Quantifying Weather and Climate Impacts on Health in Developing Countries

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QWeCI Final Project Meeting

Thursday 16th – Saturday 18th May 2013

Confortel Barcelona, Spain

SEVENTH FRAMEWORK PROGRAMME

Quantifying Weather & Climate Impacts

QWeCI

on health in developing countries

Researchers across 13 European and African research institutes will work together to integrate data from climate modelling and disease forecasting systems to predict the likelihood of an epidemic up to six months in advance. The research, funded by the European Commission Seventh Framework programme, will focus on climate and disease in Senegal, Ghana and Malawi and aims to give decision makers the necessary time to deploy intervention methods to help prevent large scale spread of diseases such as Rift Valley Fever and malaria.

It is thought that climate change will change global disease distributions, and although scientists have significant knowledge of the climate triggers for particular diseases, more research is needed to understand how far into the future these events can be predicted. The work will bring together experts in science and health to investigate the link between climate and vector-borne diseases, including zoonotic diseases transferred from animals to humans.

Scientists already know that the risk of epidemics in tropical countries increases shortly after a season of good rainfall – when heat and humidity allow insects, such as mosquitoes, to thrive. These insects can cause the spread of disease such as malaria and Rift Valley Fever, but there are a number of factors to consider before reliable predictions can be made.

Contents

Welcome

A very warm welcome to the final meeting of the QWeCI Project, held in Barcelona and ably hosted by IC3. We are expecting more than 50 delegates, representing 13 different countries to join us in the Confortel Barcelona – making this a truly international collaborative meeting.

This meeting encompasses a full agenda and I look forward, with great anticipation, to the range of talks from colleagues across the project on the progress of the individual Work Packages, as well as the working sessions to be held on the final day.

I also look forward to the science talks that fill this conference programme. The management board are pleased to see such an array of speakers from our participating institutions and, particularly, to see so many student speakers who – I am sure – will be a highlight of the conference proceedings.

We have highly distinguished academics on our External Panel that have been kind enough to come and speak to us. Each bringing a great wealth of experience, insight and energy, we are honoured to have them here with us in Barcelona.

The project is a strong, collaborative enterprise that harnesses the very best people and resources to be at the forefront of the field and, with that, it gives me great pleasure to welcome you to the final meeting of FP7–funded QWeCI project.

Andy Morse
Professor of Climate Impacts, University of Liverpool (UK)
Principal Investigator, QWeCI Project

Agenda

Thursday 16th May 2013

08.30 – 09.00 **Registration**

09.00 – 09.30 **Opening addresses:**
Welcome and overview from IC3
QWeCI address (Andy Morse, *Project Coordinator, QWeCI*)

09.30 – 11.00 **Theme 1: Climate Health Relations**
WP 1.1 Disease database (Marie McIntyre, *UNILIV*)
WP 1.2 Atmospheric database (Volker Ermert, *UOC*)
WP 1.3 Climate-disease associations (Cyril Caminade, *UNILIV*)

11.00 – 11.30 **Coffee Break**

11.30 – 12.00 **Theme 3: Seamless Atmospheric Integrations (Part I)**
WP 3.1 Downscaled and calibrated seamless seasonal atmospheric forecasts (Jose Manuel Gutiérrez, *CSIC*)
Note: WP3.2 will be presented Friday morning

12.00 – 13.00 **Science talks (Part I)**
"Rainfall and RVF emergence in Senegal: beyond twenty years of investigation, lessons learned and perspectives" – Jacques André Ndione, *CSE*

"A meta model for vector borne disease: An application model on Rift Valley fever in Barkédji" *– Ahmed Tidjane Cissé, UCAD*

"Statistical modelling of Rift Valley fever vectors abundance in a Sahelian area (Barkédji, Senegal, West Africa)" *– Cheikh Talla, IPD*

13.00 – 14.00 **Lunch**

14.00 – 14.20 **Theme 2: Dynamic Health Models**
WP 2.1 Development of dynamic health models (Cyril Caminade and Anne Jones, *UNILIV*)

14.20 – 14.40 **Theme 4: Coupled Climate-Health Projections**
WP 4.1 Seamless climate-disease model integrations (Cyril Caminade, *UNILIV*)

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14.40 – 15.30 **Theme 5: Integrated Decision Support Systems in 3 pilot projects**

WP 5.1 Integrated decision support systems (Volker Ermert, *UOC*)

WP 5.2 Ghana pilot project: peri-urban malaria (Leonard Amekudzi, *KNUST*)

15.30 – 16.00 **Coffee Break**

16.00 – 17.00 **Theme 5 continued: Integrated Decision Support Systems in 3 pilot projects**

WP 5.3 Senegal pilot project: RVF and malaria (Jacques André Ndione, *CSE*)

WP 5.4 Malawi pilot project: Disease risk dissemination by long-range WiFi technology (Maya Nkoloma, *UNIMA*)

17.00 – 18.00 **Science Talks (Part II)**

"Relative importance of climatic, geographic and socio-economic determinants of malaria in Malawi" – Rachel Lowe, *IC3*

"The Barkedji pilot project: entomological findings on malaria vectors" – Ibrahima Dia, *IPD*

"Effect of climate variability on the incidence and transmission patterns of malaria in Kumasi, Ghana" – *Anthony Wihibeturo Basing*, *KNUST*

