



**Grant agreement no. 243964**

**QWeCI**

**Quantifying Weather and Climate Impacts on Health in Developing Countries**

**M5.1.a: First versions of all SDSS, IS, and MT based on the knowledge attainment regarding the requirements of stakeholders and decision makers**

Start date of project: 1<sup>st</sup> February 2010

Duration: 42 months

**Lead contractor :** UOC  
**Coordinator of milestone :** Prof. Andreas H. Fink  
 Dr. Volker Ermert

**Evolution of milestone**

**Due date :** M18  
**Date of first draft :** M20  
**Start of review :** M20  
**Milestone accepted :** M20

Project co-funded by the European Commission within the Seventh Framework Programme (2007-2013)		
Dissemination Level		
PU	Public	PU
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

## Introduction

*Work Package* (WP) 5.1 of the QWeCI project aims to develop integrated information and decision support systems based on the scientific output of various other WPs. The main challenge is to transfer complex scientific climate-disease results to the stakeholders in the target countries. In order to put science into action the QWeCI project develops a multi agency system. This system will consist of decision support tools such as *Information Systems* (ISs), *Monitoring Tools* (MTs), or *Spatial Decision Support Tools* (SDSS). These systems are developed following a stakeholder dialogue, which is undertaken by the project partners of the pilot countries. The stakeholder dialogue identified amongst others the requirements and skills of the end-users. This will ensure a user-friendly development of the various systems.

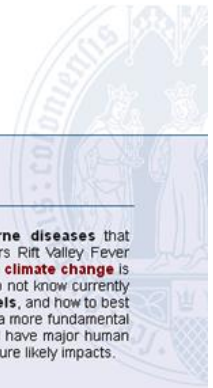
Due to the delay of the stakeholder dialogue (D5.1.a) the development of the first systems versions was also delayed. For this reason, the reporting of M5.1.a at M12 is undertaken with that of M18. So far, the UoC set up a web-based Java framework in which various systems will be implemented. In a first step, a pilot system of the multi agency system was developed by the UoC, which supported the stakeholder dialogue since this system can be considered as a prototype system. The African partners furthermore identified the required information and data that shall be included into the systems. UNIMA already successfully constructed the MT of near-real time disease incidence in health clinics of Malawi. This system is a stand-alone system and needs not to be included into the web-based Java framework of the UoC.

## The web-based Java framework

For the development of the multi agency system a web-based Java framework was set up by the UoC and a pilot system was constructed. The web-based Java framework includes:

- A virtual Linux machine (qweci.uni-koeln.de).
- The usage of Apache Tomcat (version 6.0.26), which is an open source servlet container providing a 'pure Java' web server for Java code to run.
- The application of Java, which is an open source, class-based and object-oriented programming language.
- The utilisation of the *Google Web Toolkit* (GWT, version 2.1.1). GWT is open source and represents a development toolkit for building and optimizing complex browser-based applications. The *GWT Software Development Kit* (SDK) provides a set of core *Java Application Programming Interfaces* (APIs) and widgets, which will be used for the set up of various systems of the multi agency system of WP5.1.

In addition to the set up of the framework, the UoC trained staff in terms of the application of Java. Dr. Volker Ermert as well as Roderick van der Linden attended a Java programming course of the Institute of Informatics of the UoC. Furthermore, Dr. Ermert autodidactically educated himself via a new Java video tutorial in the web (<http://www.javavideokurs.de>).



