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A surface hydrology model for regional vector borne disease models

Adrian Tompkins (1), Ernest Asare (2), Arne Bomblies (3), and Leonard Amekudzi (2)

(1) ICTP, Earth System Physics, Trieste, Italy (tompkins@ictp.it), (2) Kwame Nkrumah University of Science and Technology (KNUST) Kumasi, Ghana, (3) University of Vermont, USA

Small, sun-lit temporary pools that form during the rainy season are important breeding sites for many key mosquito vectors responsible for the transmission of malaria and other diseases. The representation of this surface hydrology in mathematical disease models is challenging, due to their small-scale, dependence on the terrain and the difficulty of setting soil parameters. Here we introduce a model that represents the temporal evolution of the aggregate statistics of breeding sites in a single pond fractional coverage parameter. The model is based on a simple, geometrical assumption concerning the terrain, and accounts for the processes of surface runoff, pond overflow, infiltration and evaporation. Soil moisture, soil properties and large-scale terrain slope are accounted for using a calibration parameter that sets the equivalent catchment fraction. The model is calibrated and then evaluated using in situ pond measurements in Ghana and ultra-high (10m) resolution explicit simulations for a village in Niger. Despite the model's simplicity, it is shown to reproduce the variability and mean of the pond aggregate water coverage well for both locations and validation techniques. Example malaria simulations for Uganda will be shown using this new scheme with a generic calibration setting, evaluated using district malaria case data. Possible methods for implementing regional calibration will be briefly discussed.