"Landsat derived environmental metric for mapping mosquitoes breeding habitats" – *Adeola Abiodun*, *UP*

18.00 – 18.15 **Open discussion & close of day**

18.30 – 21.30 **Cultural Tour (Group I)**

Led by Professor Mariano Barriendos, *University of Barcelona*

Friday 17th May 2013

09.00 – 09.30 **Theme 3: Seamless Atmospheric Integrations (Part II)**

WP 3.2 Seamless decadal predictions and projections (Francisco Doblas–Reyes, *IC3*)

09.30 – 11.00 **Science talks (Part III)**

"The Malaria Early Warning System developed under QWeCI: achievements and perspectives" – Francesca di Giuseppe, *ECMWF*

"Performance assessment of ECMWF System 4 forecasts with the Liverpool Malaria Model" – Anne Jones, *UNILIV*

"Skills and economic value of dynamical downscaling of ECMWF ensemble seasonal forecasts over southern Africa" – Adrian Tompkins, *ICTP*

"VECTRI - A high resolution regional malaria transmission model and its use in a pilot seasonal forecast system at ECMWF" – Adrian Tompkins, *ICTP*

"An integrated forecast for malaria in the middle belt of Ghana" – *Anthony Wihibeturo Basing*, *KNUST*

11.00 – 11.30 **Coffee Break**

11.30 – 13.00 **Science talks (Part IV)**

"Seasonal-to-decadal prediction of the West African monsoon" – Javier García-Serrano, *IC3*

"Seasonal prediction of the intraseasonal variability of the West African monsoon precipitation" – *Luis Ricardo Lage Rodrigues*, *IC3*

"Impact of climate change on malaria transmission in Africa: the good, the bad and the unknown" – Cyril Caminade, *UNILIV*

"Dynamic of land use in the rural communities of Barkedji in Ferlo (North Senegal)" – Taibu Ba, *CSE*

"Climate and health: observation and modelling malaria in Ferlo (Senegal)" – *Ibrahima Diouf*, *UCAD*

"Modelling the hydrological dynamic of the breeding water bodies in Barkedji's zone" – *Mamadou Bop, UCAD*

13.00 – 14.00 **Lunch**

14.00 – 15.30 **External panel discussion**

15.30 – 16.00 **Coffee Break**

Friday 17th May 2013

16.00 – 17.30 **Science talks – External panellists**

"Disease, Documents and Discourse in Eastern Africa" – Laragh Larsen

"Assessments for the impact of mineral dust on the meningitis incidence in West Africa" – Nadège Martiny

"Climate change and emergence of vector-borne diseases in Canada" – Nick Ogden

17.30 – 18.00 **Open discussion & close of day**

18.30 – 21.30 **Cultural Tour (Group II)**

Led by Professor Mariano Barriendos, *University of Barcelona*

21.30 **Final project dinner**

To be held at Can Culleretes, www.culleretes.com

Saturday 18th May 2013

Note: Working sessions to involve WP leaders together with all partners with person-months allocated to the WP – exact agenda to be updated during Thursday and Friday

09.00 – 10.00 **Breakout Session 1**

Room 1	**Room 2**
WP 6.3 Input from UNIMA/ICTP	Project reporting update and requirements – All other partners

10.00 – 11.00 **Breakout Session 2**

Room 1	**Room 2**
WP 6.3 Input from KNUST	Planning session – UOC/CSE

11.00 – 11.30 **Coffee Break**

11.30 – 12.30 **Breakout Session 3**

Room 1	**Room 2**
WP 6.3 Input from CSE/IPD	Planning session – UOC/IPD

Saturday 18th May 2013

12.30 – 13.00 **Breakout Session 4**

Room 1	**Room 2**
WP 6.3 Input from UOC/UP/UNILIV	Other WPs with outstanding deliverables & milestones TBC

13.00 – 14.00 **Lunch**

14.00 – 15.30 **Breakout Sessions**

Room 1	**Room 2**
Project Management Meeting	Further WP discussions as applicable

15.30 – 16.00 **Coffee Break**

16.00 – 17.00 Final open discussion & closing remarks

* *Names of student speakers in italics*

Abstracts

Landsat derived environmental metric for mapping mosquitoes breeding habitats

Adeola Abiodun Morakinyo,[1] Jane Olwoch,[2] Joel Botai,[1] Hannes Rautenbach[1]

[1] University of Pretoria, South Africa

[2] South African National Space Agency, South Africa

The advancement, availability and high level of accuracy of remotely sensed data has recently been used in many studies like environmental and epidemiological studies. On the other hand, the spatial-temporal distribution of mosquitoes is strongly determined by the environmental conditions. Recent studies have shown that temperature, vegetation cover, humidity and precipitation significantly influence the development and the survival of mosquitoes. The potential breeding habitats of the mosquitoes have been studied using a selected environmental metric derived from Landsat TM imagery. In the present analysis, band rationing was performed to obtain the distinct normalized difference water index (NDWI) and normalized difference vegetation index (NDVI) while the land surface temperature (LST) was also extracted from the Landsat TM. The three parameters set of the metric were used to identify suitable breeding habitat sites. The accuracy was determined using knowledge-based GIS techniques which require the use of spatial data layers for topography, rivers and clinical data. The result indicates that the derived metric is reliable for mapping the spatial-temporal distribution of mosquito habitats over Mpumalanga Province, South Africa.

