Assessment of research needs for public health adaptation to social, environmental and climate change impacts on vector-borne diseases in Africa

An informal expert consultation convened by the Special Programme for Research and Training in Tropical Diseases (TDR)

ADDIS ABABA, ETHIOPIA FEBRUARY 27-29, 2012

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Acronyms

AAU	Addis Ababa University
ACMAD	African Centre of Meteorological Applications for Development
ACPC	African Climate Policy Centre
AfDB	African Development Bank
AFENET	African Field Epidemiology Network
AFRO	WHO Regional Office for Africa
AGRHYMET	Centre Regional de Formation et d'Application en Agrométéorologie et Hydrologie Opérationnelle
AMA	Anti-Malaria Association, Ethiopia
AMMA	African Monsoon Multidisciplinary Analyses
AUC	African Union Commission
CCAA	Climate Change Adaptation in Africa
CDC	Centers for Disease Control and Prevention, USA
CCH	Climate Change & Human Health
CHICAS	Combining Health Information, Computation and Statistics
CHWG	Ethiopian Climate and Health Working Group
CIESIN	Center for International Earth Science Information Network, Columbia University
CILSS	Comité permanent Inter-Etats de Lutte contre la Sécheresse dans le Sahel
CIPHA	Climate Information for Public Health Action
CIPHAN	Climate Information for Public Health Action Network
ClimDev-Africa	Climate for Development in Africa Programme
COPEH	Community of Practice in Ecosystem Approaches to Health
CORDEX	Coordinated Regional climate Downscaling Experiment
CRM	Climate Risk Management
CRED	Center for Research on Environmental Decisions
CSE	Centre de Suivi Ecologique, Senegal
DBL	DBL-Centre for Health Research and Development, University of Copenhagen
DfID	Department for International Development, UK
DPSEEA	Driving Force-Pressure-States-Exposure-Effect-Actions Framework
ECOWAS	Economic Community of West African States
EHNRI	Ethiopian Health and Nutrition Research Institute
EIA	Environmental Impact Assessment
ESPA	Ecosystems Services for Poverty Alleviation Programme
ESRC	Economic and Social Research Council
EU	European Union

EVK	Ethnoveterinary Knowledge and Practices
FAO	Food and Agriculture Organization of the United Nations
FELTP	Field Epidemiology and Laboratory Training Program
FMoH	Federal Ministry of Health
FSSDD	Food Security and Sustainable Development Division
GCOS	Global Climate Observing Systems
GEO	Group on Earth Observations
GGW	Great Green Wall
GIS	Geographic Information System
GIZ	Gesellschaft für Internationale Zusammenarbeit, Germany
GRIPP	Getting Research Into Policy and Practice
HCF	Health and Climate Foundation
HEP	Health Extension Program
HIA	Health Impact Assessment
HINARI	Health InterNetwork Access to Research Initiative
ICPAC	IGAD Climate Prediction and Applications Centre
ICRAF	The World Agroforestry Centre
ICT	Information and Communication Technology
IFRC	International Federation of Red Cross and Red Crescent Societies
IFPRI	International Food Policy Research Institute
IGAD	Inter-Governmental Authority on Development
IHR	International Health Regulations
IKS	Indigenous Knowledge System
ILRI	International Livestock Research Institute
IPCC	Intergovernmental Panel on Climate Change
IRI	International Research Institute for Climate and Society, Columbia University
IWMI	International Water Management Institute
JRC	European Commission Joint Research Centre
KEMRI	Kenya Medical Research Institute
KMD	Kenya Meteorological Department
MACEPA	Malaria Control and Evaluation Partnership in Africa
MACEPA/ PATH	MACEPA/Program for Appropriate Technologies in Health
MDGs	Millennium Development Goals
MRTC	Malaria Research and Training Centre, Mali
MERIT	Meningitis Environmental Risk Information Technologies
MoH	Ministry of Health

MoU	Memorandum of Understanding
MV	Millennium Villages
NAPA	National Adaptation Programme of Action
NECJOGHA	Network of Climate Journalists in the Greater Horn of Africa
NGO	Non-Governmental Organisation
NIAID	National Institute of Allergy and Infectious Diseases
NIEHS	National Institute of Environmental Health Sciences, USA
NIH	National Institutes of Health
NMA	National Meteorological Agency
NOAA	National Oceanic and Atmospheric Administration, USA
NTD	Neglected Tropical Diseases
OIE	World Organisation for Animal Health
ORI	Okavanga Research Institute
PHE	WHO Department for the Protection of the Human Environment
PSRs	Pressure- State- Response Frameworks
PRSP	Poverty Reduction Strategy Paper
REACH	Regional East African Community Health
RVF	Rift Valley Fever
SACCNet	Southern Africa Climate Change Network
SADC	Southern Africa Development Community
SEA	Strategic Environmental Assessment
SECS	Sudanese Environment Conservation Society
SI-CIPH	Summer Institute on Climate Information for Public Health
STAC	Scientific and Technical Advisory Committee
SUFI	Scale Up for Impact
TAMSAT	Tropical Applications of Meteorology using SATellite data and ground-based observations
TDR	UNICEF/UNDP/World Bank/WHO Special Programme for Research and Training in Tropical Diseases
TRG	Thematic Reference Group on Environment, Agriculture and Infectious Diseases
UNCBD	United Nations Convention on Biological Diversity
UNCCD	United Nations Convention to Combat Desertification
UNDP	United Nations Development Programme
UNDP-AAP	UNDP - Africa Adaptation Programme
UNECA	United Nations Economic Commission for Africa
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNICEF	United Nations Children's Fund
USAID-PMI	United States Agency for International Development – President's Malaria

	Initiative
VBD	Vector-Borne Disease
VES	Vectors, Environment and Society
ViGIRisC	Projet de Vigilance et Gestion Intégrée du Risque Climatique en Afrique
VL	Visceral Leshmaniasis
WAHO	West African Health Organization
WCC-3	World Climate Conference-3
WHA	World Health Assembly
WHO	World Health Organization
WMO	World Meteorological Organization

Executive summary

Control strategies for vector-borne diseases (VBD) are a pillar of public health policies. Potential impacts of VBD-related risks reflect environmental exposure as well as social vulnerabilities, both of which are sensitive to climatic conditions. The existing evidence suggests that climate change impacts will substantially increase burdens on those populations that are already vulnerable to climate extremes, such as those of the African continent. Climate change in Africa induces multiple threats to development and the social dimensions of climate change are, therefore, increasingly highlighted on the development agenda. This is of particular significance for drylands in sub-Saharan Africa, in which water-related VBD are a significant disease burden while these areas are, at the same time, particularly poor, food insecure, ecologically fragile and socially vulnerable. The gap in knowledge about the relationships between social and economic vulnerabilities and environmental hazards linked to VBD in a context of climatic change, and the even larger gap in policy options for addressing the situation, have been identified by African ministers of health and environment, and technical experts internationally, as serious obstacles to evidence-based health policy change.

Capacities need to be strengthened for generating, interpreting and using socio-economic, environmental, meteorological and other climate information that could guide VBD prevention and control strategies and improve the ability of African countries to adapt to and reduce the effects of these changes in ways that benefit the most vulnerable populations. Trans-disciplinary research-for-policy frameworks for improved VBD risk management need to be developed that can sustainably improve the resilience of African populations to such VBD-related health threats under climate change conditions. An informal expert consultation was held in Addis Ababa, Ethiopia, from 27-29 February 2012 to engage key stakeholders from the region in discussions to reach consensus on the most important research gaps and identify priorities in the African context for assessing impacts of interrelated social, environmental and climate changes on the relevant VBD burden of vulnerable populations as well as for developing and testing practical strategies for mitigating these impacts through adaptation.

Workshop objectives, expected outcomes and background documents

Overall meeting objective

The overall objective of the consultation was to enable key regional stakeholders to assess and, through consensus, prioritize research needs regarding public health adaptation to social, environmental and climate change impacts on vector-borne diseases in Africa.

Specific objectives

1. To review current scientific evidence of the effects of social, environmental and climate change on vectors and vector-borne diseases in Africa.
2. To identify priority research and research capacity strengthening needs in the African region aimed at enabling public health adaptation to these effects.
3. To identify mechanisms for provision of research/technical support to meet the regional needs.
4. To identify ways of strengthening the linkage of research to policies and practices.

Expected outputs

1. Consensus on priority research and research capacity strengthening needs in Africa regarding public health adaptation to the impacts of social, environmental and climate change on vectors and vector-borne diseases.
2. Drafting and wide dissemination of the consultation report to various stakeholders, including African countries, WHO departments and regional offices.

Background documents

The meeting built on on-going processes and leveraged background documentation including:

1. The 2008 First Inter-Ministerial Conference on Health and Environment in Africa: Health Security through Healthy Environments document on the *Libreville Declaration on Health and Environment in Africa*[1]*;*
2. Report of the 2009 TDR informal expert consultation on *Effects of Environmental and Climate Change on Vectors and Vector-Borne Diseases: Current Evidence and Research Priorities;*
3. Report of the 2011 Workshop on *Climate and Health in Africa – 10 Years On*[2]
4. Report of the 2011 WHO/AFRO Regional Committee for Africa *Framework for Public Health Adaptation to Climate Change in the Africa Region*[3]*;*
5. The discussion paper on *The African drylands: key debate and emerging perspectives for the control of vector-borne diseases of humans and livestock in the context of climatic, environmental and social changes.*

Organisation and sponsorship

An informal expert consultation on "Adaptation to Social, Environmental and Climate Change Impacts on Vector-Borne Diseases" was convened by the Special

[1] http://www.afro.who.int/index.php?option=com_docman&task=doc_download&gid=3289
[2] http://iri.columbia.edu/publications/id=1090
[3] http://www.afro.who.int/en/sixty-first-session.html

Programme for Research and Training in Tropical Diseases (TDR) in collaboration with Canada's International Development Research Centre (IDRC) and the International Research Institute for Climate and Society (IRI) and hosted by the Ethiopian Climate and Health Working Group (CHWG) in Addis Ababa, February 27-29, 2012.

Outcomes and recommendations

Participants were divided into three multi-disciplinary groups and asked to reflect on the following questions:

1. What gaps in scientific evidence are there for the effects of social, environmental and climate change on vectors and vector-borne diseases in Africa (drylands) and how could these gaps be filled?

2. What are the priority research and research capacity strengthening needs in the African drylands aimed at enabling public health adaptation to the effects of the social, environmental and climatic changes on vector-borne diseases?

3. What are the mechanisms for provision of research/technical support to meet the regional and country needs identified above?

4. What gaps are there for connecting research to policy and practice and how can they be filled?

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

1. ***There are gaps in scientific evidence (and associated data) for the effects of social, environmental and climate change (including climate change adaptation) on vectors and vector-borne diseases in the African drylands that need to be filled. To do this we recommend the following:***

   Map the full range of drivers for VBDs; undertake studies of geo-referenced time series data; undertake field and laboratory studies; develop statistical and biological models; conduct situation analyses to identify vulnerable population groups; research mechanisms and risk factors for vulnerability; develop innovative interventions assessing social equity and resilience; promote data for use in policy relevant analyses; research the impact of historical large-scale climate changes; model indicators; perform health impact assessments; and research more effective communication tools to convey scientific messages to stakeholders.

2. ***Priority research capacity strengthening needs in the African drylands aimed at enabling public health adaptation to the effects of the social, environmental and climatic changes on vector-borne diseases must be identified. We recommend the following:***

   Assess the national level research capacity and build capacity to fill gaps in key skilled personnel; understand the management and analyses of disparate data

sets, the sharing of data across disciplines and the documentation of data; understand the paradigms from other disciplines to enhance dialogue in inter-, multi- and trans-disciplinary teams; build research capacity among social scientists to address socio-economic, cultural and health social science determinants, in disciplines relevant to the concept of One Health[4] and Ecohealth[5], and on the impact of policies on local coping and adaptation strategies; develop open-source spatial and temporal technologies; build capacity of doctoral as well as post-doctoral scientists; create an enabling environment for teams of scientists with the capacity to work across disciplines in a multi-, inter- and trans-disciplinary way; understand local coping/adaptation strategies; promote short term training; and understand how to translate scientific outputs into changes in policy and practice.

3. ***Research and technical support to address the regional and country needs identified can be mobilized through the following mechanisms:***

   Foster strategic networks of communities of practice; foster consortia to mobilize existing and additional resources for multi-country studies; develop platforms for knowledge repositories, knowledge-sharing and facilitated e-learning; advocate for financial support from government/NGOs/international community/public-private partnerships (PPPs); provide data methodology and tools for enabling multi-, inter- and trans- disciplinary research; facilitate partnerships with climate, environmental and social data-generating institutions; support continuing development of African centres of excellence; strengthen the capacity of research institutions to serve as reference centres on topics relevant to national and regional government needs; and develop inter-sectoral guidelines on policies for sharing data in line with One Health.

4. ***The linkage of research to policy and practices can be strengthened through the following actions:***

   Improve communication through a continual researcher-stakeholder process of reviewing research needs and existing policies and programmes; foster inter-sectoral policy systems and research approaches; assess impacts before, during and after implementation of major policies, programmes and projects; document best practices in One Health approaches to VBD research and control; foster evidence-based policy formulation and translation of good policy into practice;

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[4] One Health is defined as "the collaborative effort of multiple disciplines — working locally, nationally, and globally — to attain optimal health for people, animals and the environment". http://www.avma.org/onehealth/onehealth_final.pdf

[5] Ecohealth is defined as a field of study researching how changes in the earth's ecosystems affect human health, including changes in the biological, physical, social and economic environments.
http://en.wikipedia.org/wiki/EcoHealth

build research communication capacity within the national research institutes; develop a web-based approach to sharing information in a format that is most appropriate for policy makers; promote knowledge translation through the approach of Getting Research Into Policy and Practice (GRIPP); incorporate assessed and validated research results in existing policy making mechanisms; and incorporate the needs of particularly vulnerable groups, based on an equity/gender strategy.

Conclusion

This meeting brought together a number of key communities and provided an important platform for a discussion on an integrated approach to the control of vector-borne diseases in the African drylands in the context of social, environmental and climatic changes. We believe the recommendations from this workshop provide a significant contribution to this discussion and will be shared with the stakeholder community, ministries of health and WHO.

Background and rationale

Vector-borne diseases such as malaria, dengue fever, African trypanosomiasis, leishmaniasis, lymphatic filariasis, schistosomiasis and onchocerciasis remain significant public health problems in Africa, despite considerable national and international efforts to reduce the disease burden and economic impact they cause. The distribution of these diseases is, by and large, determined by environmental factors critical to the propagation of their insect vectors, intermediate hosts and reservoirs. Environmental changes induced by global trends such as population growth, urbanization, migration and decreasing levels of environmental sanitation are major causes for the emergence and re-emergence of vector-borne diseases in developing countries. Global climate change potentially lengthens the transmission seasons and alters the geographic range of vector-borne diseases. The increased demand and degradation of the natural resource base to meet the needs of growing human populations and to alleviate poverty often condenses the process of change in environmental and social determinants of health into a relatively short time frame worsening the situation.

African ministers in their 2008 *Libreville Declaration on Health and Environment in Africa* expressed concern that nearly a quarter of deaths in Africa are attributable to avoidable environmental risk factors, with particular impacts on the poorest and the most vulnerable groups. They stressed the need for further research based on gaps and priorities to increase understanding of the vulnerability of humans to these environmental risk factors (including climate change) in the region. The ministers committed themselves to building national, sub-regional and regional capacities to better prevent environment-related health problems, through the establishment and strengthening of health and environment institutions in the region.

At its February 2009 meeting, TDR's Scientific and Technical Advisory Committee (STAC) recommended that TDR "investigate the effects of climate and environmental change on major vectors of diseases". To initiate addressing this issue, TDR convened an informal expert consultation in December 2009 on *Effects of Environmental and Climate Change on Major Disease Vectors and Vector-Borne Diseases: Current Evidence and Research Priorities* to review current scientific evidence and identify priority research areas relating to the topic. The consultation observed that environmental and climate change affect, to varying degrees, all eight

vector-borne diseases that fall under TDR's mandate and recommended more research on risk assessment to improve understanding of environmental and climate-related health risks as well as to inform future adaptive strategies. The recommendations from the expert consultation meeting and those from the report of the TDR-facilitated Thematic Reference Group (TRG) on Environment, Agriculture and Infectious Diseases along with worldwide reports and reviews on the topic have been used to identify the need for a TDR work plan for research on effects of environmental and climate change on vectors and vector-borne diseases, to be implemented under a new research line on Vectors, Environment and Society (VES), established in April 2011 following reorganization of TDR.

The new VES unit was created to specifically address cross-cutting issues across diseases and sectors focusing on vector-borne diseases and vector control interventions at the interface of the natural and human environment. It aims to develop and evaluate innovative and improved vector control strategies in the context of social, environmental and climate changes and to explore optimal ways to engage with different types of communities (e.g. rural, peri-urban, nomadic) to scale up tools and strategies for the prevention of major vector-borne and other poverty-related diseases. This research line allows TDR to streamline and foster a number of cross-cutting issues, including vector ecology and biology, vector control technologies, community-based interventions, as well as environmental and climate change. This combination of issues addresses the multi-dimensional epidemiology of vector-borne diseases at the interface of environment and society.

At the time of the VES Unit establishment in April 2011, the Climate and Health Working Group (CHWG) of Ethiopia, in collaboration with Columbia University's International Research Institute for Climate and Society (IRI), organized a stakeholders' workshop in Ethiopia, *Climate and Health in Africa - 10 Years On.* The goal was to reduce societal vulnerabilities by evaluating lessons learned and elaborate on opportunities for managing climate change and health risks in Africa. A primary objective of the workshop was concerned with how to bring key African partners in adaptation together to focus on common demand-driven objectives around an African led agenda. Key outcomes of the workshop include a consensus agreement on priorities for policies, practice, services and data, and research and education for the integration of climate risk management into Africa's health sector.

Furthering these stakeholders' recommendations, the 61st session of the WHO Regional Committee for Africa comprising health ministers from 46 Member States held September 2011 in Côte d'Ivoire approved a *Framework for Public Health Adaptation to Climate Change in the African Region.* It urged member countries to strengthen their resilience by developing and implementing national action plans for public health adaptation to climate change. The Regional Committee called on the WHO/AFRO Regional Director to establish a Pan-African Programme for Public Health Adaptation to Climate Change with a view to leveraging and coordinating international-level technical and financial support to Member States for implementation of these country-specific action plans using the Framework to

provide a scientific and evidence-based coordinated response to the climate change adaptation needs of the African countries. The priority interventions proposed by the Regional Committee under the Framework include research and capacity building for climate change adaptation and resilience.

The informal consultation engaged key stakeholders from the region in discussions and reaching consensus on the most important research gaps and priorities in the African context for assessing impacts of interrelated social, environmental and climate changes on relevant vector-borne diseases' burden on vulnerable populations as well as leading to practical solutions for mitigating these impacts. Stakeholders considered, validated and endorsed the relevant outcomes of the 2009 informal expert consultation *Effects of Environmental and Climate Change on Vectors and Vector-Borne Diseases: Current Evidence and Research Priorities* in regard to specific gaps and priority needs in the Africa region, taking into consideration the needs and actions called for in the *Libreville Declaration on Health and Environment in Africa, the Framework for Public Health Adaptation to Climate Change in the Africa Region*, and proceedings of the stakeholders' workshop *Climate and Health in Africa – 10 Years On*. The meeting brought together policy-makers, public health practitioners and researchers who have had working experience with vectors, vector-borne diseases, climate and environmental change and other related aspects, as well as social scientists.

