Peter Dambach

Dr. sc. Hum.

Modeling malaria risk during the rainy season by remote sensing of surface water distribution and quality in a rural region of Western Burkina Faso

Malaria in many countries of Sub-Saharan Africa is, despite local and global intervention programs, still a major challenge for public health. The study region around Nouna in the Sahel zone of North-Western Burkina Faso as a holo-endemic malaria area shows a year-round transmission with a strong peak during the outgoing rainy season. Vector occurrence and hence malaria transmission patterns are highly driven by the distribution and amount of precipitations. Vector larvae breeding is dependent on the amount, type and quality of surface water, acting as a risk factor for vector prevalence. Those environmental water agglomerations with manifold ways of appearance, from pools to river banks, inundated areas and swamps were found to be not distributed evenly in the surrounding of the local villages. Hence, the risk resulting from emerging vector mosquitoes in the catchment area of their flight range is highly heterogeneous within the survey region.

High spatial resolution satellite imagery was used in this study to detect potential larval habitats in a region of 60 x 60 kilometers during the rainy season of 2009. Different approaches were used to spot and distinguish water related land cover types and delimit them from less risk bearing dryer areas. Different types of satellite image classifications, feature detection indices and a digital elevation model (DEM) were used for correlation analysis.

Entomological data collected in the field was used to assess habitat larval productivity and adult mosquito captures were used as a validation component to test the spatial prediction model. The adult mosquito prevalence is an approximation of the population´s exposure to the vector and its connected risk for malaria infection.

Different indices for land cover feature detection were calculated using the satellite images spectral bands. Significant correlations were found in uni- and multivariate analysis between the NDWI Mac Feeters (Normalized Difference Water Index), the NDTI (Normalized Difference Turbidity Index) and the DEM amongst 2.460 observations against the presence of ponds. While the NDWI is positively correlated with the presence of environmental surface water, the NDTI and the altitude were found to be protective factors. The NDVI (Normalized Difference Vegetation Index) showed a negative correlation with the *Anopheles* larval density, most probably due to the approach's high resolution scale, where vegetation does not only indicate the presence of surface water but also habitat shadowing, which itself has a negative impact on *Anopheles* larvae breeding appropriateness. The night LST (Land Surface Temperature) measured by satellite in contrast was positively related to vector larvae density, while day LST is not a limiting factor in this region. The cumulated rainfall during the 15 days preceding the day of larvae collection was found to be positively associated with

the presence of larvae and the larval density, steering the availability of surface water and hence mosquito larvae breeding.

The day LSTs were found to be significantly negatively associated with the adult mosquito prevalence in light traps, whereas the night LSTs was not correlated. The higher is the day LST, the lower is the number of caught mosquitoes, indicating elevated environmental stress and affecting survival. The cumulative amount of rainfall in the 15 preceding days is significantly positively associated with the adult Anopheles density. The NDPI (Normalized Difference Pond Index) is correlated with the number of captured mosquitoes, reflecting the mosquito´s dependence on environmental surface water for larvae breeding. Results of a multivariate analysis showed the dependency of adult mosquito prevalence on both, the NDPI and on precipitations, showing the close interweavement of spatial and temporal variables.

Taking into consideration those findings, more precise assessments about areas at risk for malaria and ameliorated recommendations for possible counter measures can be given. Observations at all steps of this study, detection of surface water, assessment of larvae presence and adult vector abundance, comprise the spatial as well as the temporal component. Counter actions may be applied at all three steps. Most possible approaches are not yet undertaken within the survey region. While the focus of intervention lies on the reduction of human-vector contact via bed nets and treatment of people showing symptoms, the reduction of vector larvae and their habitats is not performed yet but will find implication in a current project in the Nouna region.