Dynamic of land use in the rural communities of Barkedji in Ferlo (North Senegal)

Taibou Ba,[1] L. E. Akpo,[2] A. Faye,[1] J. A. Ndione[1]

[1] Centre de Suivi Ecologique, Senegal

[2] Laboratory of Ecology and Eco-Hydrology, University of Cheikh Anta DIOP, Senegal

As many Sahelian countries, Senegal is suffering for many decades from rainfall drop and increasing pressure on natural resources. The Rural Community of Barkedji, area of this study, is located in the Sahelian region, more precisely in the north sylvo-pastoral zone of Senegal. This important area of livestock raising is characterized by degradation resulting from overgrazing. This study addressed the dynamic of land cover in the Rural Community of Barkedji, using GIS and remote sensing tools. It’s aiming to be a contribution in developing new strategies for monitoring and assessing ecosystems. The results underline a

degradation of vegetation cover showing in changes in the landscape structure and an appreciable decline in the quality of the vegetation cover and in the biomass production. These results also show a dominance of Combretaceae (*Guiera senegalensis*, *Combretum glutinosum*). This, in addition to the illegal logging and trimming, bush fires and water ersosion, are the main pressures that could lead to an exacerbation of land degradations. Human factors are on the top of main causes of this situation, due to bad practices in land management: over-exploitation of pastoral resources, slash and burn agriculture, over-exploitation of forest resources.

An integrated forecast for malaria in the middle belt of Ghana

Anthony Wihibeturo Basing,[1] S. C. K. Tay,[1] S. K. Danuor,[2] L. K. Amekudzi[2]

[1] Department of Microbiology, school of medical sciences, Kwame Nkrumah University of Science and Technology, Ghana
[2] Department of Physics, Kwame Nkrumah University of Science and Technology, Ghana

Meteorological conditions, such as high rainfall or high temperature, are often cited retrospectively as some of the factors for epidemicsThe quantification and use in early warning of the effect of epidemic-precipitating factors such as weather patterns has been difficult in epidemic-prone areas where slight changes might cause devastating epidemics. Currently there are efforts to develop early warning systems that use weather monitoring and climate forecasts and other factors. This research was aimed at providing an integrated forecast for malaria in the middle belt of Ghana as an early warning system.

Data on climatic variables from December 2009–February 2013 were obtained from the Owabi, Emena, Agogo, KNUST and Airport weather stations. Data on malaria cases from December 2009–November 2011 were obtained from Nkawie hospital (near Owabi weather station), Emena hospital and Kumasi South Hospital (near the KNUST Weather station) and Manhyia hospital (near Airport weather station) and Agogo Hospital (Near Agogoweather station) from December 2009–February 2013. Based on malaria morbidity data, six communities were selected and sprayed for mosquitoes using the pyrethrum spray catch method. Data analysis was conducted with Microsoft Excel and Statistical Software Package, SPSS version (16.0). Pearson’s correlation analysis was done to establish the relationship between climatic variables and malaria transmission.

Malaria transmission was highest in Asawasi which is an urban community rural features with an Entomological Inoculation rate of 187.1infectious bites/person/year. In all the communities, Malaria transmission was highest in the Minor rainy season, the period between April and July. Mosquitoes were abundant in the Major rainy seasons between August and November, but had low circumsporozoite proteins. Both Malaria incidence and the Entomological inoculation rate were highest in the Minor rainy season. The result of this study indicates that Malaria control in the middle belt of Ghana should be intensified during the minor rainy seasons when there is intermittent rainfall.

Effect of climate variability on the incidence and transmission patterns of malaria in Kumasi, Ghana

Anthony Wihibeturo Basing,[1] S. C. K. Tay,[1] S. K. Danuor,[2] L. K. Amekudzi[2]

[1] Department of Microbiology, school of medical sciences, Kwame Nkrumah University of Science and Technology, Ghana
[2] Department of Physics, Kwame Nkrumah University of Science and Technology, Ghana

Introduction: Changes in temperature, rainfall and relative humidity are expected to influence malaria by modifying the behavior and geographical distribution of malaria vectors and by increasing or decreasing the length of the life cycle of the parasite. This study was aimed at investigating the impact of these changes on malaria incidence in Kumasi, Ghana.

Methods: Data on climatic variables from December 2009- November 2011 were obtained from the weather station in Kumasi. Data on malaria cases were obtained from hospitals in three communities which were sprayed for mosquitoes using the pyrethrum spray catch method. Data analysis was conducted SPSS version (16.0). Pearson's correlation analysis was done to establish the relationship between climatic variables and malaria transmission.

Results: Anopheles gambiaes.l. was the highest mosquito vector caught over 90% of which had fed on human blood. Sporozoite rates were 6% between April and July, 5.6% between August and November 2011 and 2.6% between December 2010 and March 2011. The annual Entomological inoculation rates were 273.8, 245.3 and 56.9ib/p/yr for April and July, August and November and December 2010 and March 2011 respectively. The period between April and July recorded a total rainfall of 278.1mm whiles the period between August and November recorded total rainfall of 941mm dry rainfall value between December 2010 and March 2011 was 222.3mm. Malaria incidence was highest in the period between April and July. There were direct relationships between minimum temperature and human bite rate, maximum temperature and CS proteins, rainfall and number of mosquitoes caught during the study period and between malaria incidence and the entomological inoculation rate. There were also indirect relationship between maximum temperature and the number of mosquitoes caught.

