# Modelling transmission of waterborne diseases under extreme environmental perturbation

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## Scientific background

The group of microbial pathogens generally referred to as Vibrios are a globally-important cause of water-related infectious diseases. They are particularly abundant and diverse in aquatic environments, most notably *Vibrio cholera*, the pathogen responsible for cholera. Cholera infections, even when they are not fatal, are debilitating to the afflicted, lower performance in the workplace, cause loss of revenue, and lower quality of life, threatening orderly and sustainable economic development. Models of cholera outbreak normally emphasise human-to-human transmission, but there is a human-to-environmental-reservoir transmission that is often neglected. The environmental link is aggravated by extreme events, such as floods, which disperse the responsible pathogens. The project provides an opportunity to help resolve a genuine societal need, with potentially world-wide application.

## Project Aims and Methods

Using Kerala, India (Vembanad Lake) as initial geographical focus, the aim is to produce a globally-applicable forecast model for cholera outbreaks due to severe environmental perturbations. The project will build on the findings of an existing UK-India water-quality (NERC) initiative on the ecology of cholera bacteria. The key requirement is to develop a model of cholera transmission that represents two distinct time scales in the dynamics: a short-time-scale process representing infection transmitted from person to person; and a longer time scale describing infection from environment to person, without the need for direct interaction with an infected individual (Hethcote, 2000). Outputs from the model will be the timing and magnitude of response as a function of the severity of any environmental perturbation, which can then be used to develop the forecast and to explore how environmental transmission might be controlled. The student will be encouraged strongly to contribute to design of the project, and to take responsibility for the work.

## Training

The student will receive training in mathematical modelling of infectious diseases, especially cholera, including the computational aspects of solving time-dependent differential equations; the ability to synthesise data from various disciplines (such as ecology, microbiology, oceanography and remote sensing) to extract the information required to make the models; to take the mathematics from the textbook to the real world, and so help to improve the wellbeing of people living in areas where cholera is endemic; to conduct research that is rigorous, well-planned, ethical and effective; to write clear, concise and useful scientific papers; to explain the research to all levels of society; and to translate the results for the public good. The student will be expected to travel to an Indian Ocean rim country, to see the situation on the ground. Participation in relevant national and international symposia will be encouraged. We aim to provide a complete training for a career as a professional scientist.

## Candidate Requirements

The main requirement is an excellent preparation in mathematics, including linear algebra, differential equations, networks and dynamical systems. Next requirement is computational ability. Otherwise, we need an open, enquiring mind, willingness to work in applied maths, and contribute to a project with a strong societal value.