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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: 1st February 2010 Duration: 42 months

Lead contractor: UoC
Coordinator of milestone: Prof. Andreas H. Fink
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Evolution of milestone

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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 Systems* (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.

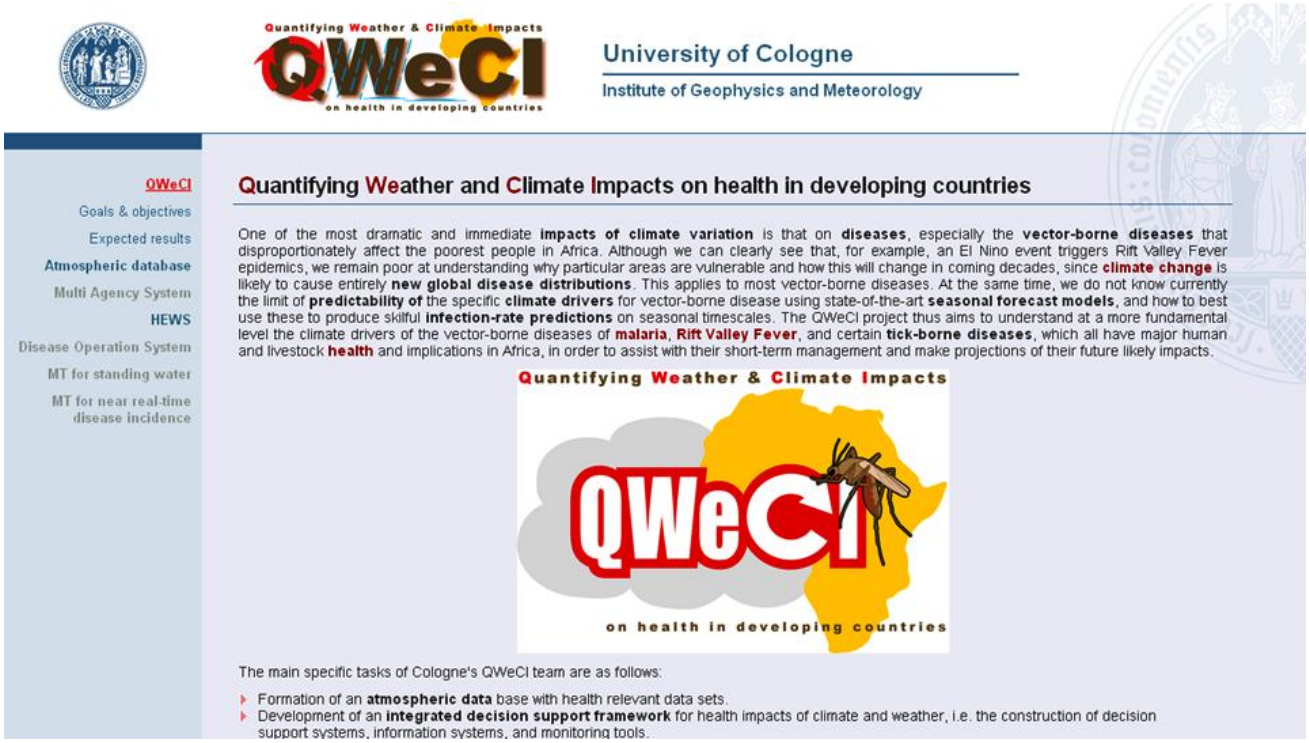
Due to the delay of the stakeholder dialogue (D5.1.a) the development of the first systems versions was also delayed. So far, the UoC set up a web-based Java framework in which various systems will be implemented. In a first step, a pilot system of the multi agency system was developed by the UoC, which 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. IPD designed a SDSS in terms of a statistical Rift Valley fever model, which relates meteorological variables to the density of Aedes mosquitoes in different environments.