Conclusion: The result of this study indicates that climatic variables are relevant for malaria forecasting and control in Kumasi; it also shows that malaria transmission is caused by a multiplicity of factors including climatic, environmental and socioeconomic factors. These

factors play diverse roles on malaria vector biology as well as on the parasite. Further studies should be designed to include larval density and other environmental stages.

Modeling the hydrological dynamic of the breeding water bodies in Barkedji's zone.

Mamadou Bop,[1] O. Seidou O,[1] C. M. F. Kebe,[3] S. Sambou,[1] J. A. Ndione[4]

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[2] Département Génie Civil, Ottawa, Canada

[3] Centre International de formation et de Recherche en Energie Solaire, Dakar, Sénégal

[4] Centre de Suivi Ecologique, Dakar, Sénégal

Temporary water bodies dynamics play an important role in the epidemiological chain-borne diseases such as Rift Valley fever as they are the main breeding habitats for mosquitoes. During the rainy season, hundreds of these temporary water bodies appear and grow in the Ferlo region (Senegal). It is well known that the Rift Valley fever is transmitted by two types of mosquitoes (Aedes vexans and Culex poicipiles) commonly found in these ponds.

The purpose of our research is to investigate the impact of physical parameters of breeding on the occurrence of diseases in the framework of the QWeCI program. A simple lumped hydrological model is developed to simulate simulates daily variations (area, and volume) of two temporary ponds located in the environment and health observatory of Barkedji. The model describe each pond's watershed as three interconnected reservoirs: canopy, surface storage and soil storage and uses linearl relations to describe infiltration, percolation and baseflow (out of the soil reservoir). Given the depth of the water table in the region, percolation out of the soil surface if considered lost. Evapotraspiration was calculated using the Penman equation and withdraws water from the canopy and surface water reservoirs. Excess runoff from the soil storage is turned into runoff using a triangular unit hydrograph.

The Calibration was done using two years of hydrological and collected during the QWeCI campaigns of 2011 and 2012 rainy seasons. The calibration was successful and water level in the two ponds was simulated with a Root Mean Square Error (RMSE) of 4cm. Due to the short duration of the observation, no validation could be done. Given the excellent agreement of the simulated and observed water levels during the calibration phase, the modeling exercise was considered to be successful. The developed models will soon be used to generate historical time series of pond areas and correlate these to mosquitoes infestation in the region. Future time series of pond areas will be generated as well in order to assess the evolution of the disease in the next 40 years.

Impact of climate change on malaria transmission in Africa: the good, the bad and the unknown

Cyril Caminade,[1] K. M. McIntyre,[1] R. S. Kovats,[2] J. Rocklov,[3] A. M. Tompkins,[4] F. Jesús Colón-González,[4] H. Stenlund,[3] P. Martens,[5] S. J. Lloyd,[2] G. Nikulin,[6] C. Jones,[6] M. Baylis,[1] A. P. Morse[1]

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Malaria is an important disease that has a global distribution and significant health. In 2010, 81% of the global number of human cases and 91% of human deaths due to malaria were reported for the African continent solely by WHO. Malaria is also one of the few health outcomes that has been modelled by more than one research group, and can therefore facilitate the first model inter-comparison for health impacts. A novel ensemble approach is utilized to estimate the impact of climate on the future burden of malaria. Five different numerical malaria models driven by an ensemble of global (ISI-MIP) and regional climate model (CORDEX) scenarios are employed to achieve such a task. Results show that a robust multi-model agreement is shown over the African highlands where future climate appear to be suitable for malaria transmission. However, this result needs to be put in the context of an observed decline in malaria endemicity over the 20th century and be put into perspective with other important factors such as anthropogenic induced changes in the ecosystems, vectors resistance to insecticides, deficiencies in control measures, demography, urbanization, deficiencies in local health services.

A meta model for vector borne disease: An application model on Rift Valley Fever in Barkédji

Ahmed Tidjane Cissé,[1] A. Bah,[1] Z. Guessoum[1]

[1] Université Cheikh Anta Diop de Dakar, Senegal

Researches on vector borne diseases epidemiology responds to a situation where the anticipation of events has a great importance. We are thus working on the designing of a meta-model on this kind of disease. What we aim is to integrate knowledge which is known to be distributed among specialists in a generic tool covering all stages from modelling a vector borne system to its simulation. Its implementation is done through a multi agent

system whose specificity is the proposal of a representation paradigm for the environment based on the duo <physics, weather>. We introduce here a technique for coupling individual-based models and environmental models (climate, water …). We reuse the Rift Valley fever agent based model to present in details these meta-model and to test our approach. Like in the previous version, ODD protocol is followed. This allows us to have an organisation in the designing of the model and a method in the calibration and the interpretation of results. We were thus able to verify our meta-model by comparing scenarios of epidemic years or non-epidemic years.