Opening Remarks

February 27, 2012 9:00 -9:30 a.m

Rapporteur: Johannes Sommerfeld, WHO/TDR

Ms Abesha Ferede, Board of the Health, Development and Anti-Malaria Association, Addis Ababa, Ethiopia

On behalf of the Health, Development and Anti-Malaria Association, and notably its Climate and Health Working Group, Ms Ferede welcomed all participants to the workshop and thanked the co-organizers. Providing a short overview of the association's activities since 1998, Ms Ferede highlighted the need for regional and context specific analyses at the interface of climate variability and change, vector ecology and social and economic patterns to understand and respond to vector-borne disease threats. In conclusion, Ms Ferede expressed the hope that the meeting would help to develop effective tools to support vector control strategies and capacity building needs.

Dr Yeya Touré, Special Programme for Research and Training in Tropical Diseases (TDR), World Health Organization (WHO), Geneva, Switzerland

Dr Touré, the leader of WHO/TDR's unit on "Vectors, Environment and Society" (VES) welcomed all participants on behalf of the Special Programme for Research and Training in Tropical Diseases, World Health Organization. Dr Touré underlined that the presence of such a wide spectrum of expert participants would indicate the importance given to the topic. He explained that the workshop is a product of a partnership between TDR and IDRC, Canada, that IDRC had been supporting TDR for a number of years and expressed thanks to Dr Martin Wiese and Dr Dominique Charron, the team leader of IDRC's Ecosystem to Human Health team who could unfortunately not join the meeting. Finally, Dr Touré thanked IRI and its staff, Dr Thomson and collaborators, and the Anti-Malaria Association, Ms Ferede and Mr Abere for their invaluable contributions in organizing the event. He underlined the importance of collaboration within WHO, with the Regional Office for Africa (Dr Manga) and the Department for the Protection of the Human Environment (WHO/PHE). Only through these collaborations would TDR be able to undertake such activities. Dr Touré closed by expressing hope for active participation of all workshop participants in contributing to research and capacity building needs assessment so that the meeting helps facilitate development of tools for policy-makers, enabling them to elaborate adaptation strategies.

Dr Martin Wiese, International Development Research Centre, Ottawa, Canada

Dr Martin Wiese, Programme Specialist with the Ecosystem Approaches to Human Health Team at IDRC (Ottawa), transmitted greetings from Dr Dominique Charron, the team leader, and from Dr Simon Carter, Director of the IDRC Regional Office in Nairobi. In his introductory remarks, Dr Wiese referred to the longstanding partnership and thematic working relationship with TDR. Concurrent with IDRC's 40th year anniversary, climate change received increasing attention. Dr Wiese underlined that IDRC has the mandate to support researchers in developing countries. The "Grants Plus" model points to the need to go beyond research outputs into policy and practice outcomes, providing multiple strategic and capacity building support. Based on long-term experience in global and climate change research support, IDRC is in the process of building up a major portfolio on climate change; a special interest exists in vulnerabilities and ways to adapt to and reduce vulnerability particularly in Africa.

Dr Youba Sokona, African Climate Policy Centre/United Nations Economic Commission for Africa (UNECA/ACPC)

Dr Sokona welcomed the workshop event and underlined its importance for three reasons: 1) The workshop topic is an area where little scientific evidence and knowledge, particularly in Africa, exists. 2) Most African countries start from a "piecemeal approach" to climate and development strategies. Health and climate are a major part of that strategy. There is, however, limited knowledge on climate change impacts on health. 3) There is a clear link from medicine/public health to other aspects of climate change adaptation. Dr Sokona highlighted that the African Climate Policy Centre (ACPC) is well endowed to bridge disciplines, and to bridge the research, practice and policy communities, for example through ACPC's annual stakeholder forums, which brings these groups together. Research on climate and health has not gained major attention, but that should change.

Introduction to the meeting

Dr Lee Willingham, WHO/TDR

Dr Willingham explained that a new unit on Vectors, Environment and Society was recently created within WHO/TDR and that understanding and mitigating the impacts of climate change on VBDs was one of the four major objectives. He then introduced the overall objective of the meeting and the specific objectives as specified in the executive summary. The workshop would be building on ongoing processes: the Libreville Declaration, the TDR informal meeting 2009, Workshop on Climate and Health in Africa, 10 Years on (2011), WHO/AFRO Regional Committee for Africa Framework for Public Health Adaptation to Climate Change in the African Region. He then provided an overview of the agenda including the six plenary sessions, the draft discussion paper, three breakout sessions, discussion, recommendations and conclusions and highlighted the intended overall outcomes.

Summary of presentations and discussions

Session 1: Introduction, scene setting and xpected Outcomes

27 February 2012 9:30 – 10:30 am

Chair: Yeya Touré, WHO/TDR
Rapporteur: Johannes Sommerfeld, WHO/TDR

Title: **Global research priorities on health and climate change**
Speaker: Diarmid Campbell-Lendrum, WHO/PHE

Research on the linkages between climate change and health, including vector-borne diseases, has tended to concentrate on testing for associations in long-term trends in meteorological versus epidemiological variables. While this is important, on its own it is unlikely to lead to definitive information in many cases, and policy-makers also require a broader range of information to make informed decisions. In the World Health Assembly resolution on Climate Change and Health in 2008, the 192 Member States of the WHO outlined the main areas in which they would like to see research and pilot projects. These cover risk assessment, effectiveness of interventions, health implications of decisions in other sectors, improving decision-support, and estimating resource requirements – all of which are highly relevant to the case of climate change and vector-borne disease in Africa. The presentation gave a brief overview of ways in which the planned work in Africa can be as relevant as possible to both health and climate policy.

Title: **Public health adaptation to climate change in Africa. Health sector's Plan of Action 2012-2016.**
Speaker: Lucien Manga, WHO/AFRO

Over the past few years, African countries have taken unprecedented political steps to address public health and environment linkages. The Libreville Declaration on health and environment in Africa was adopted in 2008. The Declaration established a health and environment strategic alliance, as the basis of plans of joint actions between the 2 sectors. In 2010, African countries reiterated their commitments to implement the Libreville Declaration in Luanda. Ministers of health and ministers of environment issued a Joint Statement on Climate Change and Health, in which they agreed to implement an essential public health package of interventions, to adapt to the negative impacts of climate change and to strengthen country resilience. In 2011, ministers of health further adopted the Resolution AFR/RC61/R 2 on a Framework for Public health Adaptation to Climate Change at the 61st Session of the WHO Regional Committee for Africa. The Framework was also endorsed by the 4th Special Session of the African Ministerial Conference on Environment (Decision AMCEN/SS4/1).

A Plan of Action for Public Health Adaptation to Climate Change has been prepared on the basis of the Framework. The general objective is to contribute to the minimization of the adverse public health effects of climate change in Africa. The specific objectives of the Plan are to: (i) identify country-specific health risks associated with climate in all African countries; (ii) strengthen core national capacities that enable the health systems to prepare for and effectively respond to climate change threats to human health; (iii) facilitate the implementation of essential public health and environment interventions for the management of both immediate and long term health risks associated with climate change; (iv) facilitate operational and applied research on local health adaptation needs and solutions; and (v) disseminate lessons learned and country experiences in order to facilitate implementation of adaptation strategies in other sectors. The core group of interventions are baseline risk and capacity assessments; capacity building; awareness raising and social mobilization; integrated environmental and health surveillance; public health oriented environmental management; and scaling-up of existing public health interventions and research. Some of these activities are on-going but require strengthening with supplementary interventions.

The African continent therefore has now equipped itself with a concerted and comprehensive policy basis to address climate change and health issues. Coordinated efforts from all stakeholders including the research community are required, through specialized technical and institutional support.

Title: **Contribution of international agricultural research to the control of human vector-borne disease in Africa**
Speaker: Delia Grace, ILRI

Vector-borne diseases abound in tropical and sub-tropical Africa where the combination of year-round warm temperatures, sufficient rain, wildlife hosts, suitable habitats, and inadequate animal health services provide suitable conditions for the diseases that have plagued people and their domestic animals for millennia. Many of the important vector-borne livestock diseases are also zoonoses. These include: trypanosomosis, Rift Valley fever (RVF), Q fever, leishmaniasis, Lyme disease, yellow fever, and dengue.

Just over 40 years ago, a consortium of international agriculture research centres was set up to avert famine in developing countries. In 2012, the consortium launched a mega-program on agriculture, health and nutrition - the first time international agriculture research centres came together at significant scale to work on these issues. One of the four themes in the new mega-program focuses on food-borne disease and zoonoses. It was discussed what agriculture research can offer to One Health approaches for managing zoonoses, especially those with a wildlife interface.

Recent and ongoing research was presented, relevant to adaptation to social, environmental and climate change impacts on vector borne zoonoses in Africa, which focuses on RVF and trypanosomiasis, including:

- Metrics to assess the multiple burdens of zoonoses across human health and the livestock sector
- Global maps of hotspots of poverty, climate change vulnerability and zoonoses
- A diagnostic platform for high throughput pathogen detection
- Searching for known and novel arbovirus in people, livestock, wildlife and vectors
- Determining main vector reservoirs for RVF
- Assessing the economic and livelihood impacts of RVF in Kenya
- Investigating how RVF dynamics are changing as a result of irrigation
- Determining the impact of migration, form of settlement and conflict on RVF
- Developing a climate driven model for RVF
- Developing a decision-support tool for RVF management
- Developing scenarios to explore the impact of different control options for RVF
- Treating cattle with ecto-parasiticides to reduce risk of trypanosomosis
- Breeding cattle that are resistant to trypanosomosis

Title: **Climate and Health in Africa: Ten Years on**
Speaker: Judy Omumbo, Wellcome Trust Consultant

The "Climate and Health in Africa: 10 Years On" workshop was planned as a forum to present, debate and evaluate lessons learned and to elaborate on newly emerging perspectives and opportunities for managing climate and health risks in Africa. Over 100 stakeholders, representing critical thinkers from multiple disciplines, participated in the three-day meeting. Participants examined examples of best practice in climate change adaptation in health and deliberated on how to bring key African partners in adaptation together to focus on common demand-driven objectives around an African led agenda. Key outcomes of the workshop include a consensus agreement on priorities for policies, practice, services and data, and research and education for the integration of climate risk management into Africa's health sector. With this as a first step, it was underscored that Africa will be taking a leading role in climate and health in the future.

The workshop was set up to develop significant partnerships, and its recommendations were intended to inform the work plans of both Africa's Libreville Declaration on Health and the Environment and the African Climate Policy Centre's initiatives towards implementing the Climate for Development in Africa Programme (ClimDev-Africa). This was seen as a significant milestone and achievement in bringing partners in Africa together around a common agenda and in developing a consensus Action Plan for Africa. The presentation provided an overview of the

outcomes and recommendations of the workshop and provided the background on the recommendations relating to research as prioritised by countries in Africa.

Key points from the session:

- There is increased international attention to climate change in Africa, supported by various political commitments leading to the development of specific policy frameworks.
- There is a need for better evidence on the effects of climate change on health.
- This specific workshop opportunity highlights a specific aspect of the debate, i.e., investigating population health vulnerabilities related to vector-borne diseases from a multi-disciplinary perspective, and developing adaptation strategies to social, environmental and climate change.
- The workshop is supported by a partnership between WHO and IDRC and supported through IRI and the Anti-Malaria Association of Ethiopia.

Session 2: Country experiences

27 February 2012 11:00-12:30

Chair and Co-Chair: Lucien Manga, WHO/AFRO, and Michel Jancloes, HCF
Rapporteur: Dia Elnaiem, University of Maryland Eastern Shore

Title: **Climate change adaptation for vector-borne diseases: a Southern African perspective**
Speaker: Samson Mukaratirwa, University of KwaZulu-Natal

Climate change is directly affecting the epidemiology, prevention and control of vector-borne diseases (VBDs) in southern African countries. Among the major VBDs in southern Africa are malaria, dengue fever, African trypanosomiasis, lymphatic filariasis, and schistosomiasis. The perceived consequences of climate change with regard to VBDs are the shortening of the development time of vector larvae, the increasing rate of transmission due to adult vector arthropods digesting blood faster and feeding more frequently, the quicker extrinsic incubation period of pathogens in the vectors, the change in geographical distribution of vectors due to change of precipitation patterns, the change in human settlement patterns due to floods or drought, and the increase in burden of vector and disease control. Irrespective of the fact that most southern African countries have made firm commitments at various fora to address climate change and mitigate its impact on VBDs, the majority of countries in the region are ill-prepared to cope with the negative impacts of climate change. Priority public health actions for Southern Africa, in relation to adaptation to climate, were presented.

Title: **West African Health Organization perspectives on climate change effects in West Africa**
Speaker: Issiaka Sombie, West African Health Organization

The West African Health Organization (WAHO) is a specialized health institution that is part of the Economic Community of West Africa States (ECOWAS). Its mandate is to help Member States to deliver a high quality of health care for their people. In the second strategic plan (2009-2013), the development of research for health is one of the ten programmes. The strategic objective of this programme is to facilitate health research in the ECOWAS sub region. The expected outcomes are to establish a network of ECOWAS researchers and promote the operational research centres of excellence. WAHO intervention strategies are oriented according to four axes: stewardship, financing operational research, strengthening capacities and promoting utilization of research for health results. Climate change effects were perceived by ECOWAS, which developed a regional plan to reduce impacts for the population. The WAHO participated in the development of this plan, although this plan is mostly agriculturally and environmentally oriented. WAHO also presented a communication on climate change effects on the health sector during the Commonwealth Ministries of Health meeting. There are also some regional initiatives including the establishment of a francophone programme, called Recherche Interdisciplinaire et Participative sur les Interactions entre les Ecosystèmes, le Climat, et les Sociétés d'Afrique de l'ouest (RIPIECSA) and a Canadian initiative. WAHO also participated in the dissemination meeting of these projects and plans to develop a programme around climate change effects in the health sector. WAHO used this meeting as an opportunity to identify some elements of the future programme on climate change effects.

Title: **Impact of changes in the environment, including climate and human geography on epidemiology of malaria and schistosomiasis in S.W. Uganda**
Speaker: Narcis Kabatereine, Ministry of Health of Uganda

There has been increasing population pressure leading to considerable ecological change in the South Western Uganda highlands. These changes are thought to have been promoted by environmental degradation, subsequently causing substantial climatic changes. Temperatures have been increasing consistently while both rainfall seasons and amounts have been decreasing. These environmental changes seem to have started about 50 years ago. Historical data shows an increasing trend of malaria cases in the region. The death rate due to the disease has been increasing over the years perhaps indicating lack of natural immunity to malaria by the highland inhabitants. This has caused a heavy burden on the health systems. Furthermore, it had earlier been shown that schistosomiasis *mansoni* transmission does not occur above 1400 metres above sea level implying that the Ugandan highlands were schistosomiasis free. However, recent studies have documented high prevalence of the disease at an altitude ranging between 1487 metres to 1682 metres above sea level. It seems changes in vector species composition and

population dynamics have occurred over time favouring transmission of vector borne diseases in the highlands. For example, while poor malaria vectors that included *Anopheles funestus* and *A. christyi* were formerly the dominant mosquito species in the region, the current data shows a dominance of *A. gambie* species which are efficient in malaria transmission. *Biomphalaria sudanica* and *B. pfeifferi*, the potential schistosomiasis *mansoni* vectors, have also colonized most highland water bodies. Therefore, there is need to study historical and current meteorological data to ascertain if there has been climate warming in the highlands. Historical and current data should also be collected on all potential disease vectors in the area. If the observed malaria and schistosomiasis increases are real, it is necessary to determine if the surge is associated with climatic changes. It is equally important to elucidate whether there is increased risk in disease epidemiology for similar highland areas in other African countries with parallel climatic conditions.

Title: **Ethiopian perspective on adaptation to social, environmental and climate change impacts on vector-borne diseases and Evaluation Partnership in Africa**
Speaker: Asefaw Getachew, MACEPA

Ethiopia is committed to abandoning its sole dependence on rain-fed agriculture and increasing its micro to macro water development schemes, in order to boost its irrigated agriculture, food security, and increase its electricity power supply five-fold over the next five years. This plan includes marketing the surplus of clean power to neighboring countries as part of the regional economic network. However, there are unintended consequences of these developmental activities associated to changes in land use and compounded by climate variability/change. These are expected to expand the reach of climate sensitive vector borne diseases, especially in highland fringe areas where temperature limits transmission, and in semiarid and arid areas of the country where water is a limiting factor. While this is a liability for development in Ethiopia, the government is not reluctant to work proactively to prevent and control climate sensitive VBDs, particularly malaria. Prior to scaling up of interventions for impact (SUFI), the malaria epidemic was frequent in the highland fringe areas of Ethiopia, especially when unusual weather events were observed inter-annually or cyclically. However, Ethiopia has made considerable progress since 2005 in SUFI at a national level through an integrated approach to health services delivery. As a result, about 68% of the total population is now protected against the risk of contracting malaria.

Therefore, one of the major challenges facing Ethiopia in sustaining the achievements of SUFI is the threat of expansion of malaria and other climate sensitive diseases to higher altitudes with the likelihood that climate change will also expand to areas suitable for transmission of vector borne diseases. Hence, Ethiopia needs to develop climate change scenarios based on risk maps for informing the surveillance and other interventions, to prevent the resurgence of malaria transmission in the highland fringe areas of the country. It also needs to

strengthen tools for vulnerability and adaptation assessment in the health sector, links with other development sectors, and tools for monitoring health adaptation.

Title: **The African drylands: key debate and emerging perspectives for the control of vector-borne diseases of humans and livestock in the context of climatic, environmental and social changes**
*Speaker***:** Madeleine Thomson, IRI

In this presentation we looked at the dryland regions of Africa – ranging from hyper-arid, arid, and semiarid to dry sub-humid areas – and explored some key dynamic processes that are occurring from political and social, environmental and climatic perspectives. We then identified key vector-borne diseases of importance in the dryland areas and explored new research opportunities that could respond to new challenges, including both the impacts of a changing climate, and the policy and practice response to climate change adaptation, such as re-greening, (including reforestation and agroforestry) and water management (local and large-scale). We then showed how new data (such as climate information) may help to frame or answer some of the critical research questions.

Key points from session:

- Although policy on climate change adaptation is available for the Southern African region, practice is disintegrated.
- Applied adaptations should adjusted to integrate with spontaneous adaptations established and accepted by communities.
- Both research and training are needed for the Southern African region.
- Introduction to the West African Health Organization (WAHO) as an emerging organized body that deals with climate change effects in 15 countries in West Africa is needed.
- The VBDs relevant to Ethiopia are malaria, leishmaniasis, lymphatic filariasis, onchocerciasis and schistosomiasis due to *Schistosoma mansoni.*
- Ethiopia are that the country is no longer dependent on rain fed agriculture and there is change towards other irrigation methods. Other factors include the fast rate of urbanization and marked population movements towards agricultural areas in the western low lands. There is also a rapid change in land use.

- HEP (Health Extension program) in Ethiopia is a successful platform that plays an indispensible role in dealing with problems.