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:

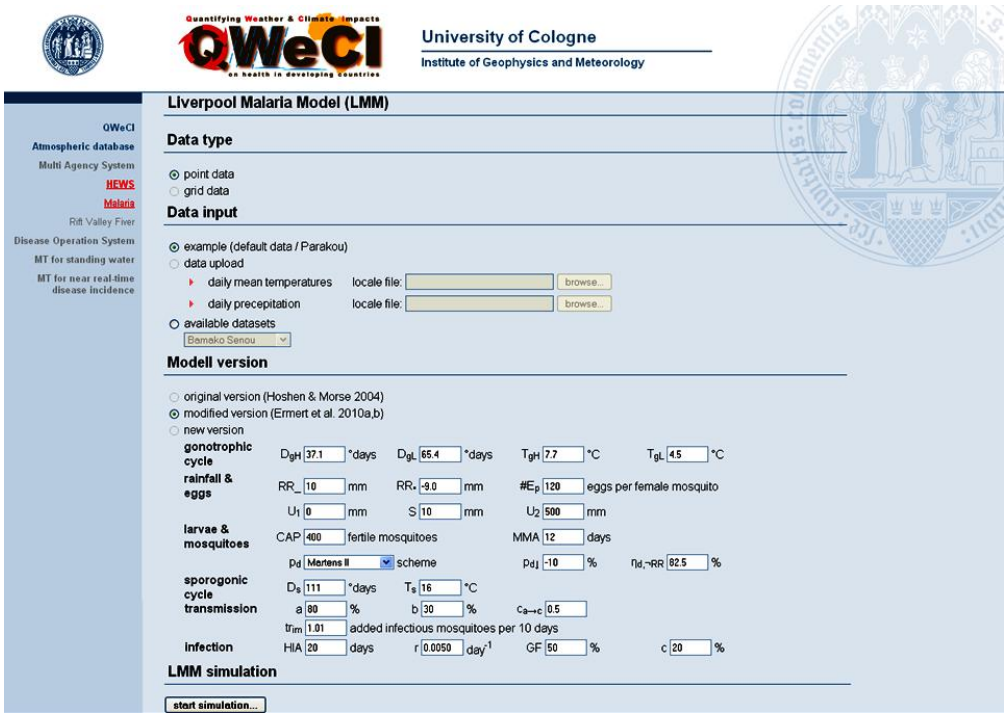
- A virtual Linux machine (qweci.uni-koeln.de).
- The usage of Apache Tomcat (version 6.0.26), which is an open source servlet container providing a 'pure Java' web server for Java code to run.
- The application of Java, which is an open source, class-based and object-oriented programming language.
- 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).



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

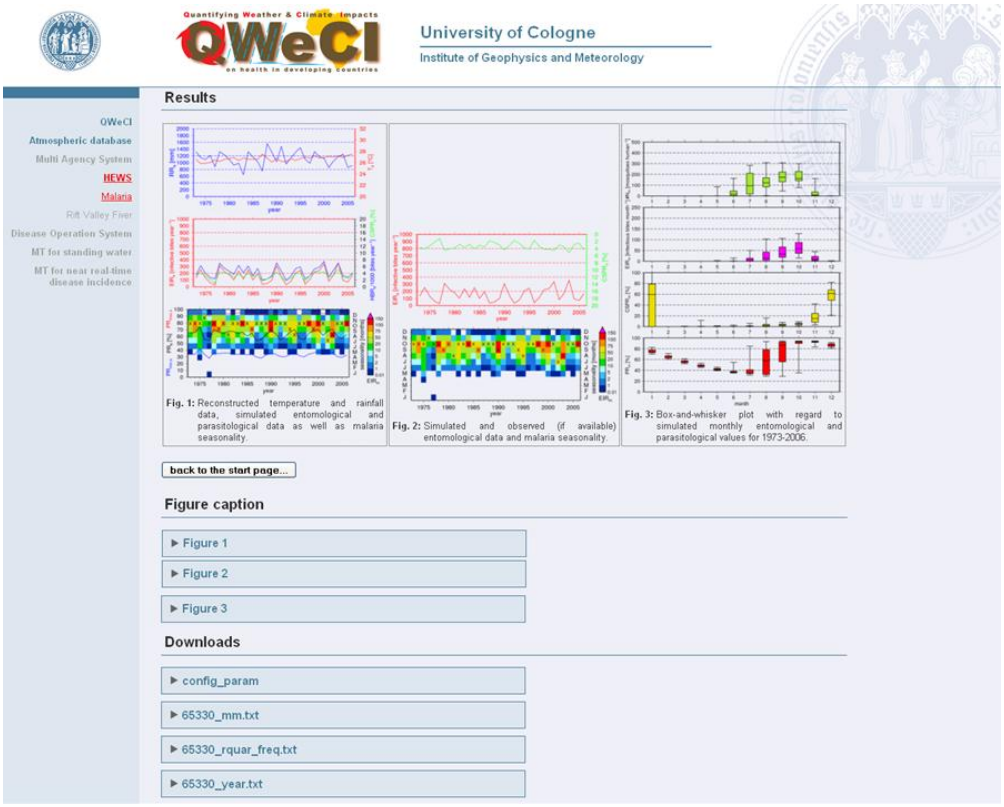
The beta version of the web-based Liverpool Malaria Model (the pilot system)



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 beta version of the pilot system was constructed.