The Barkedji pilot project: entomological findings on malaria vectors

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Malaria is one of the most serious public health problems in the world. The role of climate and environmental factors as driving force for malaria transmission has been already stressed. The Liverpool Malaria Model based on weather parameters can assess the changes to malaria transmission. With the global approach to validate and improve the LMM model, field entomological studies were conducted within the Barkedji pilot project to determine all the entomological parameters involved in this model. Six villages belonging to 4 different ecological classes (wooded savanna, shrubby savanna, bared soils and steppe) were selected. Mosquitoes were collected during the rainy season from 2010 to 2012 on a bi-weekly basis from July to December.

This study has shown within a limited area, significant variations for malaria parameters according to the landscape classes land season. Anopheline species abundance was different between villages with highest abundance observed in villages located in savanna and bared soils. Spatial and temporal significant variations were also observed in biting densities both between villages and during the three years. The study of the host-seeking behaviour exhibited an exophagic behaviour for malaria vectors and a feeding pattern dependent on the availability of alternative hosts. The entomological inoculation rate revealed a heterogeneous transmission with minima in shrubby savanna and steppe villages. The use of these estimated parameters will enable the employment of such a model in the prediction of outbreaks based on climatic and environmental parameters.

Climate and health: observation and modelling malaria in Ferlo (Senegal)

Ibrahima Diouf,[1] J. A. Ndione,[2] A. Deme,[1] A. T. Gaye,[1] B. Rodríguez–Fonseca,[3] R. Suarez[3]

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Our research on spatial and temporal variability of climate parameters such as rainfall and temperature, and their impact on seasonal malaria incidence risk is an important component in QWeCI project. The main issue is to understand and show the links between seasonal vector-borne diseases and climate variability. In our case of study we will analyse the links between malaria and climate variability in Ferlo for the present and future projections. The study is particularly conducted in the Ferlo of Senegal observatory, and extended to the Sahelian and West African areas as the large scale to be considered also. The study is based on observations and simulations monitoring database. For this reason, we use the Liverpool Malaria Model (LMM) but also its interface DMC Disease Model Cradle (DMC) for our local application framework for running the LMM.

As it is shown with our observations in conjunction with PNLP (Programme National de Lutte contre le Paludisme au Senegal), but also with the LMM and DMC simulations, the high malaria transmission is concentrated towards the end of the rainy season in Senegal. The rains in Ferlo and Senegal generally are characterized by a strong seasonality with maximum frequency in august, and strong inter-annual variability for all the West African and Sahelian regions. Moreover, it is noticed a relationship between rainfall variability observed during a month and the malaria incidence transmission risk during the following months. This shift from one to two months is consistent with knowledge on the parasite sporogonic cycle, the vectors livehood and interactions parasite-vector-human.

The main issue of the following work consists to consider CMIP5 and CORDEX simulations with different scenarios and then uses them as inputs to force LMM for malaria projections evolution. We would like also to force the LMM with the statistical prediction model developed in my host Universidad Complutense de Madrid.

Seasonal-to-decadal prediction of the West African monsoon

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[6] Department of Meteorology, University of Reading, UK

Seasonal and decadal hindcasts are analysed to explore whether current forecast systems are able to obtain skilful predictions of the dominant West African monsoon precipitation regimes in a range of time-scales. Seasonal/annual prediction skill is assessed using the ECMWF System4 and NCEP CFSv2 operational forecast systems. Multi-annual/decadal prediction skill is evaluated using the ENSEMBLES multi-model and perturbed-parameter decadal hindcasts.

The analysis of the seasonal/annual skill is based on an evaluation of the forecast systems' ability in simulating and predicting the intra-seasonal timing of the latitudinal rain-belt migration. The observed interannual variability of the monthly-mean longitudinally-averaged precipitation is dominated by the Guinean and Sahelian rainfall regimes. Both modes are skilfully predicted, although while the skill for the Guinean-mode is statistically significant up to a 3-month lead time, the Sahelian-mode skill is statistically different from zero only at zero lead-time.

Area-averaged rainfall indices and spatial EOF analysis are used to assess the ENSEMBLES decadal hindcasts. The results suggest that there is no significant multi-year skill in predicting the rainfall regimes. The Atlantic Niño (AMO) represents the leading forcing for the simulated Guinean (Sahelian) precipitation. The ENSEMBLES multi-model and perturbed-parameter forecast systems show multi-year prediction skill of the AMO and Atlantic-3 SST indices.

Performance assessment of ECMWF System 4 forecasts with the Liverpool Malaria Model

A. Jones,[1] D. Macleod,[2] J. Lauderdale,[1] F. Di Giuseppe, A. P. Morse[1]

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[2] University of Oxford, UK
[3] European Centre for Medium–Range Weather Forecasts, UK

This presentation will summarise the work carried out at Liverpool on performance assessment of the ECMWF System-4 seasonal forecasts using the Liverpool Malaria Model. Evidence of skill is found at tier-2 (relative to ERA-Interim-driven model-simulated malaria) at the epidemic fringe in the western Sahel for predictions of malaria in September to November made in July, and in north-western Malawi for malaria in March to May for predictions made in October. In Botswana, forecasts of both low and high malaria events have significant skill at tier-3 against a published index of malaria and the forecasting of high malaria events with System 4 shows a marked improvement in forecast skill compared to the ECMWF model and even the multi-models from DEMETER and ENSEMBLES. When driven with spatially bias-corrected ERA-Interim rainfall, the malaria model simulations show improvements in the position and shape of the epidemic fringe in West Africa, but the calibration scheme does not improve the forecasts for Botswana.