Session 3: Integrating Environmental Research

27 February 2012 14:00-15:30

Chair and Co-Chair: Peter Furu, University of Copenhagen, and Daniel Boakye, Noguchi Memorial Institute of Medical Research
Rapporteur: Delia Grace, ILRI

Title: **Adaptation to development and climate change induced impacts on vector-borne diseases - the potential role of Health Impact Assessment (HIA)**
Speaker: Peter Furu, University of Copenhagen

Health impact assessment (HIA) is gaining increased recognition by governments and witnesses the establishment of a more solid policy foundation for its use in intersectoral public health planning and management. Recently, the Libreville Declaration on Health and Environment in Africa (WHO, 2008) and the WHO General Assembly Resolution on Drinking-water, Sanitation and Health (WHO, 2011) have emphasized the significance of HIA as a means to safeguarding human health in connection with development induced changes to climate, environmental and social determinants of health.

More specifically, HIA has been defined as a combination of procedures, methods and tools that systematically judges the potential, and sometimes unintended, effects of a policy, plan, programme or project on the health of a population and the distribution of those effects within the population. HIA identifies appropriate actions to manage those effects. An outline of the existing policy background for HIA was presented and how HIA may be used as an entry point for ensuring healthy public policies, in particular, in relation to climate change related National Adaptation Programme of Actions (NAPAs) and National Environmental Health Action Plans (NEHAPs) of importance for prevention and control of vector-borne diseases. Inter-sectoral HIA has potential to address these issues with strategic and project level planning with a focus on vulnerable communities, associated adverse health impacts as well as on health opportunities derived from health and non-health sector development activities.

Although many governments are aware of and recognize the importance of HIA, few have the capacity, capability and jurisdiction to manage the HIA process effectively. Thus, the challenges health systems are facing in ensuring the necessary policy framework, institutional arrangements and human resource skills needed to formulate HIA terms of reference, to independently appraise HIA reports and to negotiate inter-sectoral support for Public Health Action Plans, were highlighted.

Finally, knowledge gaps and research needs with regard to testing and validating the role of HIA as a tool for impact assessment and climate change adaptation were considered in relation to vector-borne diseases' epidemiology and control.

Title: **Environmental changes and vector-borne diseases: lessons from Ghana**
Speaker: Daniel Boakye, Noguchi Memorial Institute of Medical Research

Malaria and most of the neglected tropical diseases are vector-borne and hence their distribution is greatly influenced by the factors that favour or limit the distribution of their respective vectors. One major factor that influences vector establishment, survival, abundance and distribution is change in the environment which can be natural or man-made. Thus an understanding of how environmental changes impact vector-borne diseases is critical towards their prevention and control. Studies were provided on some man-made environmental changes in Ghana, such as the creation of the Akosombo dam and deforestation in south-western Ghana, and how they have impacted the spread of onchocerciasis and schistosomiasis vectors and hence the disease distribution. Challenges and gaps in such studies, preventing them from being utilized effectively to support control efforts, are insufficient data quality, lack of pertinent information, knowledge gaps between scientists, policy-makers and communities, and limited human capacity. These challenges can be surmounted if research institutions (biomedical, climate and environment) can work together within the appropriate policy frameworks that exist in various African countries.

Title: **Environment, agriculture and infectious diseases: Assurance for healthy sustainable development**
Speaker: Suad Sulaiman, Sudan

Water- and vector-borne diseases are the main cause of morbidity and mortality in many African countries and exert a heavy burden on the economy. These diseases are frequently aggravated by poverty, lack of sanitation and health services in many parts of the countries where infections are high.

Although Africa is rich in natural resources, abounding in fertile land for agriculture and fresh water, mismanagement of the resources has led to severe land degradation, poverty and diseases that are increasing at a fast rate especially due to the impact of climate change. Also, traditional farming in Africa is mainly done manually, with farmers being in close contact with water and therefore exposed to waterborne diseases.

Agricultural development needs to expand to meet food gaps and fast population growth. Many African countries are supporting extensive irrigated agricultural schemes funded by international agencies and other rich countries. Funding donors insist on conducting an environmental impact assessment before starting projects. However, health impacts, mostly the spread of waterborne diseases, are frequently not seriously considered. Preventative measures against the spread of disease

vectors, immigrant human population pollution of water sources, or exposure to infested waters are mostly not stringent enough to curtail parasitic life cycles.

Once projects are completed, the funding agency pulls out, leaving the human settlers exposed and diseases quickly become difficult to control.

Assurance for healthy sustainable development:

- Development of agriculture is a multi-disciplinary role involving the responsibility of many departments which have to contribute collectively to come up with a holistic plan covering all the aspects.

- Introduction and development of new methodologies to reduce threats of waterborne disease vectors, reduce pollution of water bodies, reduce wastewater from irrigation, increase cultivation of products with high yield and less water consumption, and preserve land fertility using biodegradable compounds and fewer chemicals.

- Involvement of stakeholder and society ensured during the process of planning and implementation. Communities will frequently need to be educated about the project development well in advance of the project start date; this should include awareness raising about environmental changes and how to adapt.

- A brief description of the Nile Basin Initiative (NBI), an inter-governmental project and the Nile Basin Discourse (NBD) a civil society inter-organizational association will support these efforts.

- A list of what community civil society organizations can be trained on and what they can do to assist in collection of data and how to respond to threats of waterborne and vector-borne diseases at their early stages should be identified.

Title: **Climate and visceral leishmaniasis in Southern Sudan and Sudan: current problems and research priorities**
Speaker: Dia Elnaiem, University of Maryland Eastern Shore

Visceral leishmaniasis (VL, kala azar) caused by *Leishmania donovani* is a climate sensitive vector-borne disease affecting large rural populations in Southern Sudan, Sudan and other parts of East Africa. The epidemiology of kala azar in these countries is characterized by silent years followed by periods of high disease activity that claims the lives of large numbers of people. Although no comprehensive studies have been undertaken to correlate recent epidemics of kala azar with climate change, there is ample literature evidence suggesting that increased disease burden may be related to the Sahelian drought and movement of susceptible populations from non-endemic foci in Darfur to endemic sites in Eastern Sudan. Similarly, war-related displacement of people in southern Sudan has contributed to the epidemics of kala azar in the Upper Nile regions. In previous

studies we have shown that distribution of *Phlebotomus orientalis*, the main vector of kala azar in Sudan, can be predicted by the presence of black cotton soil, *Acacia seyal - Balanites aegyptiaca* woodland and records of maximum temperature. We further showed that presence and incidence of kala azar in Gedaref state could be related to variations in rainfall. We also encountered remarkable annual fluctuation of *P. orientalis* that can be related to climatic variables. We conclude that climate change has played a significant role in increasing the incidence of kala azar in the past few years in Sudan. However, more work is needed to predict the impact of climate change on the future epidemiology of the disease. Furthermore, work is urgently needed to produce detailed risk-maps and early warning models that can help in health planning and intervention against VL in Southern Sudan.

Title: **One Health: practical examples of cross-sectoral collaboration, key actions and beyond**
Speaker: Jakob Zinsstag, Swiss Tropical and Public Health Institute

Lacking a general theory of One Health, we provided an operational definition of One Health and its leverage as: Any added value in terms of human and animal health, financial savings or environmental benefit from closer cooperation of human and animal health sectors at all levels of organization. Examples of such added value of "One health" are given from the fields of health systems, nutrition and zoonoses control in Africa and Asia.

One Health must become mainstream rather than a new discipline or new association; it should be commonplace for practitioners and professionals in the health, animal and environment sectors to work together as closely as possible. Current and future challenges in financing clean energy, migration flows, food security and global trade further warrant rethinking of human and animal health services. A conceptual outlook relates health as an outcome of human environment systems called "health in social-ecological systems".

Key points from session:

- There is a need to ensure Health Impact Assessments are not just an ex ante activity (e.g. another box to check for project approval). HIA is an accepted method for assessing the health externalities (positive and negative) of programmes, projects and policies. Plans are often mentioned, although there is little use of them in Africa. These could and should be used for the climate adaption and mitigation efforts

- NTDs together impose a greater disease burden than malaria or TB. Most are vector-borne.

- The most important African water associated diseases are malaria and schistosomiasis. They are strongly associated with irrigation, dams and

deforestation, all essential for development and feeding rapidly growing populations. Extensive irrigation is the future and donors are funding large projects. We need a civil society initiative to address development-induced water associated diseases in agricultural areas.

- Health and socio-eco-systems have two-way linkages and socio-ecological phenomena can have higher effects than disease alone. Climate change may have only a small and incremental impact on health – essentially driven by poverty.

- A trans-disciplinary approach connecting science and society is needed as well as an inter-disciplinary approach linking disciplines. Economic interests of agriculture can work against sharing disease information with the health sector (e.g. Q fever in Holland).

- One Health thinking is very aligned to how communities regard health and comparative studies are warranted on human and animal health problems and solutions.

Session 4: Integrating Social Science Research

27 February 2012 16:00-17:30

Chair and Co-Chair: Francis Dodoo, University of Ghana, and Johannes Sommerfeld, WHO/TDR
Rapporteur: Derek Willis, Columbia University – International Research Institute for Climate and Society, Center for Research on Environmental Decisions

Title: **An Ecohealth approach to flood recession (Molapo) farming to reduce climate change vulnerability in the Okavango Delta, Botswana**
Speaker: Moses Chimbari, University of Botswana

Flood-recession farming (molapo farming) has been practiced in the Okavango Delta, Botswana for many decades. Floods usually arrive in June and start to recede in September. Between October and December, seasonally flooded areas become ready for cultivation. Alluvial soil deposited during flooding and soil moisture maintained after the flood plus the onset of the rainy season in December make molapo farming more attractive than dryland farming. Maize, sorghum, millet and watermelons are grown and yield can significantly exceed that obtained in dryland farms. Clearing of fields may compromise biodiversity and the tillage system used may lead to erosion. As floods recede, puddles of water are created, providing potential mosquito breeding sites; molapo farms may therefore be exposed to malaria. Molapo farmers generally settle close to the river. Some sites used for domestic water activities are infested with bilharzia transmitting snails, thus posing a risk to users. The government does not give title deeds for molapo plots and hence farmers have no incentives to develop their fields and settlements. Previous studies

have assessed livelihoods of families practicing molapo farming and the areas under cultivation and production levels are generally known. However, little work on environmental sustainability and potential health hazards associated with the farming system has been done. Using the ecohealth approach, we are gathering information on food security, sustainability issues and health hazards in the context of climate change in order to improve the lives of molapo farmers and to assist the government in formulating a policy regarding molapo farming. The presentation described the methodological approaches we have adopted and showed some of the findings obtained from 2 years of project implementation.

Title: **CILSS and MDG Center: Great Green Wall Initiative for climate change adaptation**
Speaker: Oulie Keita, MDG Center–West and Central Africa

The Sahelian Drylands Initiative is a joint initiative by CILSS (Comité permanent Inter-Etats de Lutte contre la Sécheresse dans le Sahel), the pan-African agency of the Great Green Wall and the Millennium Development Goals Center for West and Central Africa (MDG Center). It is an initiative aimed to address the limited impact of sectoral approaches to development in the Sahelian countries with complex environmental challenges posed by climate change that prohibit the attainment of the Millennium Development Goals. The initiative is a result of key recommendations from the First African Drylands Week organized from 10-17 June 2011 in Dakar (Senegal) by the CILSS, the MDG Center, FAO, the African Forest Forum (AFF), ICRAF, the European Union, the Walloon region of Belgium and representatives of the three conventions (UNCBD, UNCCD, UNFCCC).

The overall objective of the project is to improve the living conditions of the Sahelian populations and to reverse the degradation of their environment through a MDG-based integrated multi-sectoral approach that includes development, research and training across the GGW pilot sites of CILSS countries and to establish a platform to scale-up the approach to other CILSS countries that are not members of the GGW.

The project is designed for a period of five years and includes 12 integrated components to be implemented simultaneously. The components include: i) Agriculture/agribusiness; ii) Animal husbandry and pastoralism; iii) Water and sanitation; iv) Environment and sustainable development; v) Renewable energy; vi) Health and nutrition; vii) Education; viii) Infrastructure and innovation; ix) Community development and local governance; x) Gender and development; xi) Monitoring and evaluation: and xii) Research and training.

Activities will cover all CILSS ten countries. Activities will follow GGW transect in CILSS countries that are members of the GGW. For non-GGW members, activities will be implemented in project selected sites. Sites will cover three agro-ecological zones of Sahel: arid, semi-arid and semi-humid.

The Millennium Villages (MV) approach will be used as a project model. The model is a holistic approach of integrated local development to meet the MDGs at a local level in sub-Saharan Africa. The model was tested and validated in the last five years in over ten African countries. MV of Ghana, Mali, Nigeria and Senegal in West Africa showed that reaching the MDGs is possible within five years when appropriate strategies and innovative approaches to development are adopted. These strategies and innovative approaches used in the implementation of the MV model were developed by the Earth Institute of Columbia University (USA). Results obtained have inspired countries such as Mali to scale-up the model into the 166 most vulnerable food unsecured communes (I-166 initiative).

Notes from panel discussion:

The following five key cross-cutting concepts were discussed during the panel discussion: 1) engaging social scientists when initially developing a research project; 2) communication with communities during initial stages of developing a research project; 3) social scientists playing a central role in developing systems thinking frameworks to understanding systems; 4) shifting from interdisciplinary approaches to trans-disciplinary approaches; 5) conducting research on how alternative ways of presenting information to policy-makers (particularly when using web-based tools) affect their decision making process.

Two examples of the research projects that are applying these key cross-cutting concepts are the projects that were summarized at the beginning of this session– an 'Eco-health approach to food recession farming to reduce climate change effects' (Okavango Research Initiative) and the Great Green Wall initiative.

During the panel discussion, additional examples were provided of the importance of these cross-cutting concepts. Dr Barbara Ngwenya noted that her research utilizes an Indigenous Knowledge System framework in order to engage with local communities and integrate their knowledge into the research project. In addition, Dr Ngwenya described how PhD and Master's students are required to take an intensive course on how to work across disciplines in order to promote the development of trans-disciplinary research methodologies.

Dr Charles Muchunguzi highlighted the importance of being sensitive to the culture of communities when determining the most appropriate means of engaging with communities. Dr Muchunguzi referenced his experience studying the coping strategies of Bahima pastoralists along the Uganda cattle corridor to illustrate why it is critical to understand the values and attitudes of a community in order to determine the most appropriate means of engaging a community in a research project.

Dr Derek Willis highlighted his research at Columbia's Center for Research on Environmental Decisions (CRED) into how alternative ways of presenting the health

impact of interventions can lead to different decisions by policy-makers. In other words, it is important to not only understand the potential impact of interventions but to also understand how alternative ways of communicating this impact to policy makers can have a significant effect on the interventions that are chosen by policy makers.

Finally, the importance of communicating research findings to policy-makers was stressed by Dr Francis Dodoo during his summary of the work of the Regional Institute of Population Studies in Ghana. Dr Dodoo also noted that although it may be more costly to integrate social science methods into a research project's design at the initial stages of the project, it will likely lead to substantial benefits at later stages of the research.

Key points from session:

- Important to integrate social science methods into a project during the initial stages of the project's development.

- Important to engage communities in order to understand their knowledge system and which problems are most important to them.

- Need to provide community with feedback on results of research projects once projects have concluded.

- Important to conduct research into how the framing of information (how information is presented) affects the decision-making process of policy-makers – this is particularly critical when developing web-based tools for sharing information with policy makers.

Questions/discussion raised:

- Should natural, physical and computing scientists be given some basic training in social sciences so that they can better communicate with social scientists?

Session 5: Integrating climate research

28 February 2012 21:00 -22:30

Chair and Co-Chair: Chair: Cheikh Kane, ACMAD; Madeleine Thomson, IRI
Rapporteur: Dan Boakye, Noguchi Memorial Institute of Medical Research

Title: **Climate information for climate informed health decisions: What we know and what we still need to investigate**
Speaker: Cheikh Kane

Climate and health interactions have become a focus of the public health sector. A dialogue between the climate and health communities is desirable to better understand each other's needs and ways of working.

Three primary timescales could be of interest for decision-making by the health sector: (i) On a short- to medium-term, decision-making is mostly limited to emergency responses to pending near-term disasters; for the health sector this type of information might be relevant for short term operational decisions, risk announcements or delivery of supplies, for example. (ii) On a timescale of weeks to seasons, predictions are used to provide outlooks for climate-sensitive diseases; this information can be suitable, for example, for outbreaks tracking. (iii) Longer timescales (mid-term– annual to multi-year– and long range-decades) can be related to disease control and research, demographic/population models, health systems planning and increase understanding of disease trends.

Agreeing on key factors/variables to monitor is a first step in this dialogue between the climate and health communities. Developing common methodologies and tools, for example, using and developing statistical models that allow testing of the relative importance of each factor, as well as predictions of the health implications of changes in any of these factors, can significantly improve this dialogue. Adapting the CLIMAT messages codes (WMO) for reporting monthly climatological data assembled at land-based meteorological surface observation sites to data centres to monitor diseases is another way of collaborating.

Downscaled regional models are also needed to better cope with regional to local adaptation programme priorities, as climate change scenarios and seasonal climate forecasts are modelled at the global–regional scale at best. The ongoing CORDEX in which ACMAD is involved is a kind of experiment which needs to be supported.

All this depends on the availability, accessibility and quality of data for research purposes which are critical points to take into account and for which the development community should advocate for.

Title: **Climate variability and change across the African drylands**
Speaker: Sylwia Trzaska, Center for International Earth Science Information Network (CIESIN), Columbia University

Located in transition zones between habitable areas and inhospitable deserts, characterized by low rainfall and high evaporation resulting in limited primary productivity, drylands occupy about 41% of total land and are inhabited by 30% of the world population. Most of the populations in the drylands lag behind the rest of the world on human well-being and development indicators. The fragile ecosystems harbored there, although rich in biodiversity, are highly prone to degradation due to human activities.

Three main regions are classified as drylands in Africa: the Sahel, the eastern part of the horn of Africa and southwestern part of Southern Africa. Those areas are also prone to highly seasonal or even epidemic malaria and meningococcal meningitis, both climate-sensitive diseases. Evolving climatic conditions may mean expansion and/or intensification of disease incidence or its reduction depending on whether conditions become wetter or drier. But long-term projections either fail to provide unanimous response (Sahel) or point towards wetter conditions, while recent trends indicate progressive multiyear drying (East Africa).

The lack of consensus between projections can be linked to imperfect representation of the reality by the models, which, in the case of the Sahel, can translate into slightly different location and extension of the main rainbelt in West Africa, thus affecting the location and rainfall intensity in the transition zone in different models. The difference between projections and recent observed trends highlights the fact that climate varies on a number of scales, from inter-annual to decadal to long-term trends. The decadal variations, linked to the variability of sea surface temperatures, may locally override the long-term trend, linked to the modification of atmospheric composition. Those uncertainties on the modifications in climate over the next 10-20 years are unlikely to be significantly reduced in the near future – it is thus necessary to develop prevention and control strategies in the drylands given the high uncertainty on climate evolution.

Title: **Improved availability, access and use of climate information in Ethiopia**
Speaker: Kinfe Hailemariam, National Meteorological Agency, Ethiopia

Climate variability and change are serious challenges to sustainable development in Ethiopia. Building resilience against the negative impacts of climate and maximizing the benefits from favorable conditions will require the design and implementation of effective climate risk management strategies. This cannot be accomplished without the availability of decision-relevant climate information. Surface station climate data suffer from heterogeneity in space and time and also gaps in data quality; the alternative has been satellite estimates. The main advantage of the satellite products is the excellent spatial converge. However, satellite estimates also suffer from a number of critical shortcomings that include heterogeneous time series, short time periods, and poor accuracy, particularly at higher temporal and spatial resolutions. Thus, in this work, a combination of the surface and satellite data has been accomplished. The blended rainfall dataset draws on more than 600 rain-gauge stations merged with 28 years of satellite-derived METEOSAT rainfall

estimates. The rainfall satellite estimate is processed using TAMSAT methodology from the raw satellite data and new high quality calibration parameters. For temperature, data from over 300 stations are combined with Moderate Resolution Imaging Spectroradiometer (MODIS) satellite Land Surface Temperature (LST) estimates. The result is a 30-year time series of rainfall and temperature data at 10 daily timescales for every 10-km grid over the country.