The system makes use of the *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 University of Cologne 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 beta version of the pilot system, the user is able to run the *LMM version of 2004* (LMM_{2004}; Hoshen and Morse 2004), *that of 2010* (LMM_{2010}; Ermert et al. 2011a,b), as well as by a self-defined set of parameter setting. Model runs can 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.

In order to extend the scope of application of the web version of the LMM a new tool was added to the web system. The user can now also use his own temperature and rainfall time series for running the LMM. It allows scientists and stakeholders to see if the LMM is able to represent the malaria situation in their area. However, the users need to provide daily temperature and rainfall time series to the LMM. This new tool provides more information to scientists and stakeholders in terms of the application spectrum of the web-based Java framework of the multi agency system.

Before the user can start an LMM simulation by their own temperature and precipitation time series, the user must upload the input data in a specific format. The user needs to construct one single data file, which should be named by the used station (e.g. Accra.txt). This text file in ASCII (American Standard Code for Information Interchange) needs to include time series of daily mean temperatures and daily precipitation amounts. The daily mean temperatures must be provided in °C (degrees Celsius) and the daily precipitation amounts need to be given in mm (millimetres). The temperatures must be higher than -60°C and the precipitation amounts are not allowed to be negative. Note that only up to 50 years of data can be simulated by the LMM.

No data gaps are permitted for the temperature and precipitation time series and the time series must start at 1st January and end at the 31st December. Only full years are allowed including the data for 365 and 366 days, respectively. Therefore files with incomplete time series and years are rejected.

A short upload manual was also produced for the web version of the LMM. In the near future, it is planned to translate the English web version into French in order to simplify the access of French speaking stakeholders to the system. Moreover, the provision of weekly data output is foreseen in the next iteration of the LMM web version.

For the upcoming version of the pilot system, it is planned to include a translation into French and to add 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 modellers will enable skillful disease forecasts.

Against this background the final design of the HEWS is postponed until the disease forecasts are produced and have been compared with available validation data. At the present stage it is planned to included 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 following key questions were identified in terms of the generation of the HEWS:

a) Which input data (e.g. seasonal forecasts) is available for the production of health early warnings and which project partners will get access to these data sets?

b) What is the flow of the data (data input → disease model → processing of the data output → data visualization → presentation of the data)?

c) Which QWeCI partner will perform the disease forecasts?

d) Where and how are the forecasts presented? The forecast could, for example, be provided on an password protected area in the web (e.g. on the UoC Java framework).

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 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 was 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 shall 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.

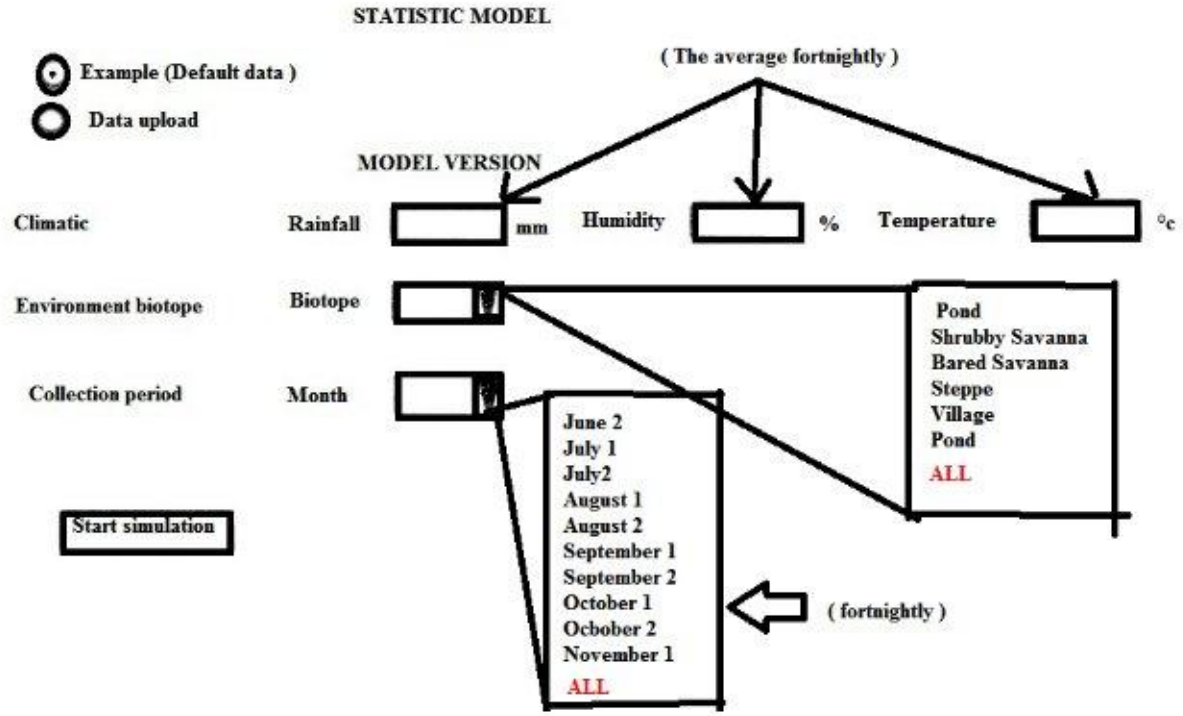
Note that the MT for standing water was due in month 24 (January 2012). Unfortunately, CSE did not undertake the design of the MT. It is unclear, when the design of the system is ready and when the first version of the MT is constructed.

