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Cholera and Climate Change

Mathematical Modelling for Long-Term Forecasting in Endemic Regions

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1. Background

Cholera is a persistent diarrhoeal disease which continues to kill around 100,000 people per year [1].

In endemic regions the disease is strongly associated with the climate and environment, showing strong seasonal and interannual patterns.

Climate change is predicted to increase vulnerability to cholera in endemic regions.

However, relationships between climate variables and cholera outbreaks are complex – making long-term projections of cholera challenging.

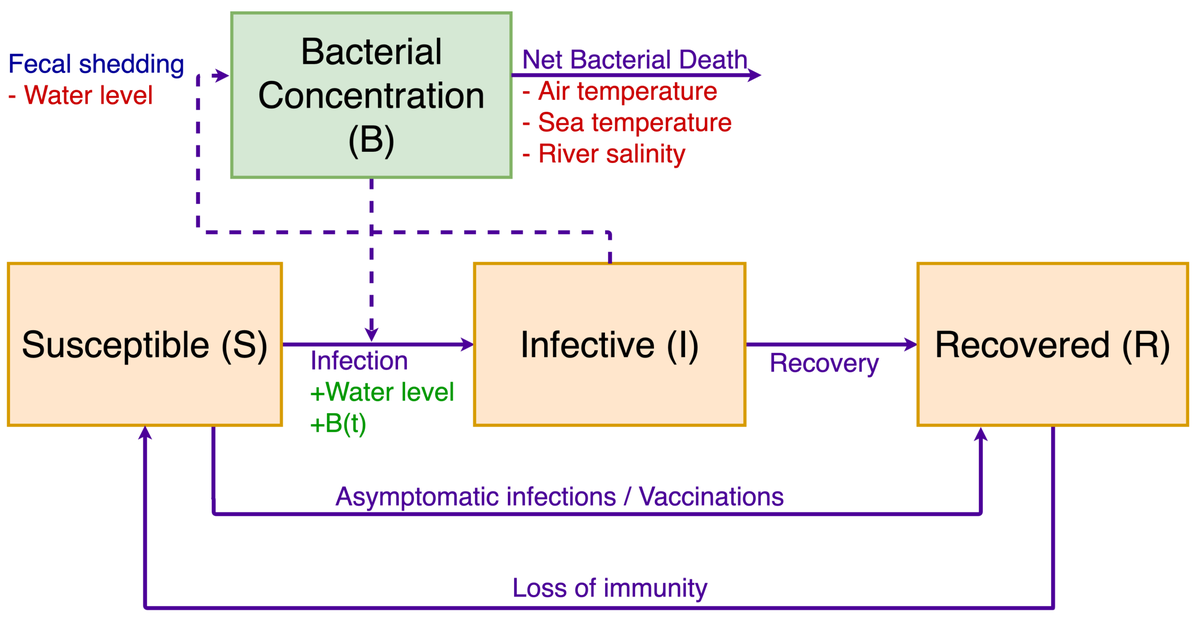
2. Research Questions

a. What are the mechanisms causing cholera in Bangladesh – and how to they interrelate?

b. How will long-term changes such as population increase and climate change affect cholera outbreaks?

c. In current and future scenarios, which intervention options will be most effective at reducing cholera?

3. Methodology



Current models do not consider long-term climate-related effects such as changes in river salinity and sea temperature

A mathematical model incorporating long-term climate variables would provide an understanding of how endemic cholera is likely to evolve over a period of around 20-30 years, with and without human intervention.

4. Expected Outcome

a. Intervention Simulation

Simulate the short- and long-term effects of possible human intervention options e.g. vaccination programs, improved flood mitigation

b. Long-range Intensity Forecasts

Provide long-range forecasts of up to 30 years describing the strength or extinction of the cholera epidemic

Case Study - Bangladesh

Bangladesh is home to the Bengal Delta – the largest delta in the world and native homeland of the cholera causing bacteria *Vibrio Cholerae* [2].

It is coastal and low-lying, with high population density, high levels of poverty and low levels of infrastructure. This makes it exceptionally vulnerable to the effects of climate change


Ganges Delta, Bangladesh
Credit: PlanetSAT

5. Work Plan

a. Develop Mathematical Model

i. Develop initial model in Python based on hypotheses gained from literature
ii. Calibrate unknown parameters via a Markov Chain Monte Carlo method using historical data
iii. Verify using untested data to conduct validation of model predictions – with focus on interannual trends

b. Model Applications

i. Assess effectiveness of possible intervention options by altering input factors.
ii. Using climate and demographic forecasts as inputs to the model, assess the long-term effects of climate change

References:
[1] *GTFCC, "Ending Cholera: A Global Roadmap to 2030," World Health Organization, 2017.*
[2] Akanda, A. S., Jutla, A. S. and Islam, S. (2009) 'Dual peak cholera transmission in Bengal Delta: A hydroclimatological explanation', *Geophysical Research Letters*. Wiley-Blackwell, 36(19), p. L19401. doi: 10.1029/2009GL039312.

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