The National Meteorological Agency of Ethiopia Website (www.ethiomet.gov.et) has been upgraded to help access this new climate information. The International Research Institute for Climate and Society (IRI) digital library Digital Maproom tools have been customized to provide climatic analysis and presentations of the climate information online. Now, users can get both climatic time series and current climate information over Ethiopia for the smallest administrative classification (Woreda) and any grid point online.

Title: **Climate, environment and perception of lymphatic filariasis and malaria in urban area of Ouagadougou: lessons from experiences at national and regional level in integrating climate information for vector-borne disease control**
Speaker: Pascal Yaka, Office of Civil Aviation and Meteorology General Direction, Burkina Faso

Space-time distribution and incidence of vector-borne diseases in urban areas, such as lymphatic filariasis and malaria, depend on many factors. These factors are mostly unknown, particularly the connection and the dynamic interplay between the environment, climate, humans and vectors. A better understanding of the mechanism of space-time distribution and the incidence of vector-borne diseases is necessary to develop a reliable strategy against the diverse consequences of these diseases in a perpetually changing area.

The aim of this study is to analyze environmental, climatic and anthropogenic factors that determine the space-time distribution and incidence of lymphatic filariasis and malaria in the urban changing area of Ouagadougou, the Burkina Faso capital. These studies were developed a few years ago by the Burkina Meteorological Authority jointly with the Minister of Health and University of Ouagadougou.

Recently, in the case of the HEALTHMET project, the Climate and Health National Working Group (CHNWG) was currently established in Mauritania and Burkina Faso. In the future, Mali, Niger and Nigeria will be supported to establish their CHNWG.

Lessons from these experiences at the national and regional level display challenges and opportunities to use climate information to help understand and control vector borne diseases, particularly in the context of climate variability and change

Title: **Monitoring and integrating environmental and climate information for infectious disease studies**
Speaker: Pietro Ceccato, International Research Institute for Climate and Society

The presentation reviewed the requirements for monitoring the major environmental and climatic factors that influence outbreaks of infectious diseases and provided examples of applications that have been made. New developments in using the IRI Data Library as a tool to display and analyze new and improved remotely sensed products which integrate in-situ measurements were presented. Problems and solutions about the requirements for integrating environmental factors with infectious diseases were discussed and this will help pave the way for implementing research strategies and creating operational early warning systems

Key points from session

- There is a need for collaboration between the Climate and Health communities to set the agenda, establish the needs and develop common tools for climate and vector-borne diseases.
- Models on climate change for Africa in most instances suffer from a lack of quality data.
- Understanding climate variability is needed for projection on diseases linked to drylands.
- Blending of ground meteorological station data with satellite acquired data is a useful way to obtain meaningful predictions of rainfall and temperature effects that have a bearing on vector-borne diseases.
- Capacity building is required for a better understanding and utilization of both climate and entomological data.
- There are many health-related climate projects and many organizations also involved, but these appear to be mostly country specific.
- Malaria appears to be the most studied vector-born disease and an effort should be made to include studies on other VBDs, which are mostly part of the neglected tropical diseases.

Session 6: Transcending disciplines for policy and practice

28 February 2012 11:00 -12:30

Chair and Co-Chair: Martin Wiese, IDRC, and Dia Elnaiem, University of Maryland Eastern Shore
Rapporteur: Diarmid Campbell-Lendrum, WHO/PHE

Title: **Transcending disciplines for change in policy and practice: The evolution of ecohealth approaches**
Speaker: Martin Wiese, IDRC

The 2009 WHO consultation on a research agenda for health and climate change, the Pan-African Climate and Health workshop in Ethiopia and the African Union Conference of Ministers of Health in Namibia, recognize the particular at-risk context of sub-Saharan Africa and recommend conducting applied research for the management of adverse effects of climate change on health. The research agenda emerging from these international initiatives emphasizes the need for multi-disciplinary, multi-sector approaches to developing actionable strategies addressing the effects of climate change on human health. Addressing such links between people's health and complex changes, such as climate change, requires innovative approaches to bridge research and development paradigms. Since we all operate in changing contexts, attribution between research and specific changes is notoriously difficult to establish.

This presentation outlined how a growing international field of research called ecohealth has evolved in tackling complex problems such as climate change impacts on human health, with the support of Canada's International Development Research Centre (IDRC). Ecohealth research addresses social, economic, and environmental changes that underlie persistent and emerging health-problems in developing regions. Systems thinking, 'trans-disciplinarity', strategic stakeholder participation, sensitivity to social equity and sciences are proven principles of an ecohealth approach to human health.

In this regard, experience gained with ecohealth approaches illustrates that multiple (and mostly indirect) pathways exist between knowledge and developmental impacts. First experiences gained by supporting research on health impacts of climate change (CC) in Africa reveal some lessons: (1) CC seems most impactful in contexts that are prone to crises and instability; (2) CC impacts can be amplified by mal-adaptations; and (3) outcome-oriented, trans-disciplinary and trans-sectoral research on CC benefits from vulnerability frameworks applied to CC impacts pathways (exposure, resilience and incidence). It is often challenging to conciliate large-scale and often ambiguous CC information (including from modeling) with local adaptation needs and capacities.

On a more general level, lessons from ecohealth tell us that "change" is not an automatic result of good research ("I do research, so change for the better will

happen"). New knowledge may be used as evidence to inform policy and action; 'policy' may request new knowledge to address an urgent need; and, most efficiently, collaborative exchanges and platforms between these audiences can promote and sustain innovation in research and development. It also helps if a project formulates, maps out, and documents its strategy to influence change.

Networks for research collaboration can be used for policy advocacy; a communication and dissemination strategy can be built into a research project that systematically introduces research into the policy process (beyond scientific publication and policy briefs). Combining rigorous empirical approaches with flexible, context-specific methodological and strategic protocols remains a major, practical as well as epistemological challenge.

Title: **Statistical modeling for the synthesis of social, environmental and health outcome data**
Speaker: Peter Diggle, Lancaster University

The development of effective disease control strategies requires a quantitative understanding of the combined effects of exposure to multiple risk factors. Often, the detailed mechanisms through which exposure leads to disease are imperfectly understood and available data sources are inadequate to parameterise a mechanistic model. In these circumstances statistical modeling has an important role to play, by formulating and parameterising empirical models of the association between exposures and outcomes whilst acknowledging and quantifying the levels of uncertainty that should be attached to model-based predictions.

A very simple example from an undergraduate physics classroom experiment to show how empirical statistical modeling connects with scientific method was presented. A description, using examples from tropical disease epidemiology, was presented on how the same general approach can be used, albeit in a technically more sophisticated form, to model spatial and/or temporal variation in disease risk.

Title: **Capacity building for climate change adaptation in public health: what are the realities?**
Speaker: Sheba Gitta, African Field Epidemiology Network

While the spread of disease is known to be an interaction between the agent, host and environment, there are inadequate public health interventions targeting the environment. Consequently, vector-borne diseases such as malaria and plague, as well as many emerging epidemic prone diseases like Ebola, continue to thrive, especially in sub-Saharan Africa. This is aggravated by weak public health systems in many African countries.

The African Field Epidemiology Network (AFENET) is a networking and service alliance of field epidemiology and laboratory training programs (FELTPs) with presence in 20 African countries. It is dedicated to helping African ministries of

health build strong, effective and sustainable public health systems through training and networking.

AFENET employs a multipronged capacity building model consisting of training and service delivery. Our training programs are competency based with 70% of the time spent in the field to facilitate "learning by doing". Trainees are involved in surveillance and outbreak investigations. They also conduct operational research projects that address local needs. The trainings range from two year FELTPs, a MSc. applied veterinary epidemiology program and postgraduate fellowships, to short courses. Trainees have varied professional backgrounds: medical doctors, laboratory scientists, veterinarians, environmental health scientists and social scientists. These graduates constitute a pool of multidisciplinary public health expertise to address cross-cutting public health issues at local, national and regional levels.

AFENET in partnership with the International Research Institute for Climate and Society (IRI) is exploring funding opportunities to allow for incorporation of IRI's Climate Information for Public Health curriculum into its existing training programs to better address climate change in the public health arena.

Some of the challenges that need to be addressed as we seek to transcend disciplines and work as one multidisciplinary team towards climate change adaptation include: overcoming funding gaps by advocating for funding from African governments and leveraging of existing vertical funding e.g. President's Emergency Plan for AIDS Relief (PEPFAR) to address the broader issues of climate change on vector borne diseases burden; identifying mechanisms for incorporating climate training in curricula of different sectors and empower researchers from different sectors to build skills in multidisciplinary research project implementation.

Title: **Taking advantage of existing networks to understand the social, environmental and climate change impacts on vector-borne diseases in Southern Africa**
Speaker: Moses Chimbari, University of Botswana

Southern Africa harbors a wide range of vectors that transmit diseases. The burden of diseases transmitted by the vectors is determined by socio-economic, environmental and climate related factors. Poor communities in rural areas and some in urban areas do not have access to safe water and hence rely on natural water sources (streams, rivers, ponds, dams) which pre-dispose them to diseases like schistosomiasis. The same poor communities often do not have good housing that protects them against bites from malaria transmitting mosquitoes. Environmental changes due to developmental activities like road construction and livelihood activities like farming and mining generally create habitats suitable for disease transmitting vectors. Climate variability and change influence both socio-economic and environmental factors resulting in changes in abundance and distribution of vectors. Until recently, most studies on vector borne disease

addressed socio-economic and environmental factors either jointly or separated, while few made analyses that factored climate change or/and variability aspects, leaving it at the level of weather parameters like humidity, temperature and rainfall. Mapping of studies on climate change and health conducted by Dube and Chimbari (2009) showed that much of the work on climate change and health in southern Africa was done by networks rather than institutions. The study also confirmed that the linkages between health and climate change were not studied in detail and that became the major justification for establishing the Southern Africa Climate Change Network (SACCNet) which brings together scientists interested in the linkages between water, health, food security and climate change. There are other networks that have a diverse membership with potential to carry out trans-disciplinary research that can improve knowledge on the impacts of social, environment and climate change on public health with special focus on vector borne diseases. The presentation introduced relevant networks for workshop objectives, focused on how the networks can be utilized to carry out research across countries in a cost effective way, and indicated the nature and extent of support that is required to achieve that.

Title: **National plan for adaptation to the adverse effects of climate change on health in Mali: experience and perspectives for vector-borne diseases**
Speaker: Seydou Doumbia, Malaria Research and Training Centre

It is widely recognized that climate changes have negative effects on health, including the increase of the transmission of vector borne diseases. Least Developed Countries (LDCs), with the highest burdens of these climate sensitive diseases and larger vulnerable populations, are likely to experience significant negative impacts of climate change without immediate and adequate adaptive (i.e. preventive) measures. With a view to minimizing adverse effects on public health and undertake measures to mitigate or adapt to climate change, Mali has signed the United Nations Convention on Climate Change. The framework of this convention provided an important legal basis for creating a framework for dialogue and exchange between different actors around the national management committee of climate change. We presented the national plan for adaptation to the adverse effects of climate change on health. The specific objectives of this plan are: 1] to improve knowledge on the impacts of climate change on health; 2] increase the awareness of people and policy-makers of the health risks from climate change; and 3] to strengthen national capacities for adaptation to the adverse effects of climate change on health. Intervention strategies of this plan include: a] assessments of the risks posed by climate variability and change on population health and health systems; b] integrated environment and health surveillance; c] the establishment of a framework for dialogue and exchange between key stakeholders; d] the conduct of research on the epidemiology of climate sensitive diseases (vector-borne diseases, diarrhea, respiratory infections, heat stress, trauma related to extreme climatic events, etc.); and e] to strengthen human and institutional capacities and inter-sectoral coordination. Experiences on research on climate change and malaria in Mali were also presented.

Title: **Climate information for public health**
Speaker: Madeleine Thomson, IRI

There is high level recognition that climate is a major concern for public health. However, few institutions or practitioners are equipped to understand the impact of climate variability and change on health, or proactively prevent and manage the consequences. In part, this is due to a critical lack of relevant applied research, and capacity building that would enable public health experts to understand the consequences of climate on the outcomes they care about and spur the creation of the requisite evidence for changes in policy. Climate must be considered pragmatically; as both a resource and challenge that must be understood and used within a broad development approach where human health and wellbeing is the ultimate outcome. The time is ripe for a new climate and health paradigm wherein 1) long-term partnerships are established to ensure the rational delivery of climate analyses and services tailored to the needs of public health decision-makers focused on the health of the poorest; 2) the next generation of climate specialists and public health experts are trained to work on a common agenda towards measurable improvements in health outcomes; 3) and the climate community is identified, and performs, as a key public health partner. The "Climate Information for Public Health Action" training, communication and knowledge network was presented.

Key points from session:

- IDRC is an example of an integrated and transdisciplinary approach to research for development. The Ecohealth Program at IDRC encapsulates the holistic vision of health represented in the WHO Constitution and the 1992 Rio Declaration and Agenda 21. Mainstreaming and building fields/networks of communities of practice are more important than reliance on a single donor and grants on individual local projects.

- Discussion on how we can apply this approach in the "real world" – more specifically, I think scaling up and linking to the large scale policy processes.

- Models are not perfect predictors, but useful devices for answering well-defined problems. Aim for simplest model. Where assumptions are made, they need to be well supported by theory, otherwise just work with the empirical data.

- Importance of focusing on the right question rather than an exact answer to the wrong question, and of building partnerships across disciplines, and non-statisticians to "think statistically", rather than training to do statistics.

- AFENET is an example of an initiative to build field epidemiology and public health laboratory capacity. Emphasis should be on surveillance and outbreak investigation and tiered training, from short courses through to post-FELTP

fellowships, including now One Health fellowships. Partnership across disciplines, covering 20 countries throughout Africa.

- Need to advocate to access funding from national government, vertical health funds and private sector. Mechanisms proposed to incorporate climate into the FELPT curriculum, and bring very large capacity of FELTP to bear on emerging climate, environment and health problems.

- Climate change should be seen as just one contributory factor, so that not everything is blamed on climate change. Different levels of vulnerability to extreme events in Africa should be highlighted.

- Operational programmes should develop early warning systems, rather than focus on long-term change.

- Training programmes should apply IRI data library to real problems—such as malaria epidemic preparedness in Southern Africa. The international IRI intensive course, focuses on the approach, and understanding the data, rather than going straight into analysis while also building a community of practice over time in countries around the world.

- Veterinary scientists can be linked into the use of climate information to promote One Health approach.

- Environmental management should be included as a cross-sectoral intervention, including the Ministry of Environment on the country task team.

- There is a barrier of having to pay US$ 6000 for climate data from national meterological services to access relevant data in Mali but anopportunity to link the experience from Ethiopia in working with meterological services to interested countries such as Mali.

Summary of parallel breakout sessions

27 February 2012 14:00-17:30 and 28 February 2012 9:00 -12:00

Participants were divided into three multi-disciplinary groups and asked to reflect on the following questions, identifying five top recommendations for each question.

1. What gaps in scientific evidence are there for the effects of social, environmental and climate change on vectors and vector-borne diseases in Africa (drylands) and how could these gaps be filled?
2. What are the priority research capacity strengthening needs in the African drylands aimed at enabling public health adaptation to the effects of the social, environmental and climatic changes on vector-borne diseases?
3. What are the mechanisms for the provision of research/technical support to meet the regional and country needs identified above?
4. What are the gaps for connecting research to policy and practice and how can they be filled?

Group 1

Discussion Leader: Samson Mukaratirwa
Rapporteurs: Jakob Zinsstag

Participants:

Diarmid Campbell- Lendrum
Pietro Ceccato
Francis Dodoo
Mark Eisler
Dia Elnaiem
Asefaw Getechew
Kinfe Hailemariama
Issiaka Sombie
Yeya Toure

Session recommendations

Question 1: What gaps in scientific evidence are there for the effects of social, environmental and climate change on vectors and vector-borne diseases in Africa (drylands) and how could these gaps be filled?

- Gap: Lack of conceptual frameworks of the full range of spatio-temporal climatic, environmental and social drivers and their interactions with vector borne diseases.

  How to fill it: Contextualize social-ecological-climate systems (human-environment-climate systems).

- Gap: Knowledge of the vulnerable populations and their behaviour.

  How fill it: Identify vulnerable populations and their behaviour and the risk factors.

- Gap: Lack of equity effectiveness of health interventions and their dependence on climate change (sanitation, vector control).

  How to fill the gap: Develop innovative interventions assessing social equity and resilience to climate change (equity effectiveness loop[6]).

- Gap: Lack of understanding of vector dynamics, transmission dynamics of pathogens and vector-pathogen interaction and climate dependence.

  How to fill it: 1) Time series data on vector and transmission dynamics and climate data; 2) Field and laboratory studies on the effect of climatic drivers (temperature, humidity, etc.) on vectors and pathogens;3) Models explaining the long-term effects of climatic drivers on vectors and pathogens.

- Gap: Need for reliable climate change indicators.

  How to fill the gap: Determine most appropriate indicators for climate change.

- Gap: Lack of algorithm to integrate climate indicators and model proxy data to understand climate change in relation to vector dynamics.

  How to fill the gap: Develop, test and validate models for climate indicators in relation to vector dynamics and disease transmission.

Question 2: What are the priority research capacity strengthening needs in the African drylands aimed at enabling public health adaptation to the effects of the social, environmental and climatic changes on vector-borne diseases?

- Lack of quantitative and qualitative skills:

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[6] Tugwell P, de Savigny D, Hawker G, Robinson V (2006). Applying clinical epidemiological methods to health equity: the equity effectiveness loop. *British Medical Journal*, 332: 358-61.

- Need for climatologists, meteorologists, statisticians, epidemiologists, entomologists andpublic health specialists able to plan, generate data, analyse, interpret and use results.

- Need for anthropologists, social scientists and economists capable of addressing socio-economic and cultural determinants of vector-borne diseases and perceptions of climate change.

- Lack of supporting mechanisms and teams of scientists with capacity to work across disciplines.

    - Need for short-term training in relevant disciplines related to vector-borne diseases and climate change (FELTP, HIA, One Health, etc).

      Incentives to create interdisciplinary networks.

Question 3: What are the mechanisms for the provision of research/technical support to meet the regional and country needs identified above?Develop communities of practice bringing the above mentioned scientists, communities and authorities together. (e.g. COPEH).

- Foster networking between communities of practice.

- Provide access to (online) medical and climate literature and training documents (HINARI).

- Advocacy for financial support from government/NGO/international community for training in research methods.

- Provision of tools and software that are easily accessible for data management and data analysis.

- Facilitate linkages with institutions working with satellite data.

  Work towards African centres of excellence.

Question 4: What are the gaps for connecting research to policy and practice and how can they be filled?

- Weak/inadequate communication between communities and their respective leaders, government authorities and scientists.

- Insufficient or inadequate engagement of all stakeholders including researchers in policy formulation (iterative process of commenting and formulating policy between legislator and stakeholders, REACH policy-research cycles).
    - Lack of review of valid research results and their translation into policy and practice.