Relative importance of climatic, geographic and socio-economic determinants of malaria in Malawi

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We propose a statistical framework to model malaria risk at the district level in Malawi, using an age-stratified spatio-temporal dataset of malaria cases from July 2004 – June 2011. The model incorporates many socio-economic factors influencing malaria incidence, but also accounts for the influence of meteorological conditions on the disease. In order to account for the unobserved confounding factors that influence malaria, which are not accounted for using measured covariates, a generalised linear mixed model (GLMM) is adopted, which includes structured and unstructured spatial and temporal random effects. A hierarchical Bayesian framework, using Markov chain Monte Carlo (MCMC) simulation, was used for model fitting and prediction. Using a stepwise model selection procedure, several explanatory variables were identified to have significant associations to malaria including climatic, cartographic, and socio-economic data. Once unobserved confounding factors and

spatial correlation were considered in a Bayesian framework, a final model emerged with statistically significant predictor variables limited to the number of health facilities per inhabitant, insecticide-treated net distribution, average precipitation (quadratic relation) and average temperature during the three months previous to the month of interest. When modelling malaria risk in Malawi it is important to account for provision of health facilities, the distribution of insecticide-treated nets, the annual cycle, spatial heterogeneity and correlation between districts. Once these confounding factors are allowed for, other socio-economic factors are not found to be statistically significant and only the precipitation and temperature in the months prior to the malaria season of interest are found to significantly determine spatial and temporal variations of malaria incidence.

Assessments for the impact of mineral dust on the meningitis incidence in West Africa

Nadège Martiny[1]

[1] Université de Bourgogne, France

Meningoccocal meningitis (mainly bacteria: *Neisseria Meningitidis* serogroups A and W135) outbreaks are a major public health problem in Africa. Every year during the dry season (February-May), 25 to 250 000 cases are recorded by WHO in the 10-15°N latitudinal belt, referred to as "the meningitis Belt". On average, 10% of cases are fatal and 10-20% of survivors present severe neurological sequelae. In addition, the affected population is predominantly young, children under 15 years. The transmission of the disease being mostly inter-human, the importance of societal factors (number of persons per house, smoke exposure, immunity, population dynamics, ...) in the expansion of the epidemics is undeniable. However, what about the intensity, the outbreak and more generally the calendar of the epidemics? Do climatic and environmental variables play a role? At which spatial and temporal scales? What are the processes involved?

The “climate-dust-meningitis” AMMA research group aims to better understand the role of climate and mineral dust on meningitis outbreaks in the Belt. Scientific research has already enabled to identify the more precise climate and environmental variables associated with the epidemics risks. The next step is the modelling of these variables in order to respond to a strong demand of WHO to improve the vaccination strategies in the Belt (MERIT groups). This work will be given possible based on the specific skills of the *Centre de Recherches de Climatologie*, international specialist in tropical climate and its modelling in Africa, but also thanks to its partners in the frame of the AMMA “climate-dust-meningitis”. Indeed, this group, mainly composed of geophysicists, climatologists and remote sensing experts at the beginnings of AMMA in 2004, has gradually opened to epidemiology, medicine, biostatistics, geography and history.

Rainfall and RVF emergence in Senegal: beyond twenty years of investigation, lessons learned and perspectives

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RVF is one of this forty emergent and re-emergent diseases that can affect human beings; it's an acute fever-causing viral disease that affects domestic animals and humans. The RVF virus belongs to the genus *Phlebovirus* in the family *Bunyaviridae*; it's transmitted to vertebrate hosts by infected floodwater mosquitoes, namely species of *Aedes* and *Culex*. RVF virus affects livestock (cattle, goats, sheep and camels) and causes high mortality and abortions in pregnant females. Humans can be infected (encephalitis, hemorrhagic ocular disease). Since the first Rift Valley fever (RVF) epidemics occurred in 1987 at the border between Senegal and Mauritania, scientific teams involved in these investigations have been widen along the years; new ideas and methodological approaches have been developed. The emergence of this zoonosis has always been associated with rainfall. This article gives an overview of the ideas and history related to more than three decades years of research, focusing on the Senegal River basin. It aims to review the major scientific results, highlight relevant and targeted scientific achievements that have been accomplished, lessons learned based on the concept dealing with tele-epidemiolology that consists in monitoring and studying the propagation of human and animal diseases (water, air and vector borne diseases) which are closely linked to climate and environmental changes, based on space technology. The French Space Agency has thus developed this concept based on a deterministic approach of the climate-environment-health relationships. This paper discusses also the perspectives for health early warning systems using remote sensing against future epidemics outbreaks.

