ababa University

09:30 - 12:00

Climate Risk Management in Health: Lessons Learned

Madeleine Thomson, IRI

Malaria and Climate: Ethiopia in Case

Adugna Woyessa, Ethiopian Health and Nutrition Research Institute (EHNRI)

Building Capacity at National Meteorological Agency (NMA)

Kinfe Hailemariam, NMA

Building Sustainable Partnerships to Improve Meningitis Surveillance and Response: The MERIT Initiative

Emily Firth, WHO

Informal Introductions

14:00 - 17:00

Hotel Intercontinental

Guinea Conakry Street, Addis Ababa

Participants gathered in the foyer of the Hotel Intercontinental for an informal and relaxed afternoon before the meeting.

Welcome Dinner and Reception

19:00 - 21:00

Wabi Shebele Hotel

Welcome dinner for MERIT participants

Friday 19th November, 2010
UNECA compound at the UN Conference Centre, Menelik II Avenue

8:00 - 9:00 Arrival of participants and registration

Session 1: Opening Remarks and Introductions

Chair: Mr Abere Mihretie, AMA/CHWG

9:00 - 10:30

Opening remarks

Mihret Hiluf, Federal Ministry of Health

Keynote address

Fatoumata Nafo-Traore, WHO Ethiopia Representative

Introductions of participants

MERIT objectives and expected outcomes

Eric Bertherat, WHO, Chair of MERIT Steering Committee

Group on Earth Observations (GEO) Health and Climate Video

Masami Onoda, GEO Secretariat

New opportunities in the context of climate and health in Africa

Madeleine Thomson, IRI

Session 2: Ensuring the Relevance of MERIT in a Changing Environment

Chair: Dr Agonafer Tekalegn, Malaria Consortium

11:00 - 11:45

Overview of the 2010 epidemic season

Eric Bertherat, WHO

Monitoring the 2010 meningitis season by ACMAD, IRI and WHO

Sylwia Trzaska, IRI

The ViGIRisC Implication for Climate and Public Health Activities⁴

Lazreg Benaïchata, African Centre of Meteorological Application for Development (ACMAD)

11:45 - 12:05 Re-orientation of research needs in response to the introduction of the conjugate meningitis A vaccine

Introduction plan of the MenA Vaccine in the Meningitis Belt

Implication for research needs

Eric Bertherat, WHO

12:05 - 12:35 Overview of country-led activities

MERIT-Ethiopia case study

Abere Mihretie, AMA/CHWG

⁴ This presentation could not be delivered during the conference

Overview of meningitis epidemics in Ethiopia

Tadesse Seda, Oromia Regional Health Bureau

Establishing a State MERIT Committee in Nigeria

Mansur Matazu, Federal University of Technology, Minna State, Nigeria

12:35-13:00 Discussion

Session 3: Overview of MERIT research activities - Achievements and New Opportunities

Chair: Dr Alemayehu Mekonnen, School of Public Health

14:30 - 17:00 Overview of current research projects and activities, particularly following the recommendations from the 3rd MERIT Meeting in Niamey.

This will be a series of brief, 10 minute presentations interspersed with questions and discussions.

Brief reports on research meetings in 2010

- New York meeting, *Madeleine Thomson, IRI*
- Lancaster meeting, *Michelle Stanton, University of Lancaster*

Demographic and Environmental Factors in Meningococcal Meningitis Frequency in Niger

Sylwia Trzaska, IRI (poster presentation)

Spatio-temporal Cluster Analysis of Meningococcal Meningitis Epidemics in Niger from 2003 to 2009

Juliette Paireau, Pasteur Institute (poster presentation)

Towards Real-time Spatio-temporal Monitoring and Forecasting of Meningitis Incidence in Sub-Saharan Africa

Lydiane Agier and Michele Stanton, University of Lancaster (poster presentation)

Spatio-temporal Modeling of Meningitis in Ethiopia using GIS and Remote Sensing

Asnakew K Yeshiwondim, Boston University

Overview of the MenAfriCar Carriage Study

Maria Nascimento, London School of Hygiene and Tropical Medicine

What can Dynamical Models Tell us about the Epidemiology of Meningococcal Disease in the Meningitis Belt?