- Insufficient/inadequate involvement of the health sector in the climate policy debate and support mechanism.
- Lack of evidence driven policies.
- Policies which do not address local needs.

How to fill the gaps:

- Involve communities, authorities and scientists from the beginning in the research process.

- Regular meetings between researchers and policy makers/process of interaction between scientists and policy makers.

- Promote intervention research (action research).

- Address local priorities over donor priorities (research for development).

- Incorporate research results in policy making mechanisms (legislation or standard operating procedures). Convert policy in effective practice.

- Create political demand for research results.

- Share information/communication between all actors (convert research papers into policy briefs). Train science journalists.

Additional discussion

Participants agreed on the above recommendations, but there was also debate on:

- Incentivise senior researcherś involvement or research students in analysis, publication and conference presentation of research results
- Better investment in students
- More horizontal research structures
- Make research more effective

Group 2

Discussion Leader: Judy Omumbo
Rapporteurs: Derek Willis

Participants:

Dan Boakye

Peter Furu
Michel Jancloes
Narcis Kabatereine
Lucien Manga
Barbara Ntombi Ngwenya
Suad Sulaiman
Lee Willingham
Pascal Yaka

Session recommendations

Question 1: What gaps in scientific evidence are there for the effects of social, environmental and climate change on vectors and vector-borne diseases in Africa (drylands) and how could these gaps be filled?

- Review of historical climate to gain insight on past climate variability and change.
- Make an inventory of interventions for VBDs across human and animal and health in dryland areas.
- Make an inventory of partners, government, research institutes and stakeholders.
- Review WHO thematic reports coming out on climate change and health.
- Develop updated disease maps of VBDs in these areas.
- Conduct a situation analysis of the above.

Question 2: What are the priority research capacity strengthening needs in the African drylands aimed at enabling public health adaptation to the effects of the social, environmental and climatic changes on vector-borne diseases?

- Assessment and mapping of national level research capacity.
- Promote capacity strengthening in disciplines relevant to the concept of One Health and ecosystems health e.g. incentivizing researchers to take up studies in this area.
- Development of GIS modules that can be applied across disciplines.
- Promotion of research from a trans-disciplinary perspective.

- Research on current local coping and adaptation strategies within Africa's drylands.

Question 3: What are the mechanisms for the provision of research/technical support to meet the regional and country needs identified above?

- Develop national reference units that define national research priorities.
- Promote more strategic south-south and south-north partnerships and research and control networks that are already in existence.
- PPPs to support the research environments.
- Promote a mechanism for regional disease research and control networks across Africa.
- Develop regional Communities of Practice supported by regional networks in VBD research and control.

Question 4: What are the gaps for connecting research to policy and practice and how can they be filled?

- Promote the approach of Getting Research Into Policy and Practice (GRIPP) using appropriate communication tools e.g. incorporation of policy briefs in research publications.
- Develop a research communicating strategy e.g. to have a research communication office and specialist within the national research institutes, in the relevant ministries and within implementing projects.
- Incorporate a research agenda outlining priority research areas within disease control strategies.
- Engage policy makers throughout the research process.
- Document best practice in One Health approaches to VBD research and control.

Group 3

Discussion Leaders: Cheikh Kane/Madeleine Thomson
Rapporteurs: Peter Diggle

Participants:

Moses Chimbari

Seydou Doumbia
Sheba Gitta
Delia Grace
Oulie Keita
Charles Muchunguzi
Johannes Sommerfeld
Martin Wiese

Session recommendations

Question 1: What gaps in scientific evidence are there for the effects of social, environmental and climate change on vectors and vector-borne diseases in Africa (drylands) and how could these gaps be filled?

- Health impacts of adaptation strategies to climate change, e.g Great Green Wall project in the Sahel, trans-frontier conservation areas in southern Africa.
- Where vector-borne diseases fit in a context of vulnerable populations experiencing multiple diseases and shocks, e.g refugee camps in Ugandan drylands, pathways to vulnerability and resilience.
- Incomplete understanding of the eco-epidemiology of important vector-borne diseases (e.g leishmaniasis, rift valley fever) and their adaptation to changing environments, including data and diagnostics.
- Research on more effective methods for communicating scientific results to stakeholders including but not restricted to use of new technologies.
- Social and economic valuation and prioritisation of vector-borne diseases and control options.

Question 2: What are the priority research capacity strengthening needs in the African drylands aimed at enabling public health adaptation to the effects of the social, environmental and climatic changes on vector-borne diseases?

- Skills for proposal development and writing for competitive grants.
- Building capacity of graduate scientists (especially post-doctoral) so they can perform at high level and lead and manage research groups.
- Understanding paradigms from other disciplines to enhance dialogue in inter-multi-trans disciplinary teams.
- Improving the level of understanding of climate change issues among public health researchers.
- Statistical thinking and the application of statistical principles to thinking about science.
- Skills for 'research into use': understanding how to translate scientific outputs into changes in policy and practice.

Question 3: What are the mechanisms for the provision of research/technical support to meet the regional and country needs identified above?

- Advocacy for funding support to mobilise existing and additional research capacity.
- Consortia (funding, networking) for supporting multi-country studies/communities of practice.
- Specific support for purchasing and procuring bio-technology equipment and reagents.
- Platforms and facilitated access for e-learning across a range of capacity-building needs.
- Policies across sectors to allow the sharing of medical, veterinary and other laboratory and research resources in line with the One Health concept.
- Provision of models, tools and inter-sectoral policies and incentives for improving surveillance of health and climate, and sharing of data.
- Services or other mechanisms that can translate the findings of research into practical advice useful to other actors (policy, program, private sector).
- Scientific meetings for sharing of research findings.

Question 4: What are the gaps for connecting research to policy and practice and how can they be filled?

- Poor governance environments impede evidence-based policy and translation of good policy into practice
    - Solution: 'Work around' poor governance. e.g. provide incentives (not only monetary) both to build engagement and also to encourage stakeholding and long-term thinking, and/or link with other initiatives that focus on improving governance

- Disconnect between research evidence and emergency responses
    - Solution: Understand needs of emergency response services and develop channels for two-way influence and communication

- Vulnerable populations, eg women and children, may be under-served, and have specific health needs that are not always met by generic programs
    - Solution: Research programs should document a disadvantaged/ gender strategy and monitor its implementation

- Problems are multi-faceted, but responses are typically sectoral leading to deficiencies and inefficiencies
    - Solution: Build inter-sectoral systems and approaches where appropriate
- Policies outside the health sector have unconsidered impacts (positive and negative) on health

- Solution: Assessment of impacts not just before but also during and after implementation of major policies, programs and projects

Additional Discussion:

General principles:

1. focus on vector-borne diseases in the drylands of Africa
2. because small changes in large-scale climate patterns induce large changes in micro-environments at particular times of year
3. combining and integrating social and natural science expertise
4. problem-driven rather than tool-driven research
5. inclusivity in chain of events from problem formulation, through research to decision-making, linking science with society
6. cognizant of and compatible with current and emerging national and regional health and environment policies (eg vector-borne disease elimination)
7. understanding leading to action/intervention

Topics:

1. Acute effects of extreme weather events on vector-borne disease in poor urban (and/or rural) environments: prediction; prevention; mitigation; control.
2. Impact of re-forestation/agro-forestry on emergence and re-emergence of vector-borne diseases
3. Understanding health impacts of (a) endogenous responses (direct action by affected communities, eg large-scale movements of people and animals) and/or (b) policy responses, including review of the impact on long-term population health of inter-annual climate variation, political instability and their interactions
4. Wildlife-livestock-human interactions in resource-scarce settings (eg emerging zoonoses around water-bodies)
5. Better understanding of the eco-epidemiology of important vector-borne diseases (eg leishmaniasis, rift valley fever) and their adaptation to changing environments
6. Understanding barriers to translating research findings into policy and action.

Final recommendations

1. ***Recommendations to fill the evidence gaps (and associated data needs) for the effects of social, environmental and climate change (including climate change adaptation) on vectors and vector-borne diseases in the African drylands.***

- Contextualize social-ecological-climate systems (human-environment-climate systems) within an overarching framework by mapping the full range of spatio-temporal climatic, environmental and social drivers for VBDs.

- Undertake studies of geo-referenced time series data (historical and prospective) linking vector and transmission dynamics to climate, environmental and social data.

- Undertake field and laboratory studies on the effect of localised climatic, environmental and social drivers of VBDs.

- Develop statistical and biological models that can explore the short and long-term effects of climate, environmental and social drivers on VBDs.

- Conduct situation analyses to identify vulnerable population groups experiencing VBDs and other health issues and shocks (e.g. conflict).

- Investigate the risk factors of vulnerable population groups and undertake research on the mechanisms of their vulnerability and opportunities for increased resilience.

- Develop innovative interventions assessing social equity and resilience to VBDs that are driven by climate, environmental and social change.

- Promote availability, access and use of quality assured climate, environmental, social and VBD data for use in policy relevant analysis.

- Undertake research on the impact of historical large-scale climate changes (e.g. Sahel drought) and their impact on VBDs.

- Determine the most appropriate indicators for climate, environmental and social change in the drylands and develop, test and validate models for these indicators in relation to VBD transmission dynamics.
- Undertake research on the health impacts and associated burden of disease of VBDs that results from sectoral adaption strategies to climate change using impact assessment methodologies.

- Undertake research to understand local coping/adaptation strategies and assess their value for public health strategies.

- Undertake research on more effective methods for communicating scientific results to stakeholders including but not restricted to the use of new technologies.

2. ***Priority research capacity strengthening needs aimed at enabling public health adaptation to the effects of the social, environmental and climatic changes on vector-borne diseases.***

- Assess and map the national level research capacity and develop a plan of action to implement capacity building that fills identified gaps in key skilled (including quantitative and qualitative skills) personnel (including climatologists, meteorologists, statisticians, epidemiologists, vector biologists, public health specialists, social scientists and veterinarians) able to plan, generate data, analyse, interpret and use results.

- Train to understand the management and analysis of disparate data sets share data across disciplines and document data (meta data). This includes data and products derived from climate observations, model outputs and remote sensing as well as socio-economic and epidemiological data. This should also involve strengthening 'statistical thinking' as a key to working across quantitative disciplines.

- Train to understand the paradigms from other disciplines to enhance dialogue in inter-, multi- and trans-disciplinary teams. This includes capacity of public health researchers to understand climate change issues and research capacity within forecasting, preparedness and response of national disaster risk reduction plans.

- Build research capacity among social scientists (including anthropologists, sociologists, policy researchers and economists) to address social determinants of vector-borne diseases and climate change.

- Promote capacity strengthening in disciplines relevant to the concept of One Health and Ecosystems Health e.g. promoting researchers to take up studies in this area through incentives such as scholarships, training opportunities, etc.

- Strengthen research capacity on the impact of policies on local coping and adaptation strategies within Africa's drylands.

- Develop open-source spatial and temporal technologies, such as GIS, that can be applied across disciplines for the storage, management, analysis and visualization of data and results.

- Foster the next generation of exceptional research group leaders by building capacity of doctoral scientists (especially post-doctoral career track).

- Foster supporting mechanisms and create an enabling environment for teams of scientists with the capacity to work across disciplines in a multi-, inter- and trans-disciplinary way using, for example, incentivised networks, seed funding promotional opportunities and visibility.

- Promote short term training in relevant disciplines related to vector-borne diseases and climate change (FELTP, HIA, One Health, Climate Information for Public Health Action, etc).

- Strengthen skills of researchers for 'research into use', understanding how to translate scientific outputs into changes in policy and practice (outcomes).

3. Research and technical support to address regional and country needs identified.

- Foster strategic networks of multi-disciplinary "Communities-of-Practice" (COPs), including established south-south and south-north partnerships, e.g. network scientific meetings should be specifically designed to share research findings within an inter-disciplinary research paradigm.

- Foster consortia to mobilize existing and additional resources for multi-country studies.

- Develop platforms for knowledge repositories, knowledge sharing and facilitated e-learning across a range of research and capacity building needs.

- Advocate for financial support from government/NGOs/international community/public-private partnerships (PPPs) for research and research capacity building.

- Provide data, methodology and tools for enabling multi-, inter- and trans-disciplinary research.

- Facilitate linkages from climate, environmental and social data-generating institutions to this research initiative.

- Support continuing development of African centres of excellence, e.g. the Pan-African University.

- Strengthen the capacity of existing national and local research institutions to serve as reference centres on specific topics relevant to national and regional government needs.

- Develop inter-sectoral guidelines and advocacy of policies for sharing data in line with One Health.

4. The linkage of research to policy and practice.

- Improve communication between communities and their respective leaders, government authorities and scientists through a continual researcher-stakeholder process of reviewing research needs and existing policies and programmes (such as national climate change adaptation plans or control programmes for VBDs) to develop a priority research to policy agenda followed by continuous assessment of its implementation and outcomes (e.g. REACH policy-research cycles).

- Foster inter-sectoral policy systems and research approaches as appropriate.

- Assess impacts before, during and after implementation of major policies, programs and projects, for example using health impact assessments.

- Document best practices in One Health approaches to VBD research and control.

- Foster evidence-based policy formulation and translation of good policy into practice by providing incentives (not only monetary) both to build engagement and also to encourage stakeholder involvement and long-term thinking, and/or link with other initiatives that focus on improving governance.

- Develop a research communication strategy e.g. to have research communication capacity within the national research institutes, in the relevant ministries and within implementing projects.

- Develop a web-based approach to sharing information in a format that is most appropriate for policy-makers.

- Promote knowledge translation through the approach of Getting Research Into Policy and Practice (GRIPP) using appropriate communication tools, e.g. incorporation of policy briefs in research publications, training of science journalists, and etc.

- Stimulate the incorporation of assessed and validated research results in existing policy-making mechanisms (legislation or standard operating procedures), to convert policy into effective practice.

- Support the incorporation of the needs of particularly vulnerable groups, e.g. women and children, in both research and policy based on an equity/gender strategy whose implementation should be continually monitored.

Closing remarks

Closing remarks were given by Madeleine Thomson (IRI), Yeya Touré (WHO/TDR), Lee Willingham (WHO/TDR) and Abere Mihretie (Health, Development and Anti-Malaria Association/CHWG).

Madeleine Thomson thanked the participants and indicated IRI would support the final report to ensure background documentation, policy issues and best contributions of the meeting were represented and captured well to support WHO/TDR in its program implementation.

Yeya Touré clarified the final document will inform WHO/TDR activities, target a wider WHO audience and hopefully support the efforts of the wider group. He recognized the challenge to summarize key recommendations and conclusions, but underscored the tremendous efforts of the group to present their work through plenary and discussions, building on previous meeting recommendations and policy frameworks, with the aim of identifying gaps on integrating and transcending disciplines for policy and practice. He expressed his commitment to identifying mechanisms to ensure research is useful to policy, countries and implementation programmes. To support specific country needs, he added that a call for letters of intent would be issued in the near future soliciting different groups to come together at the beginning from multi-/trans-/inter- disciplinary research to advance national adaptation programmes. He concluded by thanking the participants and partners for their contributions and recommendations and added a special thanks to Abere Mihretie and his colleagues for their support as organizing hosts.

Lee Willingham added his thanks to the participants, IRI and CRED team for their help in organizing and supporting the meeting.

Abere Mihretie closed the meeting with his thanks for the collaborations and expressed a wish for the group to stay in touch and develop partnerships.

Appendix

Appendix 1: Agenda

World Health Organization

TDR For research on diseases of poverty
UNICEF • UNDP • World Bank • WHO

In collaboration with

Canada's International Development Research Centre (IDRC)

IDRC CRDI
International Development Research Centre
Centre de recherches pour le développement international

and

Columbia University's

International Research Institute for Climate and Society (IRI)

IRI

TDR Informal Expert Consultation for

Assessing Research and Capacity Needs

"Adaptation to Social, Environmental and Climate Change Impacts on Vector-Borne Diseases in Africa"

Addis Ababa, Ethiopia

27-29 February 2012

Hosted by

Climate and Health Working Group

Health, Development and Anti-Malaria Association, Addis Ababa, Ethiopia

Adaptation to Social, Environmental and Climate Change Impacts on Vector-Borne Diseases in Africa

An Informal Expert Consultation convened by the UNICEF/UNDP/World Bank/WHO Special Programme for Research and Training in Tropical Diseases

Addis Ababa, Ethiopia

27-29 February, 2012

AGENDA

Day 1 **Adaptation to Social, Environmental and Climate Change Impacts on Vector-Borne Diseases**		**PRESENTERS**
Session I **09:00 - 10:30**	**Introduction, Scene Setting and Expected Outcomes**	Chair: Yeya Touré Rapporteur: Johannes Sommerfeld
9:00-9:05	- Welcome Anti-Malaria Association	Abesha Ferede
9:05-9:15	-Welcome WHO TDR	Yeya Touré
9:15-9:20	- Welcome IDRC	Martin Wiese
9:20-9:25	- UNECA/ACPC Remarks	Youba Sokona

9:25-9:30 9:30-9:45 9:45-10:00 10:00-10:15 10:15-10:30	- Introduction to meeting -Global research priorities on health and climate change - Public health adaptation to climate change in Africa: Health Sector's Plan of Action 2012-2016 - Contribution of international agricultural research to the control of human vector borne disease in Africa - Climate and health in Africa – 10 Years On	Lee Willingham Diarmid Campbell-Lendrum Lucien Manga Delia Grace Judy Omumbo
10:30 -11:00	**Coffee break**	
Session II **11:00 - 12:30**	**Country Experiences in** **Adaptation to Social, Environmental and Climate Change Impacts on Vector-Borne Diseases**	Chair: Lucien Manga Co-Chair: Michel Jancloes Rapporteur : Dia Elnaiem
11:00-11:05 11:05-11:20 11:20-11:35 11:35-11:50 11:50-12:05 12:05-12:20 12:20-12:30	- Introduction - Climate change adaptation for vector-borne diseases: a Southern Africa perspective - West African Health Organization perspectives on climate change effects in West Africa - Impact of changes in environment including climate and human geography on epidemiology of malaria and schistosomiasis in S.W.Uganda - Ethiopia perspective on adaptation to social, environmental and climate change impacts on vector-borne diseases - Discussion - Wrap up	Lucien Manga Samson Mukaratirwa Issiaka Sombie Narcis Kabatereine Asefaw Getachew Michel Jancloes
12.30-13:00	- The African drylands: key debate and emerging perspectives for the control of vector-borne diseases of humans and livestock in the context of climatic, environmental and social changes	Madeleine Thomson

13:00 -14:00	**Lunch break**	

Session III **14:00-15.30**	**Gaps and Opportunities in Integrating Environmental Research into Climate Change Adaptation for Vector-borne Diseases**	Chair: Peter Furu Co-Chair: Dan Boakye Rapporteur : Delia Grace
14:00-14:20	- Adaptation to development and climate change induced impacts on vector-borne diseases - the potential role of Health Impact Assessment	Peter Furu
14:20-14:35	**-** Environmental changes and vector-borne diseases: lessons from Ghana	Daniel Boakye
14:35-14:50	- Environment, agriculture & infectious diseases: Assurance for healthy sustainable development	Suad Sulaiman
14:50-15:05	- Climate and visceral leishmaniasis in Southern Sudan and Sudan: current problems and research priorities	Dia Elnaiem
15:05-15:30	- One Health: practical examples of cross-sectoral collaboration, key actions and beyond	Jacob Zinsstag
15:30- 16:00	**Coffee Break**	
Session IV	**Gaps and Opportunities in Integrating Social Science Research into Climate Change Adaptation for Vector-borne Diseases**	Chair: Francis Dodoo Co-Chair: Johannes Sommerfeld Rapporteur: Derek Willis