**QWeCI**

- Goals & objectives
- Expected results
- Atmospheric database**
- Multi Agency System
- HEWS**
- Disease Operation System
- MT for standing water
- MT for near real-time disease incidence

**Quantifying Weather and Climate Impacts on health in developing countries**

One of the most dramatic and immediate **impacts of climate variation** is that on **diseases**, especially the **vector-borne diseases** that disproportionately affect the poorest people in Africa. Although we can clearly see that, for example, an El Nino event triggers Rift Valley Fever epidemics, we remain poor at understanding why particular areas are vulnerable and how this will change in coming decades, since **climate change** is likely to cause entirely **new global disease distributions**. This applies to most vector-borne diseases. At the same time, we do not know currently the limit of **predictability of the specific climate drivers** for vector-borne disease using state-of-the-art **seasonal forecast models**, and how to best use these to produce skillful **infection-rate predictions** on seasonal timescales. The QWeCI project thus aims to understand at a more fundamental level the climate drivers of the vector-borne diseases of **malaria**, **Rift Valley Fever**, and certain **tick-borne diseases**, which all have major human and livestock **health** and implications in Africa, in order to assist with their short-term management and make projections of their future likely impacts.




The main specific tasks of Cologne's QWeCI team are as follows:

- ▶ Formation of an **atmospheric data** base with health relevant data sets.
- ▶ Development of an **integrated decision support framework** for health impacts of climate and weather, i.e. the construction of decision support systems, information systems, and monitoring tools.


Web-portal as based on the Java framework of the UoC regarding QWeCI available at <http://qweci.uni-koeln.de>.

**The alpha version of the web-based Liverpool Malaria Model (the pilot system)**



**QWeCI**  
 on health in developing countries

University of Cologne  
 Institute of Geophysics and Meteorology



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QWeCI

Atmospheric database

Multi Agency System

**HEWS**

Malaria

Rift Valley Fever

Disease Operation System

MT for standing water

MT for near real-time disease incidence

**Liverpool Malaria Model (LMM)**

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**Data type**

point data  
 grid data

**Data input**

example (default data / Parakou)  
 data upload

▶ daily mean temperatures    locale file:    
 ▶ daily precepitation    locale file:

available datasets

**Modell version**

original version (Hoshen & Morse 2004)  
 modified version (Ermer et al. 2010a,b)  
 new version

