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Spatial patterns of schistosomiasis in Burkina Faso: relevance of human mobility and water resources development

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We study the spatial geography of schistosomiasis in the african context of Burkina Faso by means of a spatially explicit model of disease dynamics and spread. The relevance of our work lies in its ability to describe quantitatively a geographic stratification of the disease burden capable of reproducing important spatial differences, and drivers/controls of disease spread. Among the latters, we consider specifically the development and management of water resources which have been singled out empirically as an important risk factor for schistosomiasis. The model includes remotely acquired and objectively manipulated information on the distributions of population, infrastructure, elevation and climatic drivers. It also includes a general description of human mobility and addresses a first-order characterization of the ecology of the intermediate host of the parasite causing the disease based on maximum entropy learning of relevant environmenal covariates. Spatial patterns of the disease were analyzed about their disease-free equilibrium by proper extraction and mapping of suitable eigenvectors of the Jacobian matrix subsuming all stability properties of the system. Human mobility was found to be a primary control of both pathogen invasion success and of the overall distribution of disease burden. The effects of water resources development were studied by accounting for the (prior and posterior) average distances of human settlements from water bodies that may serve as suitable habitats to the intermediate host of the parasite. Water developments, in combination with human mobility, were quantitatively related to disease spread into regions previously nearly disease-free and to large-scale empirical incidence patterns. We concluded that while the model still needs refinements based on field and epidemiological evidence, the framework proposed provides a powerful tool for large-scale, long-term public health planning and management of schistosomiasis.