16:00 – 16:05	- Introduction	Francis Dodoo
16:05-16:20	- An Ecohealth approach to flood recession (Molapo) farming to reduce climate change vulnerability in the Okavango Delta, Botswana	Moses Chimbari
16:20-16:35	- CILSS & MDGs Center: Great Green Wall Initiative for climate change adaptation	Oulie Keita
16:35-17:05	- Panel/roundtable discussion of experts	Johannes Sommerfeld Barbara Ngwenya Charles Muchunguzi Oulie Keita Moses Chimbari
17:05-17:25	- General plenary discussion	Derek Willis
17:25-17:30	- Closing remarks (5 minutes)	Johannes Sommerfeld
18:00-19:30	**Reception**	

Day 2 **Adaptation to Social, Environmental and Climate Change Impacts on Vector-Borne Diseases**		**PRESENTERS**
Session V **9:00-10:30**	**Gaps and Opportunities in Integrating Climate Research into Climate Change Adaptation for Vector-borne Diseases**	Chair: Cheikh Kane Co-Chair: Madeleine Thomson Rapporteur : Dan Boakye
9:00-9:05	- Introduction - Climate information for climate-informed health	Cheikh Kane

9:05-9:20	decision: What we know and what we still need to investigate	Cheikh Kane
9:20-9:35	- Climate variability and change across the African drylands	SylwiaTrzaska
9:35-9:50	- Improved availability, access and use of climate information in Ethiopia	Kinfe Hailemariam
9:50-10:05	- Climate, environment and perception of lymphatic filariasis and malaria in urban area of Ouagadougou: lessons from experiences at national and regional level in integrating climate information for vector borne diseases control.	Pascal Yaka
10:05-10:20	- Monitoring and integrating environmental information for infectious disease studies	Pietro Ceccato
10:20-10:30	- Wrap up	Madeleine Thomson
10:30 - 11:00	**Coffee break**	

Session VI **11:00-12:30**	**Transcending Disciplines for Policy and Practice**	Chair : Martin Wiese Co-Chair: Dia Elnaiem Rapporteur : Diarmid Campbell-Lendrum
11:00 -11:05	- Introduction	Martin Wiese
11:05-11:30	- Transcending disciplines for change in policy and practice: The evolution of ecohealth approaches	Martin Wiese
11:30-11:45	- Statistical modeling for the synthesis of social, environmental and health outcome data	Peter Diggle
11:45-12:00	- Capacity building for climate change adaptation in public health: What are the realities?	Sheba Gitta

12:00-12:15 12:15-12:30 12:30-12:40 12:40-12:45	- Taking advantage of existing networks to understand the social, environmental and climate change impacts on Vector-Borne Diseases in Southern Africa - National plan for adaptation to the adverse effects of climate change on health in Mali: experience and perspectives for vector-borne Diseases - Climate information for public health - Wrap up	Moses Chimbari Seydou Doumbia Madeleine Thomson Dia Elnaiem
12:45 – 13:00	**-** Introduction to Breakout Sessions	Barbara Platzer
13:00 - 14:00	**Lunch break**	
Session VII **14:00-17:30**	**Breakout Sessions**	Rapporteurs: Judy Omumbo, Peter Diggle, Jabob Zinsstag
14:00 - 15:30	- Breakout Groups	
15:30 - 16:00	**Coffee break**	
16:00 - 17:30	- Breakout Groups continue	
18:00 - 21:00	**Social Event**	

Day 3 Adaptation to Social, Environmental and Climate Change Impacts on Vector-Borne Diseases		PRESENTERS
Session VII **9:00-10:30**	**Breakout Sessions Continued**	
9:00 - 10:30	- Breakout Groups develop recommendations	
10:30 - 11:00	**Coffee break**	
Session VIII **11:00-12:30**	**Breakout Reports**	
11:00 - 12:30	- Report from Breakout Group 1 - Report from Breakout Group 2 - Report from Breakout Group 3	Judy Omumbo, Peter Diggle, Jabob Zinsstag
12:30 - 14:00	**Lunch break**	
Session IX **14:00-17:00**	**Open Discussion**	
14:00 - 15:30	- Overall discussion about the Breakout Groups' reports - Agreement on final recommendations for summary meeting report	

15:30 - 16:00	**Coffee break**	
	Conclusions	Chair: Yeya Touré Rapporteur: Barbara Platzer
16:00 - 17:00	- Conclusions by Organizers - Closure of meeting	

Appendix 2: Participant List and Biographies

Informal Expert Consultation:

Assessing Research and Capacity Needs for

Adaptation to Social, Environmental and Climate Change Impacts on Vector-Borne Diseases in Africa

Addis Ababa, Ethiopia

27-29 February 2012

LIST OF PARTICIPANTS

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Mr Abere MIHRETIE, Executive Director, Anti-Malaria Association, Addis Ababa, Ethiopia

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Dr Diarmid CAMPBELL-LENDRUM, Scientist, Evidence and Policy on Emerging Environmental Health Issues, (PHE/EPE), WHO, 1211 Geneva 27, Switzerland

Dr Yeya TOURÉ, Team Leader, Vectors, Environment and Society (TDR/VES), WHO, 1211 Geneva 27, Switzerland

Dr Johannes SOMMERFELD, Scientist, Vectors, Environment and Society (TDR/VES), WHO, 1211 Geneva 27, Switzerland

Dr Arve Lee WILLINGHAM, Scientist, Vectors, Environment and Society (TDR/VES), WHO, 1211 Geneva 27, Switzerland

Participant biographies

Dr Dan Boakye

Associate Professor of Entomology & Parasitology at the Noguchi Memorial Institue for Medical Research at the University of Ghana

Dan Boakye, PhD, is also a member of Ghana's National Task Force on Lymphatic Filariasis in addition to his teaching position at the University of Ghana. Dr Boakye received his PhD in medical entomology form the University of Leiden in the Netherlands and his masters in applied entomology and parasitology from the University of Jos in Nigeria. He has experience with both onchocerciasis and lymphatic filariasis.

Dr Moses Chimbari

Professor at University of Botswana

Professor Moses Chimbari has been appointed Africa's representative to the prestigious Ecosystems Services for Poverty Alleviation Programme (ESPA) Advisory Committee (I-PAC). The Programme aims to deliver high quality cutting edge research that will improve understanding on the way ecosystems function, the services they provide and their relationships with political economy and sustainable growth. Professor Chimbari brings to the fore a wealth of experience in research management having worked in various institutions in Southern Africa. His areas of interest are extensive: ranging from public health aspects on diseases like malaria and HIV to fisheries and limnology.

Dr Peter Diggle

Associate Dean for Research and CHICAS Group Leader, School of Health and Medicine, Lancaster University

Professor Peter Diggle's research concerns the development and application of statistical methods relevant to the biomedical and health sciences. Current methodological themes include: geostatistical analysis; spatial and spatio-temporal point processes; joint modelling of repeated measurement and time-to-event outcomes in longitudinal studies. Current areas of application include: real-time disease surveillance; environmental exposure measurement; tropical disease prevalence mapping; early diagnosis of primary renal disease; short-term forecasting of meningitis epidemics in sub-Saharan Africa. In addition to his substantive post in Lancaster Medical School, Prof Diggle is an Adjunct Professor of Biostatistics at the Johns Hopkins University School of Public Health, Adjunct Senior Researcher at Columbia University's International Research Institute for Climate and Society, Professor in the University of Liverpool's Department of Epidemiology and Population Health, a trustee for the Biometrika Trust, founding co-editor and member of the Advisory Board for the journal Biostatistics, Chair of the Medical Research Council's Strategic Skills Fellowships Schemes panel and a former member of the Medical Research Council's Population and Systems Medicine Board.

Prof Francis Dodoo

Director of the Regional Institute for Population Studies at the University of Ghana

Francis Dodoo also holds a research professorship as Professor of Sociology and Demography at The Pennsylvania State University. His intellectual interests focus on sub-Saharan Africa, where his research engagements lie specifically in gendered power in sexual and reproductive decision-making, and on demographic and health outcomes associated with urban poverty. He also has a serious interest in research capacity building on the continent. Professor Dodoo is widely published in leading international journals in sociology and demography, and he has received close to US$ 7 million in funding for his work over just the last decade from various sources including the National Institutes of Health (NIH), the William and Flora Hewlett Foundation, and the John D. Rockefeller Foundation, Economic and Social Research Council (ESRC)/Department for International Development (DfID), European Union, among others.

Dr Seydou Doumbia

Deputy Scientific Director of the Malaria Research and Training Centre

Professor Doumbia Seydou is a professor of Epidemiology in the Department of Public Health at the University of Bamako, Bamako, Mali. He is responsible for the MsPH training program in epidemiology, he is also the Deputy Director of the NIH/NIAID-University of Bamako Intramural Research Programs in the Malaria Research and Training Centre at the University of Bamako, Bamako, Mali. For more than 15 years he has been involved in several aspects of malaria and other infectious diseases research including leishmaniasis, schistosomiasis, and HIV/AIDS.

Dr Mark Eisler

Chair in Global Farm Animal Health, Bristol Veterinary School

Mark's areas of expertise include preventive veterinary medicine, epidemiology and control of infectious diseases of ruminant livestock, and veterinary public health, both in the UK and internationally, focusing particularly but not exclusively on vector-borne and parasitic disease. He has conducted research in the field of international animal health, including zoonotic diseases, and held a number of large collaborative grant awards. His main research interests are diagnosis, epidemiology and control of diseases of farmed livestock of economic importance. Three major research themes have included control of neglected zoonotic diseases, integrated control of vector-borne diseases and trypanocidal drug resistance. Earlier research focused on the epidemiology and control of major vector-borne protozoan diseases of livestock, including tropical parasites such as trypanosomiasis and tick-borne diseases.

Dr Dia Elnaiem

Associate Professor at University of Maryland Eastern Shore

Dr Dia-Eldin currently works in the Department of Natural Sciences at the University of Maryland. His previous work was at the Oak Ridge Associated Universities at the National Institutes of Health where he conducted research on biology of phlebotomine sand flies and transmission and epidemiology of leishmaniasis. He spent 15 years as a professor at the University of Khartoum in Sudan, where he taught courses on medical entomology, parasitology and basic

zoology and conducted research on the epidemiology of leishmaniasis and malaria. He received his PhD in Medical Entomology from the Liverpool School of Tropical Medicine.

Mr Peter Furu

Head of WHO Collaborating Centre on Health and Environment in Sustainable Development, University of Copenhagen

Peter Furu, MSc, MPH, is a Senior Adviser currently heading the WHO Collaborating Centre on Health and Environment in Sustainable Development at the DBL-Centre for Health Research and Development at University of Copenhagen in Denmark. He has more than 28 years of working experience in international health (Africa, South East Asia) from his position at DBL, which is based at the Faculty of Health and Medical Sciences, University of Copenhagen. Main duties are within research, education and consultancies in the areas of environmental health, health impact assessment (HIA), health related aspects of agricultural development and water resources development, health impacts of climate change, integrated schistosomiasis control and poverty and environmental health linkages.

Dr Asefaw Getachew

Malaria Control and Evaluation Partnership in Africa (MACEPA)

Dr Getachew is a graduate of Addis Ababa University, Ethiopia (Biology Diploma, 1980; Biology and Chemistry BSc, 1986), University of Liverpool, LSTM, Liverpool, UK (Applied Parasitology & Medical Entomology M.Sc. 1998) and Columbia University, New York, USA (Climate & Society, MA, 2005). He is currently working as a consultant for Malaria Control and Evaluation Partnership in Africa/Program for Appropriate Technology in Health (MACEPA/PATH-Ethiopia) since joining the organization in 2008. He has been responsible for coordinating the National Malaria Indicator Survey (MIS-2007) at the Carter Center-Ethiopia. He has also served as the division and department head of malaria and other vector-borne diseases control department at Tigray Regional Health Bureau and various posts within the Ministry of Health. He has undertaken various projects, the outcomes of which have been published in international journals.

Dr Sheba Gitta

Deputy Executive Director and Head of Science and Public Affairs of the African Field Epidemiology Network (AFENET)

Dr Sheba Gitta Nakacubo heads the Science and Public Affairs Unit at the African Field Epidemiology Network (AFENET) and is one of the Managing Editors of PAMJ. She has a Bachelors degree in Dentistry and a Master of Public Health from Makerere University, Uganda. At AFENET, Sheba serves as the Editor-in-Chief for AFENET's monthly newsletter, spearheads public relations, oversees new grants and initiatives, and provides scientific and technical guidance to the Executive Director and other technical staff in writing grant proposals, manuscripts and preparation of presentations. She works as an epidemiologist on AFENET's noncommunicable disease surveillance project. Prior to joining AFENET, Sheba lectured at Makerere University School of Public Health for five years where she

taught epidemiology, research methods, informatics, and scientific writing among others. She has vast experience in operational research and outbreak investigation. She has a keen interest in neonatal and child health, infectious disease epidemiology, noncommunicable disease epidemiology and health systems strengthening.

Dr Delia Grace

Veterinary epidemiologist at the International Livestock Research Institute (ILRI), Kenya

Delia Grace is a veterinary epidemiologist and food safety specialist at the International Livestock Research Institute (ILRI) in Nairobi, Kenya. She obtained her PhD from the Institute for Parasitology and Tropical Veterinary Medicine at the Free University of Berlin in Germany in 2006. Currently, her research work involves developing and managing risk-based approaches to animal diseases, particularly zoonoses (animal diseases that can be transmitted to humans), in developing countries. She has many different research interests, including training and capacity building, community-based animal health and participatory approaches, and animal welfare. Before joining ILRI as a postdoctoral scientist, Dr Grace worked for seven years in community-based animal health programs in Asia, East Africa and West Africa. She has written several papers and guides on participatory approaches to veterinary epidemiology. She has also developed and implemented training courses in participatory risk assessment and risk analysis for food safety

Kinfe Hailemariama

Meteorological Instruments and ICT Directorate Director of the National Meteorological Agency

Kinfe Hailemariama is the Meteorological Instruments and ICT Directorate Director of the National Meteorological Agency of Ethiopia. From 2006 - 2011, Kinfe was the head of the Data Management and Dissemination Department at the National Meteorological Agency of Ethiopia and prior to that he served as a meteorologist and Team Leader at the same agency. Kinfe holds a Master of Science in Climate Weather and Modeling from the Reading University, UK.

Dr Michel Jancloes

Health and Climate Foundation, Secretary

Michel is a senior consultant for WHO in Ethiopia, Iran, Mali, Sweden and USA; for the European Union in Benin; and for IDA/Dutch Cooperation in the Netherlands. From 2003 - 2005, Michel was a senior advisor of the WHO Director General (DG) in Geneva and prior to that was the WHO in Ethiopia and the representative of the WHO DG to the African Union, Addis Ababa. From 1988 to 1998, Michel was the Director of the WHO Department of Intensified Cooperation with countries in greatest needs. Michel has also held the posts of advisor in WHO DG office on Health Economics, Medical Officer in the World Bank, Washington DC. Michel's interests include sectoral approaches for integrated service delivery, in particular, related to Family Health; decentralized policies and strategies; and policy development including health issues and climate change, and dialogue with high level policy

makers and multimedia support. Michel holds doctorates in Medicine (surgery and obstetrics) and Public Health.

Dr Narcis Kabatereine

Senior Entomologist, Vector Control Division of the Ministry of Health in Uganda

Dr Narcis Kabateriene is an entomologist by training, one of four senior entomologists who respectively run the onchocerciasis, trypanosomiasis, lymphatic filariasis and schistosomiasis (bilharzia) control programmes in the Vector Control Division of the Ministry of Health in Uganda. Narcis' first degree was from the Makerere University in Kampala, and his second degree was from Nairobi University in Kenya. After several years in his position in the Vector Control Division he was awarded a scholarship to study for a PhD in epidemiology of schistosomiasis in Copenhagen University. He has been responsible for bilharzia control in Uganda for over ten years, but it is only now that he has funds for control, because previously the problem of bilharzia was not allocated money for drugs.

Dr Cheikh Kane

Technical Assistant, Projet de Vigilance et Gestion Intégrée du Risque Climatique en Afrique (ViGIRisC)/African Centre of Meteorological Applications for Development (ACMAD)

Cheikh Kane currently acts as a technical adviser in the African Center of Meteorological Applications for Development, based in Niamey for the project: "African Early Warning and Advisory Climate Services – AEWACS (ViGIRisC project)". The objective of the project is to enhance African countries' capacities for the prevention of risks and socioeconomic impacts related to climate variability, through the provision of products and services tailored for different areas, including health. Prior to joining ACMAD, Kane was managing international research programmes for the French Institute of Research for Development in France, the Pacific region (New Caledonia) then in west Africa. In particular, he coordinated, from 2005 to 2009, a consortium of 60 institutions involved in an international scientific project called the "African Monsoon Multidisciplinary Analysis - AMMA" project. One of the aims of this project was, inter alia, to provide the underpinning science that relates climate variability to issues like health in the west African region and the definition and implementation of subsequent relevant monitoring and prediction strategies. Prior to joining IRD he held a position at University Paris 13, France. Kane graduated from the University of Nice, France with a dual background in Geography and Economics.

Oulie Keita

Regional Partnership Development and Gender Manager, Millenium Development Goals – West and Central Africa Center

Oulie Keita is a graduate of the University of Regis, USA, (Master's degree in Nonprofit Management and Certificate in Program Management) and the University of Maryland, USA, (Bachelor of Science in International Relations). Over the years in her professional career, she has been active in various capacities, including project management, fundraising, proposal development, grant management,

communications, advocacy, reporting, financial management, and research. She has managed programmes and held consultancies with international organizations, bilateral and multi-lateral organizations, private firms, and non-governmental organizations based in America and in Africa.

Dr Charles Muchunguzi
Faculty of Development Studies, Mbarara Universitiy of Science and Technology
Charles Muchunguzi is a lecturer at Mbarara University of Science and Technology and is completing a PhD in Development Studies, specialising in Pastoralism Development. Using participant observation Muchunguzi collected anthropological data on the value attitudes of Bahima towards the Long Horn Ankole Cow. He took residence in Bahima Pastoralists community for a period of two years.

Dr Samson Mukaratirwa
Head of the School of Biological and Conservation Sciences, University of KwaZulu-Natal
Dr Samson Mukaratirwa has developed research interest and expertise in the epidemiology of gastrointestinal nematodes and trematodes of domestic and wildlife ruminants and applied malacology. In particular, he has focused his research in designing effective control programmes based on epidemiological data and use of geographical information systems as a tool for mapping and predicting parasitic diseases. He has also carried out extensive research work in parasitic zoonosis with special emphasis on trichinellosis and *Taenia solium* cysticercosis and has expertise in experimental parasitology involving these parasites. Dr Mukaratirwa is currently working on taxonomical status and biology of African amphistomes in domestic ruminants and wildlife supplemented by DNA analysis and parasitic fauna of free-range chickens in different South African ecological zones. He is also currently a WHO temporary adviser on neglected zoonotic diseases and member of the OIE-World Organization for Animal Health *ad hoc* team on parasitic zoonoses.