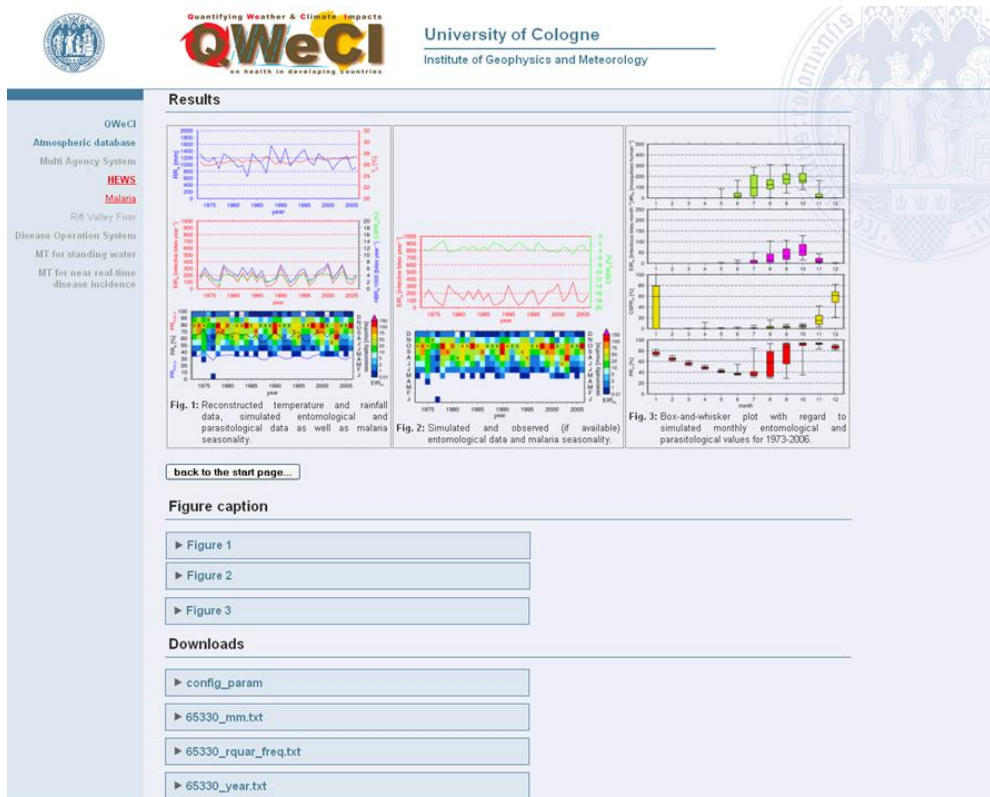
<b>gonotrophic cycle</b>	D <sub>gH</sub> <input type="text" value="37.1"/> *days	D <sub>gI</sub> <input type="text" value="65.4"/> *days	T <sub>gH</sub> <input type="text" value="27"/> °C	T <sub>gI</sub> <input type="text" value="45"/> °C
<b>rainfall &amp; eggs</b>	RR <sub>1</sub> <input type="text" value="10"/> mm	RR <sub>2</sub> <input type="text" value="3.0"/> mm	#E <sub>0</sub> <input type="text" value="120"/> eggs per female mosquito	
	U <sub>1</sub> <input type="text" value="0"/> mm	S <input type="text" value="10"/> mm	U <sub>2</sub> <input type="text" value="500"/> mm	
<b>larvae &amp; mosquitoes</b>	CAP <input type="text" value="400"/> fertile mosquitoes		MMA <input type="text" value="12"/> days	
	Pd <input type="text" value="Martens II"/> scheme	Pd <sub>1</sub> <input type="text" value="-10"/> %	Pd <sub>2</sub> -RR <input type="text" value="82.5"/> %	
<b>sporogonic cycle</b>	D <sub>s</sub> <input type="text" value="111"/> *days	T <sub>s</sub> <input type="text" value="16"/> °C		
<b>transmission</b>	a <input type="text" value="80"/> %	b <input type="text" value="30"/> %	c <sub>a-c</sub> <input type="text" value="0.5"/>	
	τ <sub>im</sub> <input type="text" value="1.01"/> added infectious mosquitoes per 10 days			
<b>infection</b>	HIA <input type="text" value="20"/> days	r <input type="text" value="0.0050"/> day <sup>-1</sup>	GF <input type="text" value="50"/> %	c <input type="text" value="20"/> %

**LMM simulation**

Start page of the pilot system including the configuration of the following LMM simulation.

In order to represent parts of the application spectrum of the web-based Java framework a pilot system is developed. At present the alpha version of the pilot system was

constructed. The system makes use of the so-called *Liverpool Malaria Model* (LMM), which is a weather-driven malaria model that is run by daily temperature and rainfall data (see Hoshen and Morse 2004). The system will be primarily intended to be used for the construction of specific sets of parameter settings for the QWeCI pilot regions (e.g. for rural and urban areas of Kumasi). Users can, for example, use this system to hindcast malaria epidemics for specific locations or they could try to forecast malaria outbreaks via the seamless weather forecasts/projections of the QWeCI project. Due to the lack of calculating capacity of the QWeCI server, the model runs will be performed only for specific locations.



*Final page of the web-version of the LMM that includes the output data as well as pre-defined figures of the LMM simulation.*

In the alpha version of the pilot system, the user is able to run the *LMM version of 2004* (LMM<sub>2004</sub>; Hoshen and Morse 2004), *that of 2010* (LMM<sub>2010</sub>; Ermert et al. 2011a,b), as well as by a self-defined set of parameter setting. At present, model runs can only be performed for 34 synoptic weather stations in West Africa (including three stations in Cameroon) covering the period 1973 to 2006. The model output can be analyzed by means of three pre-defined figures, which are visualizing eleven entomological and parasitological malaria variables. Furthermore, the user is able to download the output files of the LMM including the monthly and yearly output as well as quartile statistics in terms of the simulated and observed (if available) annual values between 1973 and 2006.

