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On a DDE model describing malaria transmission dynamics in a patch environment

I will present some results on a DDE model that describes the transmission dynamics of malaria over a patchy environment. The model incorporates two important factors into the classic Ross-McDonand model: disease latencies in both humans and mosquitoes, and dispersal of humans between patches. The basic reproduction number $\mathcal{R}_0$ of model is identified by the theory of the next generation operator for structured disease models and the dynamics of the model is investigated in terms of $\mathcal{R}_0$. It is shown that the disease free equilibrium is asymptotically stable if $\mathcal{R}_0 < 1$, and it is unstable if $\mathcal{R}_0 > 1$; in the latter case, the disease is endemic in the sense that the variables for the infected compartments are uniformly persistent. For the case of two patches, more explicit formulas for $\mathcal{R}_0$ are derived by which, impacts of the dispersal rates as well as the latency delays on disease dynamics are explored. Some numerical computations for $\mathcal{R}_0$ in terms of dispersal rates are carried out, which visually show that the impacts could be very complicated: in certain range of the parameters, $\mathcal{R}_0$ is increasing with respect to a dispersal rate while in some other range, it can be decreasing with respect to the same dispersal rate.

This is a joint work with Dr. Yanyu Xiao.