



A eco-hydrological model of malaria incidence depending on soil water balance

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The occurrence of malaria cases is particularly difficult to model and predict because malaria depends on both climatic and non-climatic factors. We propose a original model to simulate the dependence of malaria occurrence on meteorological variables, which have an effect on mosquitoes' habitat, mosquitoes' life cycle and malaria agents. It is well known that temperature, rainfall, wind and vegetation density are capable of explaining part of malaria incidence. However, previous studies did not explore the dependence of malaria on soil water content. The model herein proposed establishes a direct link between malaria variability and the dynamics of the regional water balance. Regional and monthly-aggregated malaria data for three areas of South Africa are analysed and modelled depending on soil moisture which is in turn expressed as a function of rainfall and temperature. We set up a ordinary differential equation model at monthly time scale, using a simplified equation for the soil water content and a dynamic equation for malaria variability. After introducing mild hypothesis, we obtain a parsimonious formulation in term of number of fitting parameters. The results show that soil moisture and surface water storage are key elements to explain malaria dynamics. In fact, the seasonal behaviour of malaria incidence is well reproduced in all regions.