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Some tough analytical and numerical problems in population dynamics

We present some models of population dynamics and epidemics with spatial structure in which susceptible individuals move away from foci of infection. The model consists of a system of partial differential equations with degenerate diffusion. This degeneracy causes the PDE to switch from parabolic to hyperbolic and opens up the possibility of finite time blow up of the solution, phenomenon that is illustrated with numerical simulations. Analytically, on the other hand, the system is very difficult to analyze and even local-in-time existence of solutions has yet to be established. A second family of models will be described which includes also displacement of susceptibles away from crowded areas. Local and global existence results are available in this case for the total population, but not for the subpopulations of susceptible, infected and recovered individuals.