For the upcoming beta version of the pilot system, it is planned to enable runs via the input of data from the user and to include additional pre-defined graphics in terms of the analysis of the model runs. It is further planned that the final version of the web-version of the LMM will enable to drive different model versions by downscaled and calibrated seamless seasonal atmospheric forecasts as well as decadal projections. The pilot system will be therefore part of the *Health Early Warning System* (HEWS).

## **The Health Early Warning System**

The formation of the *Health Early Warning System* (HEWS) strongly depends on the performance of seasonal health forecasting (WP 4.1). This system will be developed for the stakeholders in the target countries. Operational disease forecasts will only be set in place, when both the seamless seasonal atmospheric forecasts and the disease modeling provide skillful results. Note that at present the disease modeling lacks detailed validation data such as long and quality-controlled time series of malaria cases. In case that a robust validation of the disease models is not possible, the disease forecasts will only be provided to the stakeholders and will not be published. These prototype forecasts might be able to raise the awareness of the stakeholders in terms of the provision of validation data and the set up of an adequate monitoring system. Only the involvement of the stakeholders in the target countries as well as an intense interaction between the stakeholders and modelers will enable skillful disease forecasts.

Against this background the final design of the HEWS is delayed until the disease forecasts are produced using ECMWF System 4 hindcasts and have been compared with available validation data. At the present stage it is planned to include the web-version of the LMM into the HEWS. It is furthermore foreseen to add other malaria and rift valley fever models like the *VECTOR borne disease infection model of ICTP TRIeste* (VECTRI) into the HEWS. These models would enable end-users to carry out their own climate-health analyses and seasonal to decadal projections of disease transmission and to compare the results from various models.

One component of the HEWS will be an IS in which KNUST and IPD describe mechanisms for early planning of vector control programs in Ghana and Malawi, respectively.

## **The Monitoring Tool for Standing Water**

This formation of the MT for standing water in Senegal in the Barkedji area is led by CSE and the UoC will support the inclusion of the MT into the web-based Java framework. CSE intends to use remotely sensed water bodies from Senegal that serve as mosquitoes breeding sites. Satellite images and other datasets were identified that shall be used by the MT. Preliminary results for the year 2010 rainy season were produced and will be included into the MT.

The draft of a first system version by CSE is foreseen for M21 of the project (October 2011). The proposed design will include an analysis of the data flow as well as a design of the MT. The first draft will be discussed with the UoC in terms of the feasibility of the inclusion of the MT into the web-based Java framework. In the following, the alpha version of the MT will be produced by the UoC and will be presented by CSE to the end users.

## **The Disease Operation System**

The construction of the Disease Operation System is led by IPD and the UoC will support the inclusion of this system into the web-based Java framework. IPD reviewed the strategies developed for malaria and *Rift Valley Fever* (RVF) and current methods of control developed in Senegal. The large distribution of *Insecticide Treated Nets* (ITNs), the introduction of *Rapid Diagnostic Test* (RDT), the treatment using *Artemisinin-based*

*Combination Therapies* (ACTs), and *Indoor Residual Spraying* (IRS) have generated a considerable decrease of malaria cases. It was found that in the context of an increased epidemic risk of malaria a functional system of monitoring, early detection and response of malaria cases is required. This information might be included into an information system, which could form one part of the Disease Operation System in Senegal.

Concerning the RVF disease, statistical models tracking the relationship between environmental variables and the proportion of mosquito vectors were analyzed. The validation process of the different models is underway. This could lead like the web-version of the LMM to the production of a SDSS.

The draft of a first system version by IPD is foreseen for M21 of the project (October 2011). The proposed design will include an analysis of the data flow as well as a design of the Disease Operation System. The first draft will be discussed with the UoC in terms of the feasibility of the inclusion of the system into the web-based Java framework. In the following, the alpha version of the Disease Operation System will be produced by the UoC and will be presented by IPD to the end users in Senegal.