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 can be part of 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 developed. The validation process of the different models is underway. This leads like the web-version of the LMM to the production of a SDSS.

The draft of a first system version of the RVF model was undertaken by IPD in November 2011 (M22). The proposed design includes an analysis of the data flow as well as a design of the Disease Operation System (see below).

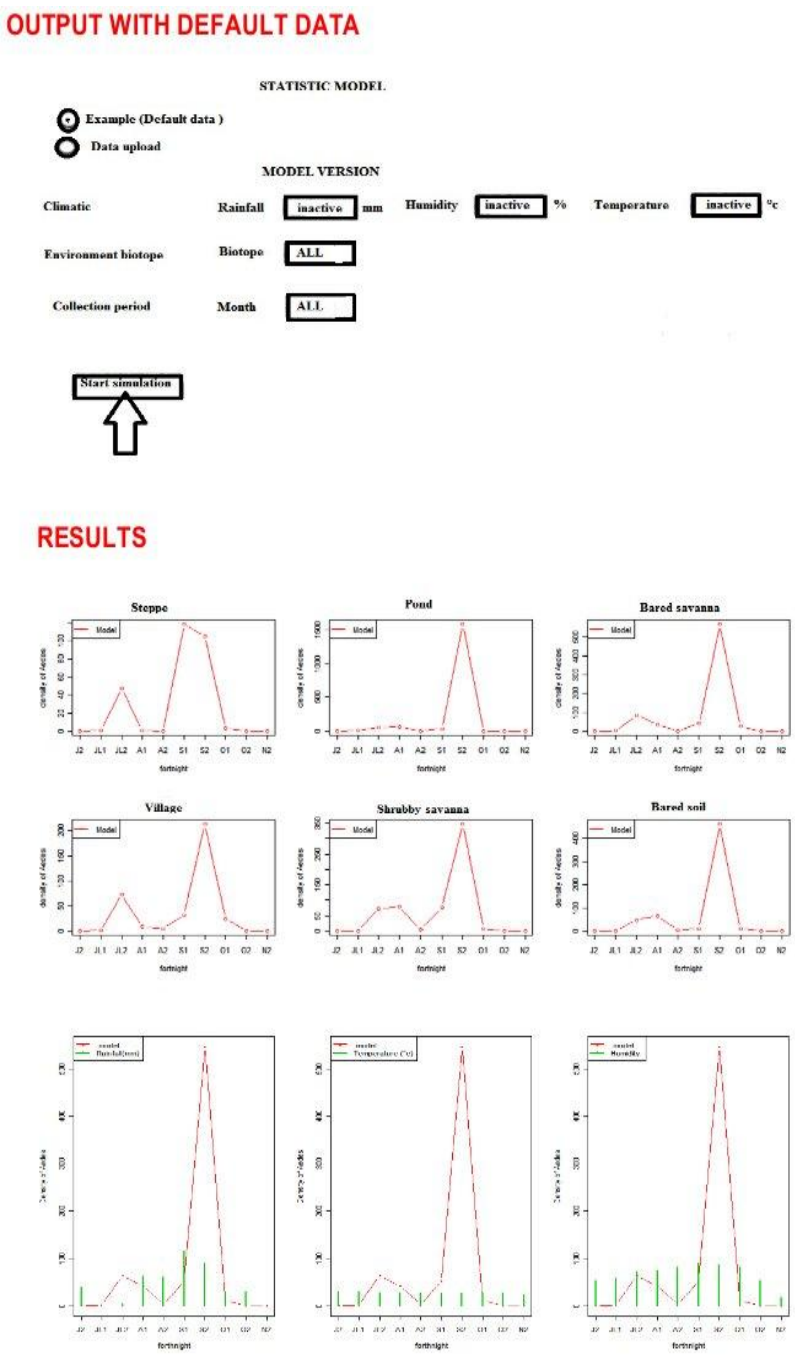


Draft regarding the start page of the RVF model including the configuration of the following RVF model simulation.

The input data of the RVF model are either time series or single values. For time series, the user shall be able to upload his own data via the "Data upload" button. In this case, only the drop down menus “Environment biotope” and “Collection period” will be active. In terms of single values, the user can enter a specific value for the temperature, humidity, and precipitation, which shall represent average fortnightly atmospheric conditions.