Tom Irving, University of Bristol

A 30-year High Resolution Model Reanalysis of Dust and Climate for the Meningitis Belt

Carlos Perez, IRI

The Use of Remote Sensing Datasets for Health Impacts Studies in the Frame of the ADCEM Project

Adrien Deroubaix, University of Bourgogne

An update on the Google-funded UCAR Meningitis Weather Project

Mary Hayden, UCAR/NCAR

Session 4: Identifying priority areas for research

Chair: Dr Madeleine Thomson, IRI

Co-chair: Dr Yared Amara, MERIT Ethiopia/CHWG

17.00 - 18.00

Plenary group discussion to brainstorm and discuss priority areas for research, including:

- Informing **reactive vaccination** strategies today
- Informing **preventive vaccination** and reactive strategies in areas after conjugate A vaccination in the next three years
- Understanding the **characteristics of the Meningitis Belt** given epidemiological and environmental changes over the next 10 years

Saturday 20th November, 2010

Venue: UNECA compound at the UN Conference Centre, Menelik II Avenue

Session 5: Data sharing, visualization and tool developments

Chair: Dr Habtamu Belete, UNICEF

9:00 - 10:30

Contribution of the Joint Research Council (JRC) to Monitoring Environment for Public Health in Africa

Andreas Skouloudis, JRC

Demographic Data in Support to Improved Meningitis Research and Operational Activities

Greg Yetman, CIESIN

IRI Data Library Meningitis Maproom

John del Corral, IRI (poster presentation)

SERVIR/IRI Data Library

John del Corral, IRI

How do we Approach Data Interoperability and Sharing?

Rajul Pandya, UCAR

Session 6: Focus of MERIT in 2011 and beyond

Chair: Dr Michel Jancoles, Health and Climate Foundation (HCF)

11:00 - 11:10

An instance of Country-based Climate and Public Health Collaboration: The Climate and Health Working Group of Madagascar

Laurence Cibrelus, on behalf of the Malagasy CHWG

11:10 - 13:00 Working groups to brainstorm on ways to transfer research outcomes into operational strategies in regards to the following issues:

1. Informing **Reactive Vaccination** Strategies Today – Decision Tool

Moderator: *Laurence Cibrelus, WHO/IRI Consultant*

Rapporteur: Carlos Perez, IRI

2. Informing **preventive vaccination** strategies in the Meningitis Belt after the introduction of the conjugate A vaccination in the next three years – Research Questions

Moderator: Maria Nascimento, LHTM

Rapporteur: Helene Broutin, CNRS

3. **Country Case Studies** – Operational Recommendations

Moderator: Ahmed Bedru, AHRI

Rapporteur: Hiwot Tekla, USAID

Session 7: Closing Session

Chair: Dr Eric Bertherat, WHO

15.00-16.30 Feedback from working groups to the plenary

1. Informing **Reactive Vaccination** Strategies Today – Decision Tool
2. Informing **preventive vaccination** strategies in areas after conjugate A vaccination in the next three years – Research Questions
3. **Country Case Studies** – Operational Recommendations

16:30 - 17:00

Wrap up of the meeting, closing remarks

Abere Mihretie, AMA/CHWG

Appendix 3: Meeting Sponsors

The sponsors for the meeting include:

- The European Commission Joint Research Centre (JRC) Institute for Environment & Sustainability
- WHO, with support from the Spanish Ministry of Foreign Affairs and Cooperation for the introduction of the meningitis A conjugate vaccine.
- The IRI, with support from the Google.org-funded project 'Building Capacity to Produce and Use Climate and Environmental Information for Improving Health in East Africa'
- Group on Earth Observations Secretariat
- Health and Climate Foundation

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