A Lattice Model for Malaria Transmission: mean-field approach and simulation

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We study a simple lattice model for the transmission of malaria in a population. Our model is based on Ross' model with the inclusion of diffusion by mosquitoes. The transmission of the disease to humans occurs through contact with an infected mosquito, while a healthy mosquito can become infected through contact with an infected human. Recovered individuals are susceptible to re-infection. The mosquitoes diffuse through the lattice, spreading the disease. We obtain the evolution equations for the densities of infected humans and mosquitoes using mean-field theory (MFT), via cluster approximation at site level. We show that our model is equivalent to Ross' model if we use independent probabilities or in the limit of high diffusion rate. We also determine the basic reproduction number. An estimation of the covariance for having two infected individuals at the same site stresses the importance of the correlation among the system components, mainly for low diffusion rates. A high mosquito diffusion provokes a mixture of the system components, therefore, diminishing the correlation between the populations. As a result, the probabilities are independent, explaining the mean-field behavior in this limit. We show preliminary results of Monte Carlo simulation.