If the “example (Default data)” button is activated by the user, then no time series can be uploaded and no single values are enabled to be specified. In this case only the “Environment biotope” and “Collection period” drop down menus are activated.

In the following, the RVF model (programmed in the R software) is executed on the QWeCI Linux server and the model results in terms of different time periods and environments are displayed on the screen. Selected could be, for example, fortnightly time series of the density of Aedes within the bared Savanna biotope.



Draft of the output of RVF model simulation in terms of the use of default data and all environmental biotopes.

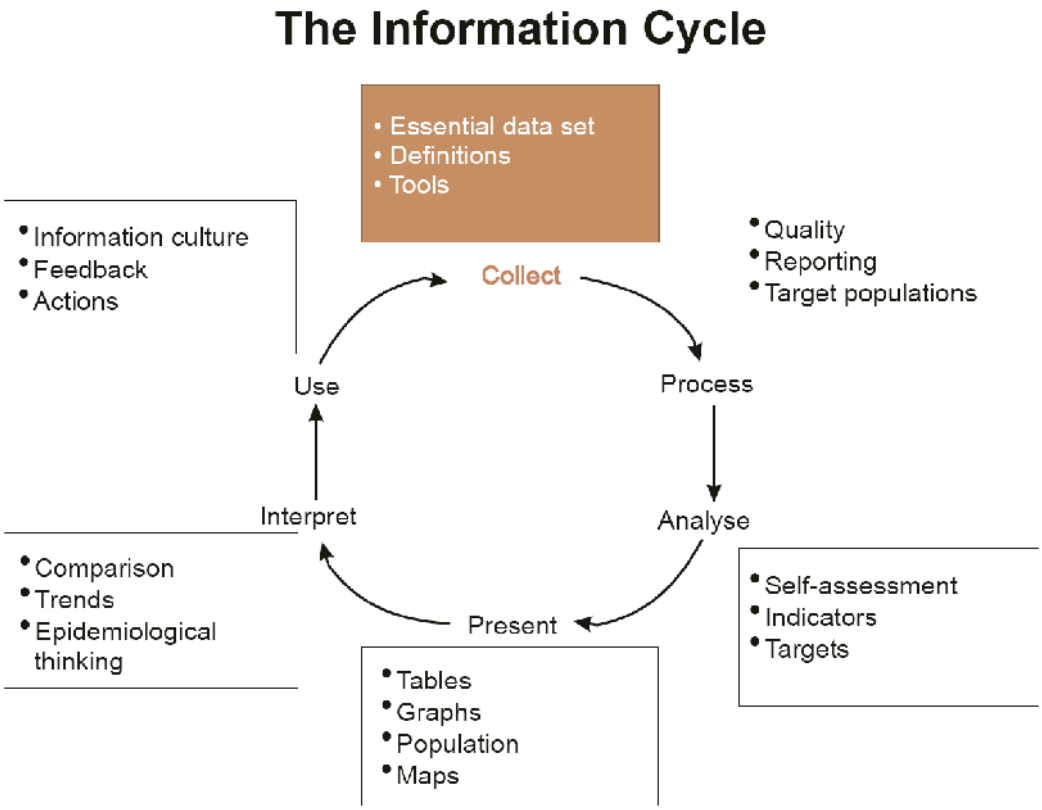
IPD is actually working on the user manual. The user manual will be presented bilingually in French and English. The first draft was discussed with the UoC in terms of the feasibility of the inclusion of the system into the web-based Java framework. In the following, the alpha version of the RVF model will be produced by the UoC and will be presented by IPD to the end users in Senegal. Unfortunately, at present the R software code of the RVF model was not passed by IPD to UoC. Note that UoC requires the model code for the production of the first system version.