## **The Monitoring Tool of near-real time disease incidence in health clinics**

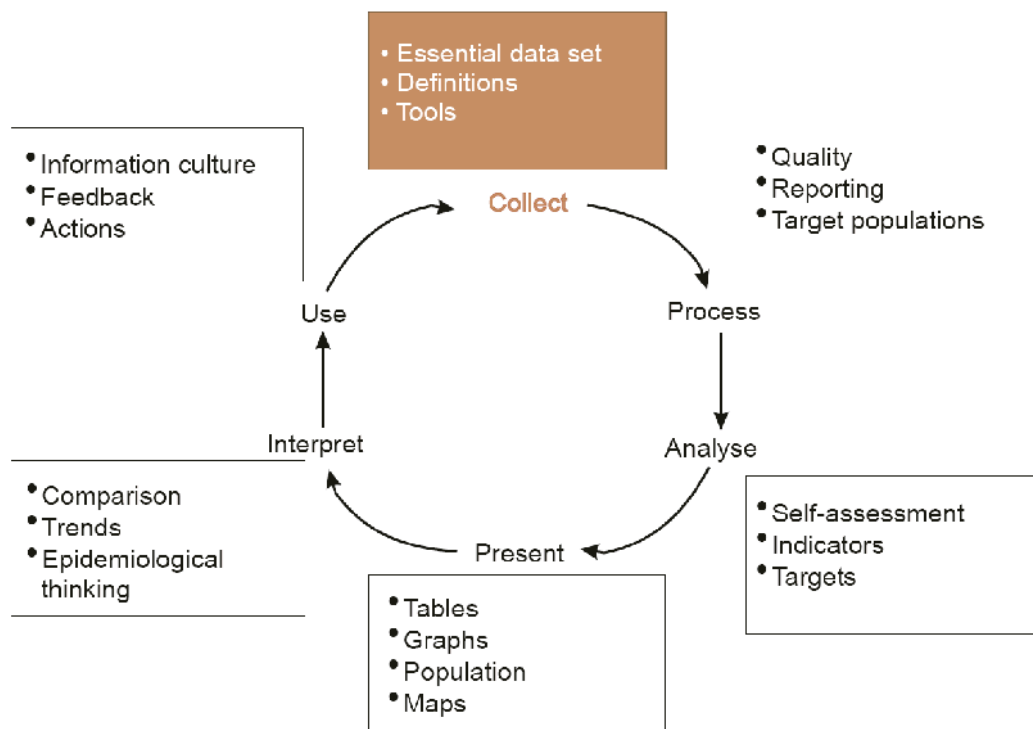
UNIMA successfully constructed the MT of near-real time disease incidence in health clinics of Malawi. This system is a stand-alone system and will not be included into the web-based Java framework of the UoC.

In the preparatory stages of the MT development, a preliminary study of the format, quality, and availability of the malaria incidence rate and meteorological data from individual locations was undertaken. In the following, the UNIMA was setting up the so-called *district Health Information System version 2* (dHIS2) of the University of Oslo (available from <http://www.dhis2.org>). The dHIS2 is a web-based IS (available under the password protected web page <http://www.hispmalawi.org.mw>) and was implemented at the UNIMA under the Linux Ubuntu platform. The IS is developed for the Malawi Ministry of Health and is used for the following purposes:

- Definition of data elements such as monthly malaria reports from health clinics
- Collection of disease data from health facilities in Malawi
- Serves as an data archive of disease incidence data in Malawi and provides quality checks of the data
- Visualization of time series of disease incidence data
- Computation of indicators of disease outbreaks and for the provision of early warnings
- Measures the impact of control measures/intervention
- Provides an assessment of the quality of outreach programs of the Ministry of Health (Is there a decline of, e.g. malaria cases, after the training of health facilities?)
- Construction of disease incidence reports that include predefined graphs and analyses

- Includes a Geographic Information System component, which is able to map the disease incidence data

## The Information Cycle



The information cycle of the dHIS2 (source: <http://www.dhis2.org>).