Seasonal prediction of the intraseasonal variability of the West African monsoon precipitation

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The West African monsoon (WAM) rainy season peaks in boreal summer. Its variability can be understood as the result of two rainfall regimes: the Guinean and the Sahelian regimes. In this study, three operational dynamical forecast systems are used to assess the current seasonal forecast quality of these two modes of the WAM rainfall variability. A simple statistical-empirical model based on lagged regression, which has the equatorial Pacific and Atlantic Ocean sea surface temperature as predictors, is used to predict the principal components associated with these two modes of variability. Decision makers usually require a single source of probabilistic information instead of a set of uncalibrated predictions. The multi-model technique has been widely used to combine several sources of information into a single forecast. The Forecast Assimilation, which is a Bayesian approach for calibrating and combining predictions from different sources, is used to combine the four forecast systems. The skill of this combination is compared to the skill of a simple multi-model where all single forecast systems are merged with equal weight. The forecast quality assessment of the deterministic and probabilistic predictions of the two modes of variability is assessed for the combinations and the single forecast systems.

Statistical modelling of Rift Valley fever vectors abundance in a Sahelian area (Barkédji, Senegal, West Africa)

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Rift Valley Fever (RVF) is an emerging mosquito-borne disease representing a threat to human and animal health in Senegal. Although promising modelling approaches have been proposed in East Africa, their application to West Africa remains so far unsatisfactory since data available are rare and the dynamics of emergence seems to be different. Indeed it is well known that RVF virus outbreaks in East Africa follows periods of abnormally high rainfall and could be predicted up to 5 months in advance using sea surface temperature anomalies, satellite normalized difference vegetation index. In contrast, models proposed for West Africa are rare, restricted to the analysis of rainfall impact and do not integrate a spatial dimension.

A spatio-temporal model (Bayesian GLMM models) was developed in order to predict the temporal period and the specific areas with highest vector productivity. Dataset on RVF vectors as well as environmental and climatic parameters were generated as part a longitudinal study conducted in 2005 every fortnight at 79 sites including temporary ponds, barren, shrubby savannah, wooded savannah, steppes, and villages at different distances (between 0 and 600 m) from the main ponds in Barkedji area.

Our finding showed the importance of environmental factors and weather conditions in predicting mosquito abundance. Relative humidity was positively correlated with the main RVF vectors abundance. Maximum temperature and rainfall were associated with the number of collected mosquitoes. The highest vector densities were observed around ground pools and neighboring sites.

Identifying biotopes, weather conditions and geographical areas where the vectors abundance are highest can help for better intervention strategies implementation and for the improvement of our knowledge on RVF epidemiology.

Select biographies

Laragh Larsen

Trinity College, Dublin (Ireland)

Laragh Larsen is a Research Fellow in the Department of Geography, Trinity College, Dublin, Ireland. She is currently investigating the historic and socio-economic dimensions of environmental change and disease transmission in eastern Africa as part of the EU FP7–funded project, HEALTHY FUTURES. Prior to this she carried out research on the human dimensions of environmental change theme of the EU–funded CREATING project. Laragh carried out her Ph.D. thesis in historical geography in Trinity College, Dublin, graduating in 2007, and also previously obtained a B.A. in Geography through Natural Science and a Postgraduate Diploma in Statistics from Trinity College, Dublin. The title of her Ph.D. thesis is '*Shaping the Symbolic Landscape: Public Monuments in Nairobi, 1899-1992*'.

Nadège Martiny

Université de Bourgogne (France)

Nadège Martiny is a physicist specialist of the atmosphere and passive optical remote sensing of aerosols. She is a university lecturer at the Centre de Recherches de Climatologie team in the Biogeoscience laboratory in Dijon, France. She works on the regional impacts of climate in semi-arid Africa since 2004. She coordinates the research team 'Climate–Aerosol–Meningitis' in the frame of the 'Climate-Health' working group of the African Monsoon Multidisciplinary Analyses (AMMA) programme since 2007 and works with epidemiologists since 2009 in the frame of the Meningitis Environment Risk Information Technologies (MERIT) community.

Nick Ogden

Centre for Food–borne, Environmental & Zoonotic Infectious Diseases, Public Health Agency of Canada (Canada)

