RIVER NETWORKS AS ECOLOGICAL CORRIDORS FOR SPECIES, POPULATIONS AND PATHOGENS OF WATER-BORNE DISEASE

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The Lecture proposes a synthesis of recent (and, in the lecturer's opinion, rather exciting) research developments, appeared in disparate fields at the interface of hydrology, geomorphology, epidemiology and ecology, seen through the integrated framework of analysis for riverine ecological corridors – a traceable conceptual thread whose origins and functions are presented and discussed in the Lecture.

In the first part of the Lecture, I shall address a range of related topics, including the biodiversity of freshwater fish in river networks and vegetation along riparian systems, how river networks affected historic spreading of human populations, and how they influence the spreading of water- borne diseases. Metacommunity and individual- based theoretical models are studied specifically in the contexts of hydrochory, population and species migrations, and the spreading of infections of water- borne diseases along the ecological corridors of river basins. Laboratory studies on experimental metacommunities, a new frontier of hydrologic research in this Lecturer's view, are studied for understanding biodiversity under directional dispersal. Field studies are analyzed in the context of species persistence times.

In the second part, I shall provide one specific example of real-life application with direct social and economic implications, the predictive modeling of epidemic cholera in Haiti. The overarching claim is that mathematical models can indeed provide predictive insight into the course of an ongoing epidemic, potentially aiding real-time emergency management in allocating health care resources and by anticipating the impact of alternative interventions. To support the claim, I examine the *ex-post* reliability of published predictions of the 2010-2011 Haiti cholera outbreak from four independent modeling studies that appeared almost simultaneously during the unfolding epidemic – where river network ecological corridors feature prominently. For each modeled epidemic trajectory, it is assessed how well predictions reproduced the observed spatial and temporal features of the outbreak to date. The impact of different approaches is considered to the modeling of the spatial spread of V. cholera, the mechanics of cholera transmission and in accounting for the dynamics of susceptible and infected individuals within different local human communities. A generalized model for Haitian epidemic cholera and the related uncertainty is thus constructed and applied to the year-long dataset of reported cases now available. Lessons learned and open issues are discussed and placed in perspective, supporting the conclusion that, despite differences in methods that can be tested through model-guided field validation, mathematical modeling of large-scale outbreaks and their hydrological drivers and corridors emerges as an essential component of future cholera epidemic control.

I will conclude that a general theory emerges on the effects of dendritic geometries on the ecological processes and dynamics operating on river basins that are establishing, in the lecturer's view, a new and significant scientific research field. Insights provided by such a theory will lend themselves to issues of great practical importance such as integration of riparian systems into large- scale resource management, spatial strategies to minimize loss of freshwater biodiversity, and effective prevention campaigns against water- borne diseases.