The screenshot shows the 'Create new data element group' form in the dHIS2 interface. The form includes a 'Name' field, a list of 'Available data elements' (such as 'Adult started on ART', 'Adverse Events Following Immunization', etc.), and a 'Group members' section with a filter and a list of members. The interface also shows navigation buttons like 'Add' and 'Cancel'.

Creation of a new data element group within the dHIS2 (source: <http://www.dhis2.org>).

Dashboard

[Insert Close Clear](#)

Map views

- ANC1 Coast ✖
- Fully Immunised Coast ✖

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[Insert Close Clear](#)

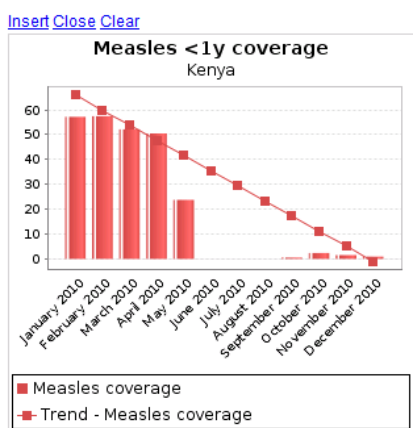
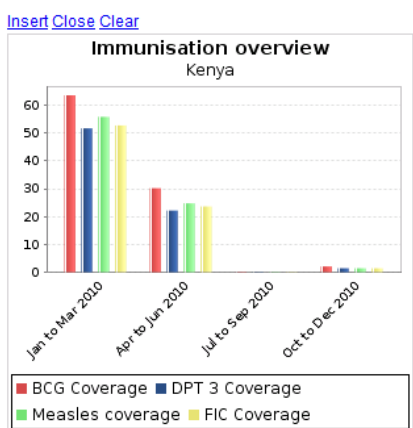
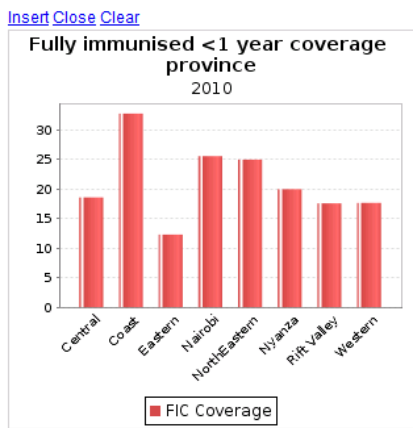
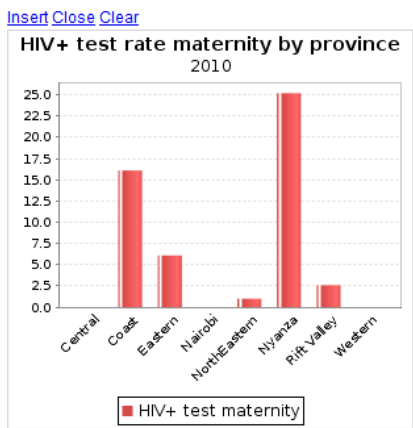
Reports

- Immunisation cumulative coverage chart ✖
- Life cycle ✖
- OPD top 10 new cases Total ✖
- PMTCT ✖
- Safe delivery overview ✖

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[Insert Close Clear](#)

Report tables



*Dashboard of the dHIS2 as providing analyses and pre-defined figures (source: <http://www.dhis2.org>).*

After the successful implementation of the system disease incidence data was digitized and inserted into the incidence database of the dHIS2. Training was provided at the facility and district level. Note, the data is usually collected and digitized at the district level. One key element in terms of the provision of the data is the WiFi link that was installed by ICTP in collaboration with UNIMA. Without the WiFi link a near-real time collection of the data would not be possible.

Various problems were faced, when the disease incidence data was collected:

- Untimely reporting
- No reporting
- Insertion of arbitrary disease values by the health facilities

For this reason, training programs were started and control audits were undertaken up to the facility level.

UNIMA intends to provide a detailed report on the formation of the MT of near-real time disease incidence at health clinics in Malawi until M21 of the project (October 2011).