Dr Barbara Ntombi Ngwenya
Senior Research Fellow, Okavanga Research Institute (ORI)
ORI Senior Research Scholar Dr Barbara Ntombi Ngwenya has recently been promoted to Associate Professor. A graduate of the University of Michigan's School of Social Work, Professor Ngwenya taught in the Department of Social Work, University of Botswana prior to joining the Institute in 2003 as a cultural anthropologist specializing in natural resource management and conservation of the Okavango and other regional wetlands. Additional responsibilities have included the supervision of both local and international undergraduate and graduate students. Prof Ngwenya has also published extensively in the areas of sustainable rural livelihoods and development, HIV/AIDS, poverty and food (in) security, community-based natural resources management and indigenous knowledge systems and environment. She has presented over 45 research results to the academic community and policy makers around the world including Australia, Canada, USA, Portugal, Italy, Thailand, Korea, Uganda, Malawi, Swaziland and Botswana.

Dr Judy Omumbo

Wellcome Trust-Kenya Medical Research Institute (KEMRI)

Judy Omumbo holds a PhD in epidemiology (Oxford University) an MPH (Hebrew University, Jerusalem) and a Bachelor's degree in Dentistry (University of Nairobi). She began her career in epidemiology at the Centre for Public Health and Geographic Medicine, KEMRI/Wellcome Trust Collaborative Programme, Kenya. While there, she worked extensively on malaria risk mapping using empirical data and considering climatic and environmental drivers of malaria transmission. She was awarded a Wellcome Trust Prize for her PhD studies in 2000. Judy serves on the Scientific Advisory Committee of the World Wide Anti-malaria Resistance Network (WWARN) and the External Technical Advisory Group for AvecNet, a project on 'Targeting malaria by hitting the vector' that is led by the Liverpool School of Tropical Medicine and sponsored by the European Union.

Barbara Platzer

Assistant Director at the Center for Research on Environmental Decisions (CRED), the Earth Institute, Columbia University

Barbara Platzer is the Assistant Director at the Center for Research on Environmental Decisions (CRED), the primary social science unit within the Earth Institute at Columbia University. She contributes to the operational and strategic objectives of the center, supporting the work of over 20 active projects and serves as a key point of contact on programme implementation and grants management. Barbara has over seven years experience in project delivery, facilitation of international collaborations and partnerships, as well as grant and research proposal development. She has a proven track record of successful implementation of workshops, stakeholder meetings and training initiatives (including in Nairobi, Addis Ababa, Niamey, Geneva, Stockholm and New York) with expertise in resource mobilization, capacity building, reporting and public/private outreach. In her previous work with the Earth Institute's International Research Institute for Climate and Society as Africa Regional Programme Coordinator, Barbara facilitated climate adaptation strategies in Africa, at research and policy levels and across sectors (including in health, agriculture, index insurance and water) with a view towards buttressing the ClimDev-Africa process.

Dr Youba Sokona

Coordinator, African Climate Policy Centre (ACPC)

Youba Sokona is the Coordinator of the African Climate Policy Centre (ACPC) based in the United Nations Economic Commission for Africa. The ACPC is a joint initiative of the African Union Commission, the African Development Bank and the United Nations Economic Commission for Africa. He is also a co-chair of IPCC Working Group III. He was the Executive Secretary of the Sahara and Sahel Observatory (OSS) from June 2004 to May 2010. As a citizen of Mali, Sokona focuses on the energy, environment and sustainable development nexus and he has broad experience in Africa in policy development. Before joining OSS, he worked for the "Environnement et Développement du Tiers Monde," based in Dakar, Senegal. Prior

to that, he served as professor at Ecole Nationale d'Ingenieur of Bamako in Mali. Throughout his career, SOKONA has served in various advisory capacities to African governments. He has published several books and articles on the issues of energy, environment and development with a focus on Africa.

Dr Issiaka Sombié

Researcher, West African Health Organization

Dr Issiaka Sombié was born and raised in Burkina Faso. He received his medical degree from the University of Ouagadougou in 1994. He has worked since January 1995 in the research center called Centre MURAZ in the area of maternal and perinatal health (maternal and perinatal mortality, maternal morbidity, prevention of HIV transmission of maternal and infant, sexually transmitted disease, quality of care, improving maternal services utilization). He obtained his Master in Public Health in 2002 and completed his PhD in epidemiology in 2007 at the Public Health School of Brussels Free University. He also obtained many certificates in reproductive health at the Institute of Tropical Medicine (Belgium), at Bordeaux II University and at the Institute of Word Bank. In 1999 he became a research fellow at the Centre MURAZ and since 2007 has been an Assistant Professor at the medical school at Bobo-Dioulasso University (Burkina Faso). He is a member of many international societies including the Ditrame Study Group, GASP, West African network of surveillance of gonococci sensibility of antibiotics. He serves on the editorial boards of two journals. He is also secretary of the Association of the Health Sciences at Bobo-Dioulasso. During his career, Dr Sombie has authored more than 20 articles in peer-reviewed international journals. In September 2008, Dr Sombié became a professional officer of research at the West African Health Organisation, a regional health office for the 15 countries of the Economic Community of West African States. Dr Sombié's research interests include maternal mortality and morbidity, quality of care, sexually transmitted diseases, utilization of maternal health services and urology diseases linked with reproductive health.

Dr Suad Sulaiman

Health and Environment Adviser

Prof. Suad Mohamed Sulaiman graduated from the Faculty of Science, University of Khartoum, holds MSc (Medical Parasitology) from London School of Hygiene and Tropical Medicine and a PhD from University of Khartoum. She is a professor of parasitology with special training skills in scientific research methodology, ethics in research, proposal writing, editing of scientific material, community development, health and environment, water-borne diseases risks and prevention, health and sanitation for community development, project management, human parasitology surveys, biological transmission of tropical diseases, applied field research on water-borne diseases (mainly schistosomiasis, and malaria), developing and implementing cohort research plans, mentoring and training of research students and health personnel, laboratory management, and post-graduate teaching. She held the posts of research professor and adviser on health issues and co-ordination, Ministry of Science & Technology, research professor and director, Tropical Medicine Research Institute, National Centre for Research, Khartoum, Bilharzia

Research Unit, National Health Laboratories, and currently is the Health and Environment Adviser.

Dr Sylwia Trzaska
Associate Research Scientist, Center for International Earth Science Information Network (CIESIN)
Dr Sylwia Trzaska's research interests include climate variability in the tropical Atlantic on the regional scale including Southern America and Africa, with special focus on tropical areas, including the Nordeste, Sahel and Southern Africa. She is also interested in observed, re-analyzed and model data analysis on seasonal to decadal time-scales model sensitivity studies to boundary condition modifications, as well as decadal modifications of the major teleconnections in the tropical Atlantic region. She received her doctoral degree from Université de Bourgogne.

Dr Derek Willis
Fellow at the Center for Research on Environmental Decisions (CRED), the Earth Institute, Columbia University
Derek received his PhD in public affairs from the Woodrow Wilson School at Princeton University and an MPA/International Development degree from Harvard's Kennedy School. His doctoral work developed a systems thinking framework for enabling policy-makers to identify the most appropriate anti-malaria programs to implement in their communities. As an Earth Institute Fellow, he works with both the Center for Research on Environmental Decisions (CRED) and the International Research Institute for Climate and Society (IRI). His work with CRED uses a web-based malaria decision support system to examine how malaria policy-makers use information to make policy decisions. His research with IRI analyzes the impact of temperature and precipitation on malaria transmission.

Dr Pascal Yaka
Head of the Environment of Bioclimatology, Office of Civil Aviation and Meteorology General Direction
Prior to his current position, he was a Lecturer and Research Deputy at the Practical School of High Studies of Paris, worked as a Geographer at the University of Paris VII, and held several scientific positions as a Climatologist and Biometeorologist. Additionally, Dr Yaka has consulted for the World Bank and World Meteorological Organization, and has authored several peer-reviewed publications. He earned his Bachelors degree in Mathematics and Biology from Philippe Zinda Kabore High School in Burkina Faso, Engineering degree in Meteorology from Hydrometeo Training and Research Institute in Algeria, and PhD in Climatology from the Practical School of High Studies, Paris.

Dr Jakob Zinsstag
Deputy Head of the Department of Epidemiology and Public Health, Swiss Tropical and Public Health Institute
Jakob Zinsstag graduated with a doctorate in veterinary medicine on salmonella diagnosis at the Veterinary Faculty of the University of Berne in 1986. After his

studies, he worked in rural practice and as a postdoctoral fellow on trypanosomiasis research at the Swiss Tropical Institute. From 1990 to 1993, he led a livestock helminthosis project for the University of Berne at the International Trypanotolerance Centre in The Gambia. From 1994 to 1998, he directed the Centre Suisse de Recherches Scientifiques in Abidjan, Côte d'Ivoire. Since 1998, he has led a research group at the Swiss Tropical and Public Health Institute (Swiss TPH) in Basel on the interface of human and animal health with a focus on health of nomadic people and control of zoonoses in developing countries under the paradigm of "one medicine". He also holds a PhD in Tropical Animal Production from the Prince Leopold Institute of Tropical Medicine of Antwerp, Belgium and serves as Professor of Epidemiology at the University of Basel.

Organizers

Climate and Health Working Group, Anti-Malaria Association of Ethiopia

Mr. Abere Mihretie
Executive Director of the Anti-Malaria Association
Abere is the Director of the Ethiopian Anti Malaria Association (AMA). Founded in 1999 in Addis Ababa, the AMA is dedicated to creating a strong and self-reliant society that can easily protect itself from major communicable diseases and problems of reproductive health. Abere has dedicated his life to improving the well-being of Ethiopians. In addition to directing the work of the AMA, amongst other activities, Abere is chair of the Board of Directors of the Ethiopian Association for Voluntary Service, a Life member of the Red Cross & Red Crescent Society, The Children's Heart Fund of Ethiopia, the Family Guidance Association of Ethiopia, and a member of the Board of Directors of the Christian Relief and Development Association.

Mrs. Abesha Ferede
Board member of the Health, Development and Anti-Malaria Association, Addis Ababa, Ethiopia
Mrs Abesha Ferede is a medical technologist, served as head of clinical Laboratories at various hospitals and as manager of various private companies engaged in pharmaceutical business, participated in research work related to the possible causes of neonatal death in Ethiopia (handling the bacteriological aspect) under the medical faculty of A. A. University and is a member of the Ethiopian Medical Laboratory Technical Association and the Health, Development & Anti Malaria Association. She also serves as a voluntary chairperson of the board of Health, Development & Anti Malaria Association and member of the board of the Abebech Gobena Children Center.

International Research Institute for Climate and Society (IRI)

Dr Madeleine Thomson
Senior Research Scientist at the International Research Institute for Climate and Society (IRI)
Madeleine Thomson is a Senior Research Scientist at the International Research Institute for Climate and Society (IRI) with over 8 years of service in the management team as Director of Impacts Research, Chair of the Africa Regional Programme and Senior Advisor to the PAHO-WHO Collaborating Centre for malaria and other climate sensitive diseases. She currently leads the health portfolio at IRI. She trained originally as a field entomologist and has spent much of her career engaged in operational research in support of large-scale health interventions, mostly in Africa. Her research focuses on the development of new tools for improving climate sensitive health interventions (e.g. risk mapping and early warning systems for malaria, onchocerciasis, kala azar, etc).

Dr Pietro Ceccato
Research Scientist at the International Research Institute for Climate and Society (IRI)
Pietro Ceccato trained originally as an agronomist and soil science scientist. He spent two years in Central African Republic working with local communities to improve agricultural practices. He obtained a Master in Environmental Management using decision-support systems and worked as a research scientist at the Natural Resources Institute in United Kingdom. He developed remote sensing products to monitor active fires and vegetation status for the purpose of assessing the risk of fire occurrence. He worked at the European Commission Joint Research Centre (Ispra, Italy) on the use of remote sensing to monitor vegetation status and used this work to obtain his PhD in Remote Sensing (2001, University of Greenwich, UK). Pietro then joined the UN Food and Agriculture Organization (Rome) to develop an early warning system for Desert Locust monitoring. He developed remote sensing products and Geographical Information Systems to be used operationally by the ministries of agriculture in 21 countries in Africa and Asia.

International Development Research Centre (IDRC)

Dr Martin Wiese
Senior Program Specialist, Ecosystems and Human Health, International Development Research Centre (IDRC)
Martin Wiese is a health geographer and biologist who specializes in issues related to emerging health problems and the environment in the developing world. Before joining IDRC's Ecohealth team in 2008, Wiese worked in China, where he advised a provincial government on the relationships between sustainable development, public health, climate change mitigation, and natural resource management. From 1997 to 2006, he worked in Chad, advising a scientific institute on animal and human health in relation to rural development, and studying the health of nomadic communities. Wiese has worked for the German and French development cooperation agencies, the Swiss Tropical Institute as well as the University of Freiburg (Germany), where he studied the delivery of health care to vulnerable populations. Before concentrating on health issues, Wiese conducted research in tropical ecology and did fieldwork in Latin America. Wiese holds a PhD in geography and an MSc in biology from the University of Freiburg.

World Health Organisation (WHO)

Dr Diarmid Campbell-Lendrum
Senior Scientist, Envrionmental Risks to Human Health, World Health Organisation (WHO)
Dr Diarmid Campbell-Lendrum is an environmental epidemiologist working with the World Health Organization in Geneva. He is the author and editor of several scientific papers and reports addressing environmental health issues, including on climate change, environmental change and their impacts on health. He was responsible for the WHO report *Climate change and human health – risks and*

responses and the WHO report *Ecosystems and human well-being – health synthesis*, which is WHO's contribution to the Millennium Ecosystem Assessment. He also co-authored a recent WHO report *Preventing Diseases through Healthy Environments*, which states that about a quarter of the global burden of disease could be removed through available environmental interventions. For many years he has been conducting workshops to promote awareness and action related to protecting health from climate change. Carlos manages the Interventions for Healthy Environments unit at WHO in Geneva.

Dr Lucien Manga

Regional Adviser, Protection of the Human Environment, WHO/AFRO

Lucien Manga holds a Doctorate in Biology from the University of Yaoundé, Cameroon and a PhD in Medical Entomology and Parasitology from the University of Montpellier I, France. Dr Manga was assistant lecturer at the Universities of Yaoundé and Ngaoundéré in Cameroon between 1992 and 1997 and a researcher at the OCEAC (a regional research institution for central African countries) in Yaoundé, Cameroon between 1989 and 1997. His research activities focused on the epidemiology of malaria in the forested areas of Cameroon, relationships between environmental factors, vectors and malaria transmission dynamics, and on insecticide resistance in malaria vectors, publishing several papers on these topics. Lucien Manga joined the World Health Organization in 1997 as the Head of the Vector Biology and Control Unit at the Regional Office for Africa. He has been the Manager of the Health and Environment Programme for Africa at the Regional Office of WHO. He is also coordinating the Secretariat of the Interministerial Conference on Health and Environment in Africa.

Dr Johannes Sommerfeld

Scientist, Research Manager, Special Programme for Research and Training in Tropical Diseases (TDR), Neglected Priority Research (NPR), Unit on "Vectors, Environment and Society" (VES)

Johannes Sommerfeld (Dr phil, MPH, MA) is a health social scientist originally trained in cultural and medical anthropology, sociology, economics and epidemiology. A staff member of TDR since 2000, Johannes Sommerfeld has been managing a series of research and knowledge management activities related to the social, economic, cultural, policy- and health systems related issues in infectious diseases and their control. From 2000-2007 he was Manager of the TDR Steering Committee on Strategic Social and Economic Research (SEB). He is currently working on community-based interventions and on cross-disciplinary (eco-bio-social) research on dengue and Chagas with IDRC (Canada). He was leader of the business line on integrated community-based interventions prior to its merger into the new unit "Vectors, Environment and Society". Prior to joining TDR in 2000, he held research associate appointments with the Harvard Institute for International Development, Cambridge, USA (1992-1996) and the Institute of Tropical Hygiene and Public Health, Heidelberg University Medical School, Germany (1996-2000). His professional interests focus on the social sciences applied to public health.

Dr Yeya Touré

Team Leader, Vectors, Environment and Society, Special Programme for Research and Training in Tropical Diseases (TDR)

Dr Yeya Tiemoko Touré (PhD) joined TDR in 2001 as the Manager of the Molecular Entomology Committee (2001-2007). From 2008-2011, he led the innovative vector control interventions and is currently the leader of the Vectors, Environment and Society unit. Dr Touré is from Mali, is fluent in French and English, and spent more than 20 years as a researcher in medical entomology and professor of cell biology and genetics in the Faculty of Medicine (FMPOS), Bamako, Mali; as director general of the National Research Council (CNRST) of Mali; and head of the Malaria Research and Training Center (MRTC) of FMPOS. His research focused mainly on malaria and lymphatic filariasis epidemiology and transmission; vector biology, ecology, genetics; resistance to insecticides and control. While there, he published more than 80 papers, managed research grants, trained 30 PhD and MSc students, was a member of several scientific and technical advisory committees and is an elected member of the Academy of Sciences for Developing World (TWAS).

Dr Arve Lee Willingham

Scientist, Vectors, Environment and Society, Special Programme for Research and Training in Tropical Diseases (TDR)

Arve Lee Willingham is a scientist in TDR's Vectors, Environment and Society unit since May 2011, after originally serving in the Stewardship unit from April 2010. He is responsible for developing and managing interdisciplinary research on the impact of environmental and climate changes on vector-borne and other poverty-related diseases. Lee is a veterinarian (University of Georgia, USA, 1986) with a PhD in parasitology-helminthology (Royal Veterinary and Agricultural University, Denmark, 1997). Originally from Georgia, USA, he has been living in Europe and Africa for over 20 years. While in Denmark at the Royal Veterinary and Agricultural University and University of Copenhagen 1993-2010, he conducted doctoral studies on the population biology of zoonotic schistosomiasis (*Schistosoma japonicum*) and then coordinated research capacity enhancing projects in Africa related to parasitic zoonoses and served as Deputy Director of the WHO/FAO Collaborating Center for Research and Training on Neglected Parasitic Zoonoses. Lee's interest in parasitic zoonoses of both public health and agricultural importance (e.g. cysticercosis, echinococcosis, zoonotic schistosomiasis, food-borne trematode infections) emerged from his service as a U.S. Peace Corps volunteer in Morocco 1990-1992, where he mainly worked with sheep and goat farmers in the Middle Atlas Mountains. He was seconded by DANIDA to the CGIAR's International Livestock Research Institute (ILRI) in Nairobi from 2004-2006 to work with the People, Livestock and Environment theme on a programme concerning human health impacts of livestock keeping.

Appendix 3: Workshop Organizing Institutions

Special Programme for Research and Training in Tropical Diseases (WHO/TDR)

TDR was created in 1975 to support the development of new tools to fight tropical diseases of poverty and to strengthen the research capacity of affected developing countries. The research environment has changed significantly in recent decades:

- The epidemiology of infectious diseases is changing with some diseases moving to elimination and others emerging or re-emerging;
- There are many new initiatives and actors in the field providing new momentum but also leading to a more complex environment;
- Disease endemic countries have enhanced research capability but are increasingly left behind in global research planning and priority setting;
- Priority research needs are unequally covered and there remain several research areas that are neglected even though they are critical for the ultimate health impact of the global research effort.

TDR's new vision and strategy responds to this research environment and to the need to make the collective global research effort more effective and responsive to research priorities in disease endemic countries. It also recognizes the need for these countries to play a major role in research and priority setting to ensure relevance, sustainability and optimal health impact for the poor.

World Health Organization- Africa Regional Office (WHO/AFRO)

The WHO is the specialized United Nations agency for global health matters. The mandate of the Organization, defined by its Member States in the Constitution adopted in 1946, determines the objectives and functions of the organization, its membership and its organs.