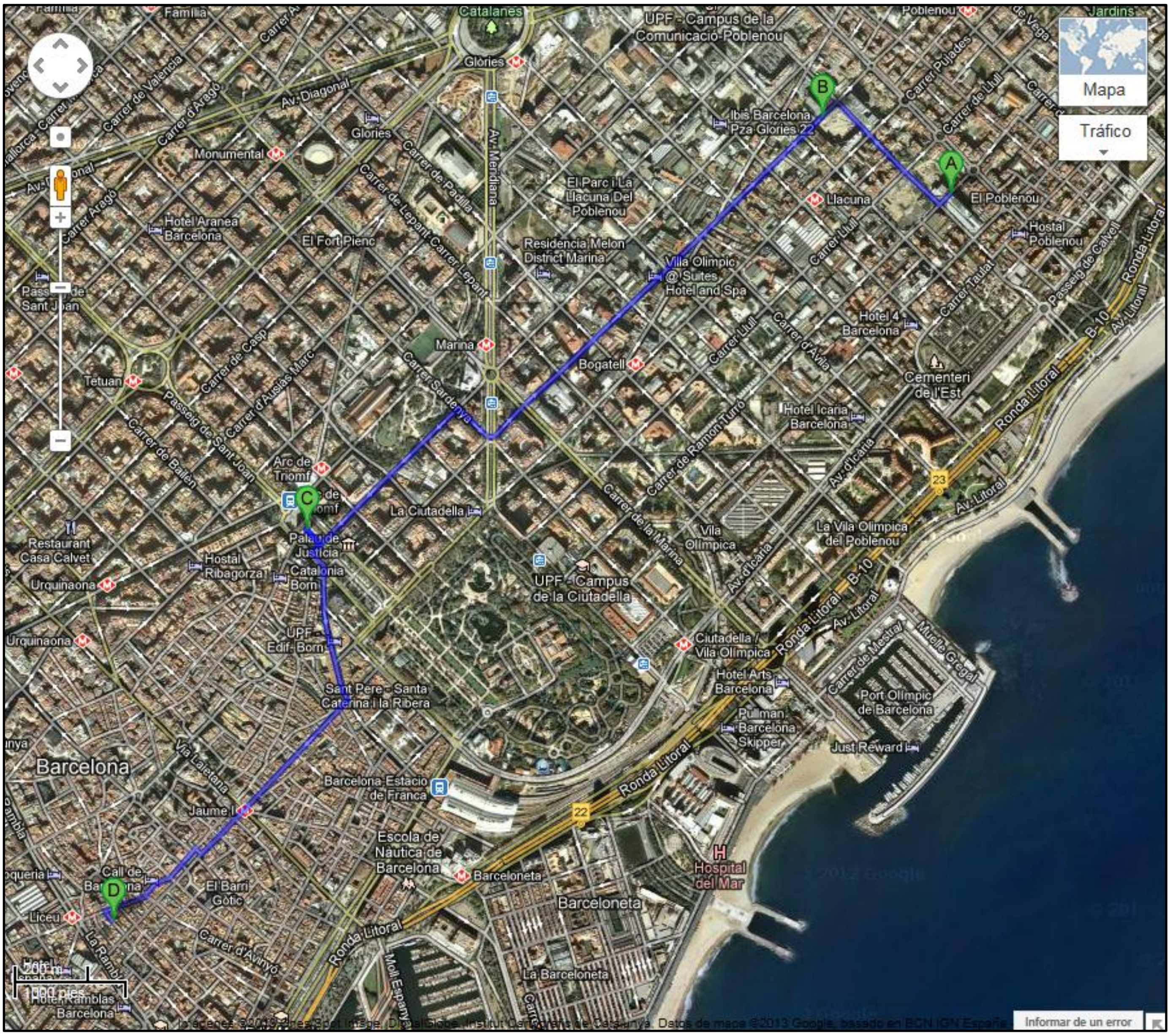
Nick Ogden is a UK–trained veterinarian (University of Liverpool, UK, 1983). After 10 years of mixed clinical practice, he then completed a doctorate in Lyme disease ecology at the Department of Zoology, University of Oxford, UK, in 1996. During the six years he spent as a lecturer at the Faculty of Veterinary Science, University of Liverpool, he continued his research into the ecology and epidemiology of tick–borne diseases of public health importance in Europe and those of importance to livestock production in Africa. In 2002 he moved to Canada, where he continued research on the ecology of Lyme disease and other zoonoses and climate change as a research scientist at the Public Health Agency of Canada. As interim Director of the Environmental Issues Division of the Public Health Agency of Canada he directed a program on climate change and vector and water-borne disease risks, and community adaptation to these risks. After two years as a Director he is currently a senior research scientist within the Zoonoses Division of the Public Health Agency of Canada focusing on the ecology and epidemiology of zoonoses.

Jan Polcher

Institut Catala de Ciencies del Clima (Spain)

Jan Polcher is the Head of Environmental Modelling Unit (EMU), based at Institut Catala de Ciencies del Clima, Barcelona, Sapin, which develops multidisciplinary tools able to assess the state of the environmental resources and their evolution under various assumptions of climate change and societal usage of these resources. His self-professed career goal is to enhance understanding of the global environment and to predict its evolution and impact, using modern computer technology. Current research interests include: improving the understanding and ability to model land–surface/atmosphere interactions; studying the influence of land–surface changes on the mean climate and its variability; and predicting the impact of climate change on land–surface processes, and he is involved in the African Monsoon Multidisciplinary Analyses (AMMA) programme.

Key locations



A
Conference Venue
Confotel Barcelona
Carrer Ramon Turró, 196 – 198,
Barcelona

B
Holiday Inn
Carrer Pallars, 203,
Barcelona

C
Starting point of the Cultural Tour
Led by Professor Mariano Barriendos
Arc de Triomf,
Barcelona

D
Project Meal Venue
Can Cullen Restaurant
Carrer Quintana, 5,
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Coordination

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Keep up to date

Please visit the QWeCI website for project details, partner information, and regular updates:

http://www.liv.ac.uk/qweci

Twitter

The QWeCI Project will be tweeting about the final meeting. If you're on twitter, follow us: **@QWeCI_FP7**

If you're interested in tweeting about the conference, please use **#QWeCI**

Our Twitter account will be used to publicise major results throughout the reporting period and to publicise work going on beyond the QWeCI Project.

Publications

The Project Office would be grateful if partners and researchers could send details of any publications as part of the QWeCI Project.

Please use the following wording when acknowledging QWeCI funding in your publications:

> *This study was funded by the EU project QWeCI (Quantifying Weather and Climate Impacts on health in developing countries; funded by the European Commission's Seventh Framework Research Programme under the grant agreement 243964)*

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