An epidemic model for the future progression of the current Haiti cholera epidemic

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As a major cholera epidemic progresses in Haiti, and the figures of the infection, up to December 2011, climb to 522,000 cases and 7,000 deaths, the development of general models to track and predict the evolution of the outbreak, so as to guide the allocation of medical supplies and staff, is gaining notable urgency. We propose here a spatially explicit epidemic model that accounts for the dynamics of susceptible and infected individuals as well as the redistribution of *Vibrio cholera*, the causative agent of the disease, among different human communities. In particular, we model two spreading pathways: the advection of pathogens through hydrologic connections and the dissemination due to human mobility described by means of a gravity-like model. To this end the country has been divided into hydrologic units based on drainage directions derived from a digital terrain model. Moreover the population of each unit has been estimated from census data downscaled to 1 km x 1 km resolution via remotely sensed geomorphological information (LandScan ™project). The model directly accounts for the role of rainfall patterns in driving the seasonality of cholera outbreaks. The two main outbreaks in fact occurred during the rainy seasons (October and May) when extensive floodings severely worsened the sanitation conditions and, in turn, raised the risk of infection. The model capability to reproduce the spatiotemporal features of the epidemic up to date grants robustness to the foreseen future development. To this end, we generate realistic scenario of future precipitation in order to forecast possible epidemic paths up to the end of the 2013. In this context, the duration of acquired immunity, a hotly debated topic in the scientific community, emerges as a controlling factor for progression of the epidemic in the near future. The framework presented here can straightforwardly be used to evaluate the effectiveness of alternative intervention strategies like mass vaccinations, clean water supply and educational campaigns, thus emerging as an essential component of the control of future cholera epidemics.