The WHO African Region is one of the six regions of WHO. The mission of WHO AFRO is the attainment by all peoples of the highest level of health. As defined by the WHO Constitution: "Health is a state of complete physical, mental and social well-being and not merely the absence of diseases and infirmity."

The core functions of WHO-AFRO are:

- To provide leadership on matters critical to health and engaging in partnerships where joint action is needed;
- To shape the research agenda and stimulating the generation, translation and dissemination of valuable knowledge;
- To set norms and standards, and promoting and monitoring their implementation;
- To articulate ethical and evidence-based policy options;

- To provide technical support, catalyzing change, and building sustainable institutional capacity; and
- To monitor the health situation and assessing health trends.

WHO/Department of Public Health and Environment (WHO/PHE)

WHO/PHE's role is to promote a healthier environment, intensify primary prevention and influence public policies in all sectors so as to address the root causes of environmental threats to health.

How significant is the impact of environment on health?

An estimated 24% of the global burden of disease and 23% of all deaths can be attributed to environmental factors.

The Department of Public Health and Environment influences policy by:

- Assessing and managing risks (such as outdoor and indoor air pollution, chemicals, unsafe water, lack of sanitation, ionizing and non-ionizing radiation, to mention a few) and formulating evidence-based norms and guidance on major environmental hazards to health.

- Creating guidance, tools and initiatives to facilitate healthy policy development and implementation in priority sectors.

By focusing on reducing environmental risk factors, nearly a quarter of the global burden of disease can be prevented. Some examples include the promotion of safe household water storage, better hygiene measures, improved management of toxic substances in the home and workplace. At the same time, actions by sectors such as energy, transport, agriculture, and industry are required urgently, in cooperation with the health sector, to address the root environmental causes of health.

PHE focuses on developing and advocating effective preventive policies and interventions based on improved scientific understanding of the environmental determinants of human health.

International Research Institute for Climate and Society (IRI)

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

The IRI was founded in 1997 on the belief that scientific breakthroughs in our

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

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

Ethiopian Climate and Health Working Group (CHWG)/Health, Development and Anti-Malaria Association (AMA)

The Ethiopian CHWG was established in February 2008 Initiated by the HDAMA (the then name Anti Malaria Association (AMA)). 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 organisation of technical meetings and workshops (e.g., MERIT conferences in December, 2008 & and 2010; Stakeholders workshop, training and pilot project implementation 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).

Appendix 4: Workshop working glossary

Glossary of Terms

Absolute humidity: the quantity of water vapor expressed as grams per cubic meter of air. Absolute humidity, also expressed as dew point, is a measure of the amount of water in the air independent of temperature. So while relative humidity drops when temperature goes up in a data centre, absolute humidity stays the same.

Adaptation: "a process by which strategies to moderate, cope with, and take advantage of the consequences of climate events (as opposed to just anthropogenic climate change) are enhanced, developed, and implemented" UNDP's Adaptation Policy Framework

Bimodal rainfall distribution: an annual cycle of rainfall that has two rainy seasons and two dry seasons.

Climate: the average values and frequencies of the weather including its extremes (e.g., rainfall, air temperature, relative humidity, solar radiation and wind speed) over periods longer than a month (e.g., a season, a year, a decade, 30 years, and so on). *For example:* The average September to December rainfall at Entebbe from 1902 to 1992 is 438mm.

Climate change: long-term changes in the climate. Climate change can be natural *(e.g.,* ice ages were caused by changes in the distance between the Earth and the sun), or anthropogenic *i.e.* caused by changes people have made to the land and atmosphere (e.g., urbanization, pollution).

Climate information: Information about historically observed climate (e.g., the average and typical range of variability of the rainfall total for a given location for a given month or season), or a forecast of the climate for a future time (whether for an immediately forthcoming season, or on a much longer time-scale such as 30 years into the future). An important part of climate information is its probabilistic aspect, which pertains to what is most likely, what is relatively less likely, and what would be considered rare (extremely unlikely).

Climate risk management: the use of climate information in a multidisciplinary scientific context to cope with climate's impacts on development and resource-management problems. Climate risk management covers a broad range of potential actions, including: early-response systems, strategic diversification, dynamic resource-allocation rules, financial instruments, infrastructure design and capacity building.

Climate variability: the range of values the climate at a particular location can take over time. *For example:* Although the average September to December rainfall in

Entebbe from 1902 to 1992 was 438mm, the actual amounts each year were somewhere in between 200mm and 1000mm, which is a large range of values.

Climatology: the long-term average of a given variable, often over time periods of 20-30 years.

Community: A group of people who occupy a defined territory under common leadership, with access to shared local resources, as the base for carrying out the greatest share of their daily activities. Such a group may vary by country to include villages, quarters, groups of hamlets, mobile populations, and temporary settlements.

Community expectations: Prospective opinions that people have about the roles and outcomes of responsive health systems.

Community participation: The process by which people are enabled to become actively and genuinely involved in defining the issues of concern to them, in making decisions about factors that affect their lives, in formulating and implementing polices, developing and delivering services and in taking action to achieve change.

Community perception: The view that individuals and communities have about health services. It can be influenced by outcomes of previous health care experiences.

Community perspectives: The sum of collective knowledge, attitudes, valuation, awareness, perceptions and experience of the community with respect to health and the delivery of essential health services.
Research to ensure that communities that are usually not part of the process should be involved in the development of policies and systems for their own health: ownership – go beyond perception

Decision analysis: application of probability theory with the aim of calculating the optimal strategy from a series of alternative decisions, which are often expressed graphically in the form of a decision tree. Decision analysis is a tool to help decision-makers choose from several options which is the optimal choice for treatment or control of a disease.

Deterministic model: a mathematical model in which all the relationships are fixed and the concept of probability is not involved, so that a given input produces one exact prediction as an output. See also: Stochastic Model.

De-trending: to remove the general long-time drift, tendency, or bent of a set of statistical data in relation to time. Regression and other statistical techniques are used to remove the effects of a long term trend in order to show only the absolute changes in values and to allow potential cyclical patterns to be identified. An

example would be to subtract a moving-average (e.g., for five years) from the value of the variable.

Drought: defined as a prolonged period of poor rainfall distribution resulting in deterioration of natural resources.

Ecosystem resilience: a measure of how much disturbance (like storms, fire or pollutants) an ecosystem can handle without shifting into a qualitatively different state. It is the capacity of a system to both withstand shocks and surprises and to rebuild itself if damaged.[7]

Endemic disease: the perennial or seasonal presence of a disease, or infectious agent, within a given geographic area, or population group. It also implies a prevalence that is usual in the area or in the population. When applied to meningitis—there is a constant measurable incidence both of cases of the disease and of its natural transmission in an area over a succession of years.

Ensemble forecasts: An ensemble is simply a group of model forecasts that are valid over an identical time period. These forecasts provide information on the different ways in which the atmosphere may evolve over the next few hours or longer. Ensembles are needed because we do not have enough information to accurately depict the present state of the atmosphere. Even with all the information we obtain from satellites, radars, weather balloons, surface instruments, and other data sources we are unable to provide a perfect three-dimensional picture of the atmosphere at any given time. This means that the information we use to start a numerical weather forecast model, called an initial condition, is imperfect. By analyzing different scenarios, we can determine the most likely evolution of the atmosphere and determine the odds that certain weather events will occur. Numerous studies have shown that ensembles are more accurate than providing a single forecast from the best initial condition, and we also know that ensembles provide more useful information to decision makers.

ENSO: Stands for El Niño–Southern Oscillation. ENSO refers to an irregular cycle of warming and cooling of the sea surface temperatures (see definition) of tropical Pacific Ocean. The cycle has an average length of about 4 years, and is a natural part of the Earth's climate system. The oceanic warming and cooling is accompanied by changes in air pressure above the tropical Pacific Ocean (the "Southern Oscillation"). These changes in the Pacific Ocean's temperatures and the atmosphere above it affect the global climate system, and therefore can affect the climate in regions that are far away from the Pacific (like Africa).

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[7] http://www.stockholmresilience.org/research/whatisresilience/resiliencedictionary.4.aeea46911a3127427980004355.html

Epidemic: the occurrence in a population or region of cases of disease clearly in excess of normal expectancy for that area and time period. When applied to malaria this includes the occurrence of malaria among a population in which the disease was unknown or an unusual seasonal rise or other unusual increase of clinical malaria cases in an area with low or moderately endemic malaria (based on an epidemic thresholds derived from historic data).

Epidemic curve: a histogram in which the X-axis represents the time of occurrence of disease cases and the Y-axis represents the number of disease cases. It is a useful tool to determine the epidemiology of disease occurrence in an outbreak investigation.

Epidemiology: the study of the distribution and determinants of health related states and events in populations.

Evapotranspiration rate: of actual loss of water from soil through a combination of evaporation and transpiration by plants over a given area with time.

Factor: an event or characteristic that brings about a change in health condition - a causal role is often implied.

Geo-reference: record of data's location in a known mapping co-ordinate system (such as degrees Latitude and Longitude) or projection.

Geographic Information System: a computer-based database designed to store, manage, analyze and System (GIS) visualize geo-referenced data in locational relation to each other. Grid uniform matrix of discreet values – used in some GIS (grid-based) to represent continuous data surfaces such as mean temperature or rainfall estimates or other attributes associated with mapped entities. Some GIS use the term "raster" in place of grid.

Health Impact Assessment (HIA): A combination of procedures, methods and tools that systematically judges the potential, and sometimes unintended, effects of a policy, plan, programme or project on the health of a population and the distribution of those effects within the population. HIA identifies appropriate actions to manage those effects (Quigley, R., L. den Broeder, P. Furu, A. Bond, B. Cave and R. Bos. 2006 Health Impact Assessment International Best Practice Principles. Special Publication Series No. 5. Fargo, USA: International Association for Impact Assessment).

Health system: "A health system is the sum total of all the organizations, institutions and resources whose primary purpose is to improve health. A health system needs staff, funds, information, supplies, transport, communications and

overall guidance and direction. And it needs to provide services that are responsive and financially fair while treating people decently."[8]

Immunity: the resistance of an individual to infection, or disease, due to a particular agent. Immunity may be innate (natural), passive (e.g., maternal or through administration of immune serum), or active (acquired from previous exposure or vaccination).

Incidence: the number of new cases of disease or other condition, which occur in a specified population during a given period of time.

La Niña: the cold phase of the El Niño Southern Oscillation. Like its "brother" El Niño it is associated with periodic variability in regional climatic processes (See also El Niño). Recent La Niña events occurred in 2007, 2000, 1999, 1998, 1996, and 1988. Typically, La Niña events last into the beginning of the following year.

Microclimate: the mean values and frequencies of the weather including its extremes (e.g., air temperature, relative humidity, solar radiation and wind speed) in a small geographic area.

Normalized Difference Vegetation Index (NDVI): a commonly used proxy for vegetation condition. NDVI is derived from a manipulation of data from two satellite wave bands presented as a ratio [NDVI = (near infrared—red)/(near infrared + red)]. NDVI is often used in routine monitoring of seasonal vegetation development in response to regional rainfall distribution.

Outbreak: occurrence of disease in a population, at a level greater than normally expected where the epidemic is limited in terms of population and geographic area affected.

Population (herd) immunity: the resistance of a group of subjects to invasion and spread of an infectious agent based on the resistance to infection of a high proportion (but not all) members of the group. Also called "herd" or "population" immunity.

Potential evapotranspiration (PET): may be used as a proxy measure for soil moisture budget. It describes the amount of evapotranspiration that could occur if a limitless supply of water were available in the soil. It is based on weather conditions such as wind and temperature and biological factors such as vegetation cover.

Predictability: A technical term that describes how well we can predict the future weather or climate in a particular region. Predictability varies depending upon how far into the future the forecast extends. In a region with high seasonal predictability

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[8] http://www.who.int/features/qa/28/en/

(mainly in the tropics) we can make good forecasts of what the climate will be in the next few months given what is happening now. There is no place on Earth that has perfect predictability. There are also some places that have no seasonal predictability at all.

Prevalence: the proportion of cases of a disease or other condition present in a population at a point in time without any distinction between old and new cases. When used without qualification the term usually refers to the number of cases as a proportion of the population at risk at a specified point in time (point prevalence).

Probability: The chance or degree of likelihood that an event will occur. *For example:* In Entebbe, below normal rainfall in the September to December season has occurred in 10 out of 30 years. If we assume that September to December rainfall in Entebbe in the future will have the characteristics as in the past, then there is a 10 in 30 chance (or 33%) that rainfall will be below normal in the coming season.

Probabilistic forecast: measure of the degree of likelihood that a given event will occur. A probabilistic forecast type includes an objective measure of certainty. This type of prediction may be more reliable than a deterministic forecast that gives no indication of certainty.

Public health surveillance: the ongoing, systematic collection, analysis, interpretation and dissemination of health data used by public health authorities to monitor the health of their communities. Its purpose is to provide a factual basis from which health authorities can appropriately set priorities, plan programs, and take action to promote and protect the public's health. See also: Surveillance.

Rainfall: the quantity of rainfall measured by a rain gauge during a fixed period of time (e.g., 24-hour period for daily rainfall). The term "precipitation" may be used which is inclusive of water as snow, sleet, hail, *etc.*

Rainfall estimates: (RFE) estimates of rainfall derived from satellite data combined with ground station data and model outputs.

Relative humidity: (%) is the amount of water vapor in a sample of air, divided by the amount that the sample could hold if it were saturated, multiplied by 100.

Relative risk: the ratio of the disease incidence in individuals exposed to a hypothesized factor to the incidence in individuals not exposed.

Reliability: (for probabilistic forecast system). "If the system forecast is 30% above, 10% normal and 60% below normal rainfall then in 100 years, 30 years should be above normal, 10 years should be normal and 60 years should be below normal in order to be thought of as being perfectly reliable".

Remote sensing: observation of the earth's surface and its physical, biological, hydrological and atmospheric processes from a distance. Usually means data collected from airborne sensors on aircraft or satellites.

Resilience: the capacity to deal with change and continue to develop.[9]

Risk: the probability that an event will occur within a fixed time period e.g., that an individual will become infected, become seriously ill or die within a set period, or by certain age.

Risk factor: an attribute, or exposure that increases the probability of occurrence of the specific risk outcome.

Risk indicator: a risk factor that can be monitored routinely for use in an early warning system.

Satellite proxies: satellite-derived estimates of environmental variables.

Saturation deficit: the pressure exerted by water vapor that could exist in saturated air (saturation vapor pressure) minus the actual vapor pressure (the actual pressure exerted by the water vapor present).

Saturation vapor pressure: The partial pressure exerted by water molecules in a parcel of air if saturated at a given temperature (may be calculated from wet and dry bulb temperatures).

Seasonal climate forecast: A forecast for how rainfall or temperature in a coming season is likely to be different from climatology (see definition). Seasonal climate forecasts can be made in several different ways (*for example,* using statistical or dynamical method). Because the climate system is so complex, it is almost impossible to take all the factors that determine the future seasonal climate into account. Therefore, climate forecasts are generally given in terms of the probability (see definition) that rainfall or temperature will be either below normal, near normal, or above normal.

Seasonality: Changes in patterns (of a disease, for instance) which occur predictably at given times of the year.

Sea surface temperature: is the temperature of water at the ocean surface—often derived as a proxy from thermal satellite channels. SSTs are an important influence on seasonal rainfall and temperature over land.

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[9] http://www.stockholmresilience.org/research/whatisresilience/resiliencedictionary.4.aeea46911a3127427980004355.html

Sensitivity: a statistical measure of how well a binary classification test correctly identifies a condition, e.g., how well a medical screening tests identifies a disease compared to some absolute (Gold standard); for example, for a medical test to determine if a person has a certain disease, the sensitivity to the disease is the probability that if the person has the disease, the test will be positive. The sensitivity is the proportion of true positives of all diseased cases in the population.

Social change: Paradigmatic change in socio-economic structure, can affect social institutions, social behaviours and social relations.

Social resilience: the ability of human communities to withstand and recover from stresses, such as environmental change or social, economic or political upheaval. Resilience in societies and their life-supporting ecosystems is crucial in maintaining options for future human development.[10]

Social-ecological systems: linked systems of people and nature. The term emphasizes that humans must be seen as a part of, not apart from, nature — that the delineation between social and ecological systems is artificial and arbitrary. Scholars have also used concepts like 'coupled human-environment systems', 'ecosocial systems' and 'socioecological systems' to illustrate the interplay between social and ecological systems. The term social-ecological system was coined by Fikret Berkes and Carl Folke in 1998 because they did not want to treat the social or ecological dimension as a prefix, but rather give the two the same weight during their analysis.[11]

Social vulnerability in relation to environmental change: "the state of susceptibility to harm from exposure to stresses associated with environmental and social change and from the absence of capacity to adapt". (Adger 2006)

Spatial Distribution: the relationship of disease events to location of individual subjects or clusters of subjects.

Specificity: in diagnostic tests, the proportion of people that tested negative of all the negative people tested (true negatives); that is (1-false positives).

Stochastic model: a mathematical model founded on the properties of probability so that a given input produces a range of possible outcomes due to chance alone c.f. deterministic model.

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[10] http://www.stockholmresilience.org/research/whatisresilience/resiliencedictionary.4.aeea46911a3127427980004355.html
[11] http://www.stockholmresilience.org/research/whatisresilience/resiliencedictionary.4.aeea46911a3127427980004355.html

Surveillance: observation of a susceptible (uninfected) population aimed at the early detection of cases of a particular disease so that control action can be quickly instituted (see also monitoring). Surveillance is often subdivided into two categories, passive and active: passive surveillance is the secondary use of routinely collected data, which was generated for some other purpose such a diagnostic service; active surveillance is the routine collection of data whose primary purpose is for surveillance. See also "Public health surveillance."

Vector: arthropods that transmit disease pathogens following a multiplication and a maturation cycle occurring in their bodies; e.g., mosquitoes, sand flies, ticks. Key determinants of vector distribution are their feeding, resting and habitat preferences. Vectors that prefer to feed on humans are referred to as *anthropophilic*. In general, the vectors of African malaria bite at night and after feeding, some will rest in shady areas outside houses. Such vectors are termed *exophilic* i.e. they prefer to rest outdoors after feeding. Others are endophilic and rest indoors on walls and in hidden corners after feeding. These vectors are dominant around human settlements. Other vectors may bite humans and thus transmit malaria but they prefer to bite animals (i.e. they are *zoophilic*). Such vectors are often most abundant where livestock is kept.

Vector-borne disease: disease caused by pathogens that are transmitted by insects or other arthropods.

Virulence: the degree of severity of disease produced by an agent in a given host. Epidemiologically, it is measured as the proportion of individuals with disease who become seriously ill or die. The case-fatality rate is a measure of virulence.

Vulnerability refers to the propensity of social and ecological system to suffer harm from exposure to external stresses and shocks. Research on vulnerability can, for example, assess how large the risk is that people and ecosystems will be affected by climate changes and how sensitive they will be to such changes. Vulnerability is often denoted the antonym of resilience.[12]

Weather: the short-term variations of the atmosphere in terms of pressure, wind temperature, moisture, cloudiness, precipitation and visibility. It is a phenomenon that varies very much from day to day, even hour to hour and we experience it as wet or dry, warm or cold, windy or calm.

Zoonosis: Any disease or infection that is naturally transmissible from vertebrate animals to humans and vice-versa.[13]

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[12] http://www.stockholmresilience.org/research/whatisresilience/resiliencedictionary.4.aeea46911a3127427980004355.html
[13] http://www.who.int/zoonoses/en/

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