Modelling faecal pathogen flows and health risks in Dhaka

What it means for sanitation decision-making

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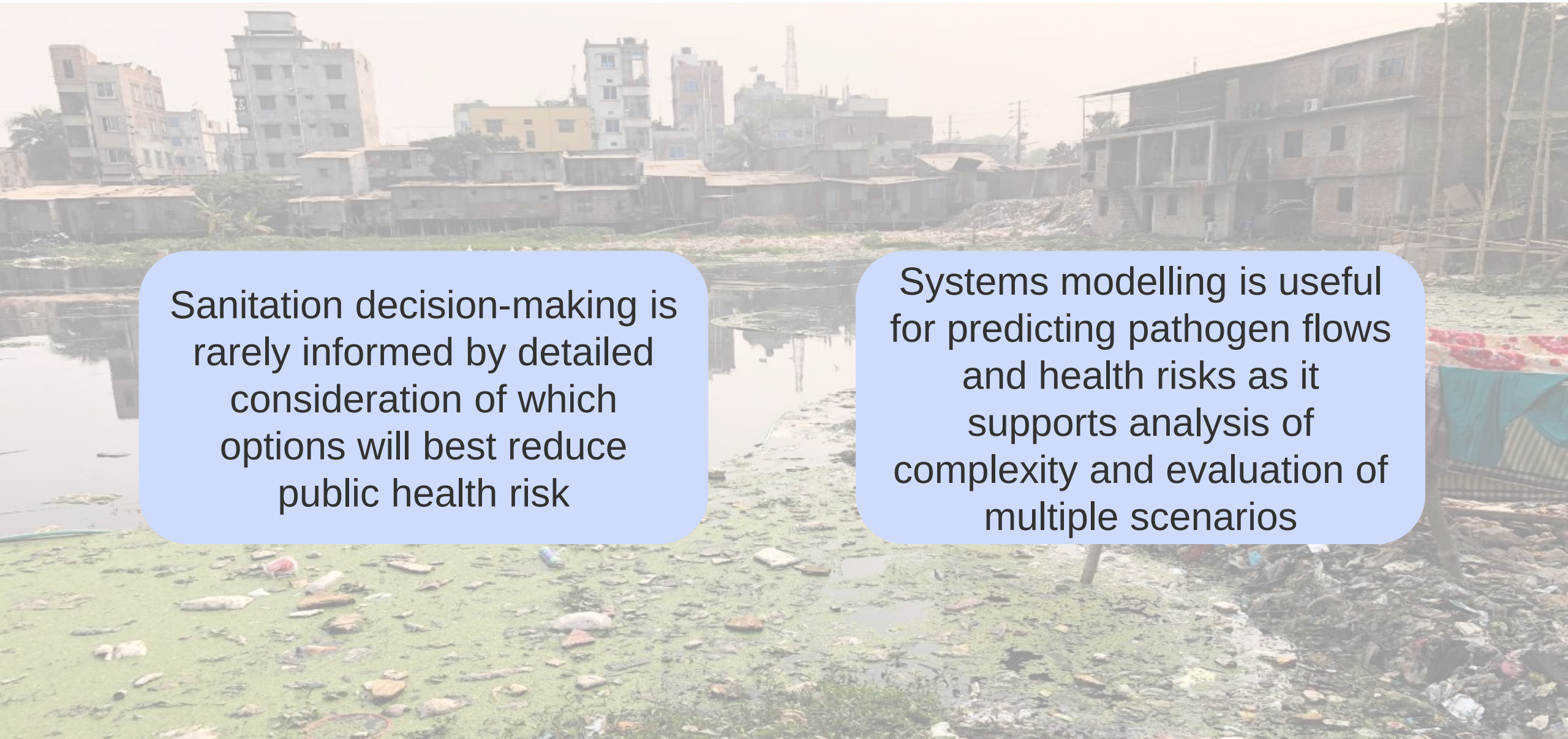
Study developed systems modelling approach to support sanitation decision-making that considers health risk



Sanitation decision-making is rarely informed by detailed consideration of which options will best reduce public health risk