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

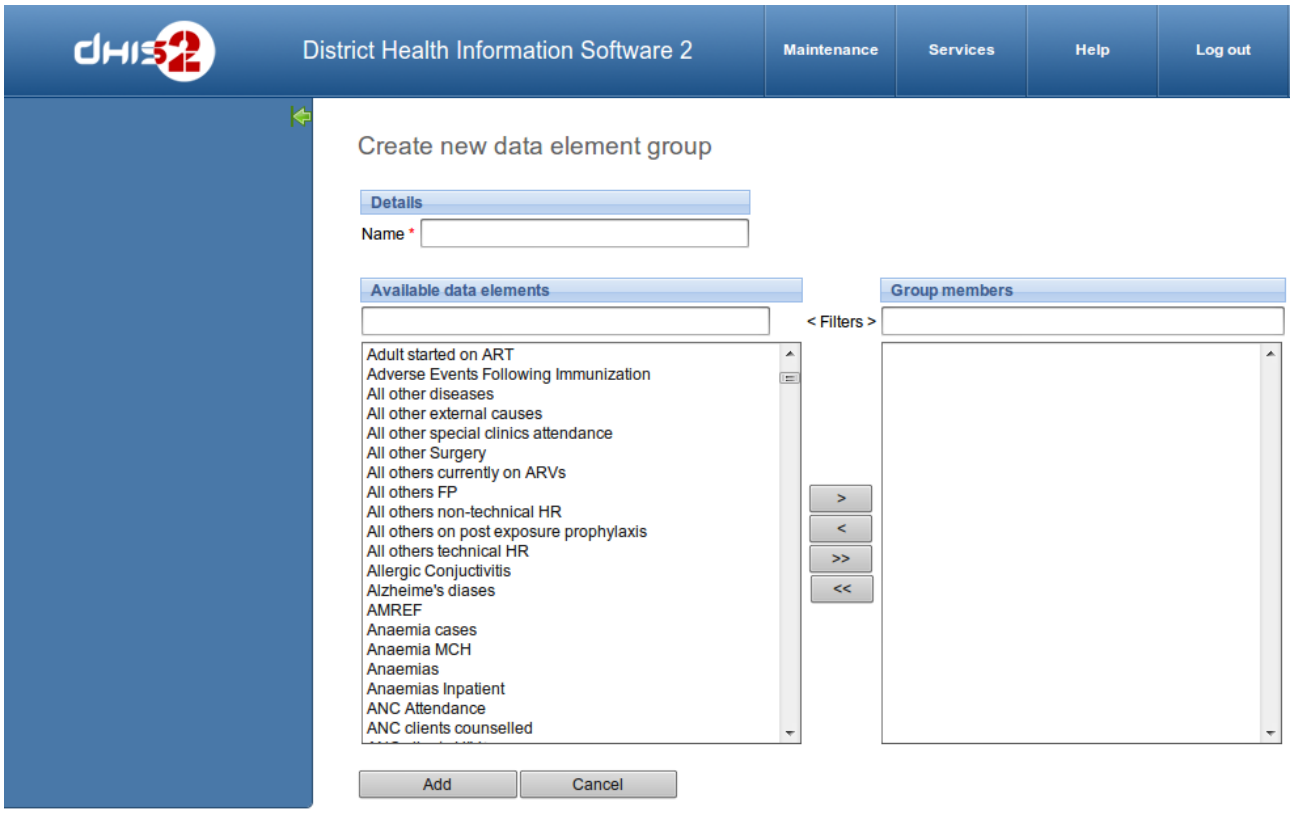
UNIMA successfully constructed the MT of near-real time disease incidence in health clinics of Malawi. This system is a stand-alone system and will not be included into the web-based Java framework of the UoC.

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 of the dHIS2 (source: http:www.dhis2.org).



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

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).