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Hydrological transport, human mobility and cholera epidemics: a spatially explicit modeling approach

Lorenzo Mari (1), Enrico Bertuzzo (1), Lorenzo Righetto (1), Renato Casagrandi (2), Marino Gatto (2), Ignacio Rodriguez-Iturbe (3), and Andrea Rinaldo (1)

(1) Laboratoire d'Ecohydrologie, Ecole Polytechnique Fédérale de Lausanne, Lausanne, Switzerland, (2) Dipartimento di Elettronica e Informazione, Politecnico di Milano, Milano, Italy, (3) Department of Civil and Environmental Engineering, Princeton University, Princeton (NJ), USA

Cholera is an acute enteric disease caused by the ingestion of water or food contaminated by the bacterium *Vibrio cholerae*. We investigate the role of human mobility as a driver for long-range spreading of cholera infections, which primarily propagate through hydrologically controlled ecological corridors. Since most infected individuals do not develop acute symptoms, they can be responsible, while traveling or commuting, for the dissemination of the disease. We present a two-layer network model that accounts for the interplay between epidemiological dynamics, hydrological transport and long-distance dispersal of the pathogen *V. cholerae* due to host movement, described by means of a gravity-model approach. We test our model against epidemiological data recorded during the extensive cholera outbreak occurred in the KwaZulu-Natal province of South Africa during 2000–2001. We show that long-range human movement is instrumental in quantifying otherwise unexplained inter-catchment transport of *V. cholerae*, thus playing a key role in the formation of regional patterns of cholera epidemics. We also show quantitatively how heterogeneously distributed drinking water supplies and sanitation conditions may affect large-scale cholera transmission.