Grant agreement no. 243964

QWeCI

Quantifying Weather and Climate Impacts on Health in Developing Countries

Deliverable 5.1.e: Disease Operation System

Start date of project: 1st February 2010 Duration: 42 months

Lead contractor: IPD
Coordinator of deliverable: IPD
Evolution of deliverable

Due date :	M36
Date of first draft :	4 July 2013
Start of review :	22 August 2013
Deliverable accepted :	30 August 2013

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

The control of malaria and RVF is assured by two different ministries through two different government departments namely the National Malaria Control Program (PNLP) and the Direction of Veterinary Services). These services are responsible for the identification, development and implementation of appropriate strategies to fight against these two diseases. In this process, they collaborate with research institutions for the precise identification of areas and periods at risk as well as the acquisition of a useable health Early Warning System (HEWS). Therefore, the main concern is how to integrate environmental and climate events in field based surveillance monitoring in order to improve the knowledge of the mechanisms involved in disease emergence, an important step before going forward in building a HEWS.

The Disease Operation System (DOS) presented here provides information for proper operational methods for disease control. It was developed as part of the entomological field surveys in the project that contributed to the development and implementation of the country operation system. It contains two main components including a review of the strategies developed for malaria and Rift Valley Fever (RVF) current methods of control developed in Senegal and the development of a RVF vector model (RVF).

1. Review of the strategies developed for malaria and Rift Valley Fever (RVF) and current methods of control developed in Senegal

This step was done using existing information from the two main stakeholders: the National Malaria Control Program and the Direction of Veterinary Services.

1.1. Malaria

In Senegal, the National Malaria Control Program achieved remarkable results with the identification and implementation of pertinent intervention and strategies for reducing malaria. The morbidity and mortality of the malaria disease decrease strongly in all medical sanitary districts. The large scale distribution of Insecticide Treated Nets (ITNs), the introduction of the Rapid Diagnostic Test (RDT) and treatment using artemisinin-based combination therapies have generated a considerable decrease of malaria cases. In 2007, these interventions were sustained by the introduction of vector control using Indoor Residual Spraying (IRS), first, in three pilot districts before an extension to three other in 2010. Actually this strategy is used in 10 sanitary districts.

One of the key questions addressed actually by the program is the management of adverse events of such success. The main issue would be the potential outbreak that the country could experienced with regards to: (i) the loose of immunity of population after several years free of transmission or with a low level of transmission, (ii) the ecological patterns found in the northern and central parts of the country are favourable for epidemic occurrence, iii) the sustainability of the current methods used as they are funded by foreign institutions. In that context a functional system of monitoring, early detection, and response of malaria cases is required. Therefore, the key parameters underlying the transmission of the new malaria profile need to be thoroughly identified and use for improving, for example, weather-driven malaria models.

Within the QweCI project, several sets of data were generated including entomological data from six villages belonging to four different ecological (surrounding land use) classes. The existence of environmental and climatic data will enable the validation and improvement of existing weather-driven models.

1.2. Rift Valley fever

Concerning RVF, due to the lack of treatment and limitation for using existing vaccines, the only available control method is related to disease prevention. An active surveillance of virus amplification and virus infection via sentinel herd surveys is recommended to prevent RVF emergence. In Senegal, this surveillance program started after the first RVF outbreak in 1987 in Mauritania but was restricted to areas that were considered at highest risk of RVF risk. In 2000, the program was very effective and was part of a Food and Agriculture Organization (FAO) Technical Cooperation Programme project (TCP/RAF/8931) that allowed the implementation of a “System for monitoring and controlling RVF and transboundaries diseases in Mali, Mauritania and Senegal”. The system covers several aspects including training and education, animal sampling and serological investigation, and collection of scientific information. Furthermore, general information such as environmental, climatologic, and weather forecasting at local and regional levels was included.

Therefore, one of the main requests of stakeholders is the development of a straightforward tool of prediction of the virus emergence several weeks before the infection of any vertebrate (human or animal). Such a system is highly relevant for the vaccination of livestock with a live attenuated vaccine without any risk of reassortment with eventual virus strains circulating in nature. Indeed different modelling approaches in East Africa showed that RVF emergence can be predicted up to five months in advance using sea surface temperature, climatic and environmental parameters. However this method cannot be applied to West Africa due to the fact that the dynamic of emergence seems to be different. The models proposed for West Africa restrict the analysis to the impact of rainfall and do not integrate a spatial dimension. It was in this context that IPD developed a statistical RVF vector model that include several climatic and environmental parameters to quantify the abundance of vectors, identify the key variables affecting abundance of RVF vectors as well as the periods and areas at risk by generating forecast maps

2. Rift Valley fever vector model (RVF)

2.1. Overview

A spatio-temporal model (statistical Bayesian model) was developed in order to assess the impact of climate factors in RVF vector abundance and to predict the temporal period as well as the specific areas with highest vector productivity. Datasets on RVF vectors and 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. Further improvements of this model have been carried out as part of this study.

2.2. Presentation of the model

The IPD Rift Valley Fever Vector (IPDRVFV) model is an environmental and weather driven model using bi-weekly mean temperature, relative humidity, Normalized Difference Vegetation Index (NDVI) and precipitation amounts 15-20 days prior to the trapping of mosquito vectors. For the current version of the online system, the user is only able to use the "example" data (default) from the weather station of Barkedji (a village situated in the Sahelian area of Senegal). The model was driven by environmental and weather observations from the Ferlo region in Senegal from 2005. The available information system interactively illustrates the results of the RVF model. At present, it is not possible to run the model on the web-based Java framework (http://qweci.uni-koeln.de/). On-going deveopments would make it possible in the follow-up of the QWeCI project. In addition, the upload of new input data might be possible in a future version of the online IPDRVFV system.

The information system is presenting the input and simulated data of the RVF vector model. Illustrated are observed atmospheric values from Barkedji and measured values of the NDVI. The meteorological data includes precipitation amounts, minimum and maximum temperatures, and relative humidity values. Fortnightly time series are produced in terms of the observed and simulated two RVF vectors *Aedes vexans* and *Culex poicilipes*. The 95th confidence interval is included for the simulated vector numbers. Moreover, the simulated spatial distribution of both vectors is presented for different periods of the year 2005. The results can be presented either for different landscape classes (the biotopes) or they can be combined for all biotopes. The user can steer the illustration of the model output via two buttons: (i) different biotopes and (ii) the two vector species can be selected.

2.3. Configuration of the model

Data type
Currently, only time series can be used.

Data input
The user can use the "example" data (default) from the weather station in Barkedji (Senegal).

Model version
This is the first version of IPD RVFV model; a new version is under development by IPD.

Simulation

The user needs to click on the button “start simulation” and the output of the model is processed. After few seconds, the model output will be displayed by means of figures. In case that, different users start simultaneous runs, the QWeCI server might be very slow and the production of the output can require a fairly long time. The simulation might then be interrupted either when an error occurs. In this last case, the user can request assistance on the following address vermert@meteo.uni-koeln.de.