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Hydroclimatological And Anthropogenic Drivers For Cholera Spreading

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The nature of waterborne diseases, among which cholera has a prominent importance, calls for a better understanding of the link between epidemic spreading, water and climate. To this end, we have developed a framework which involves a network-based description of a river system, connected with local communities which act as nodes of the network. This has allowed us to produce consistent simulations of real case studies. More recent investigations comprise the evaluation of the spreading velocity of an epidemic wave by means of a reaction-diffusion modeling approach. In particular, we have found that both transport processes and epidemiological quantities, such as the basic reproduction number, have a crucial effect in controlling the spreading of the epidemics. We first developed a description of bacterial movement along the network driven by advection and diffusion; afterward, we have included the movement of human populations. This latter model allowed us to establish the conditions that can trigger epidemic waves that start from the coastal region, where bacteria are autochthonous, and travel inland. In particular, our findings suggest that even relatively low values of human diffusion can have the epidemic propagate upstream.

The interaction between climate, hydrology and epidemic events is still much debated, since no clear correlation between climatologic and epidemiological phenomena has emerged so far. However, a spatial assessment of hydrological and epidemiological mechanisms could be crucial to understand the evolution of cholera outbreaks. In particular, a hotly debated topic is the understanding of the mechanisms that can generate patterns of cholera incidence that exhibit an intra-annual double peak, as frequently observed in endemic region such as Bangladesh. One of the possible explanations proposed in the literature is that spring droughts cause bacteria concentration in water to rise dramatically, triggering the first peak. On the other hand similar mechanisms can occur during flood recessions in autumn together with major water sanitation system failures and higher population density. We show here the results of an ecohydrological model that couples the dynamics of the disease to a description of both the local water reservoir and of the local river section. The goal of this modeling exercise is to reproduce and understand the mechanisms behind intra-annual cholera incidence dynamics driven by hydrologic variability.