Systems modelling is useful for predicting pathogen flows and health risks as it supports analysis of complexity and evaluation of multiple scenarios

Study developed systems modelling approach to support sanitation decision-making that considers health risk

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Article

Faecal Pathogen Flows and Their Public Health Risks in Urban Environments: A Proposed Approach to Inform Sanitation Planning

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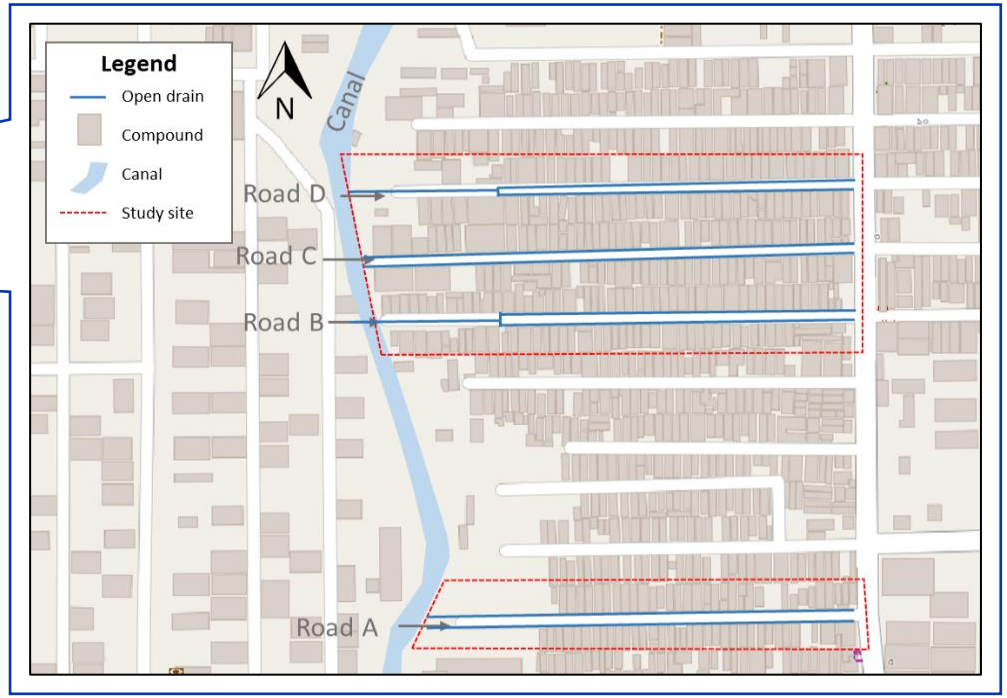
Abstract: Public health benefits are often a key political driver of urban sanitation investment in developing countries, however, pathogen flows are rarely taken systematically into account in sanitation investment choices. While several tools and approaches on sanitation and health risks have recently been developed, this research identified gaps in their ability to predict faecal pathogen flows, to relate exposure risks to the existing sanitation services, and to compare expected impacts of improvements. This paper outlines a conceptual approach that links faecal waste discharge patterns with potential pathogen exposure pathways to quantitatively compare urban sanitation improvement options. An illustrative application of the approach is presented, using a spreadsheet-based model to compare the relative effect on disability-adjusted life years of six sanitation improvement options for a hypothetical urban situation. The approach includes consideration of the persistence or removal of different pathogen classes in different environments; recognition of multiple interconnected sludge and effluent pathways, and of multiple potential sites for exposure; and use of quantitative microbial risk assessment to support prediction of relative health risks for each option. This research provides a step forward in applying current knowledge to better consider public health, alongside environmental and other objectives, in urban sanitation decision making. Further empirical research in specific locations is now required to refine the approach and address data gaps.

Keywords: pathogens; urban sanitation; wastewater; public health; risk assessment; decision making; faecal waste; options assessment

Study focused on four roads in a low-income neighbourhood of Dhaka with mix of septic tanks and direct-to-drain toilets



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Study focused on health risk associated with exposure to faecal pathogens in open drains






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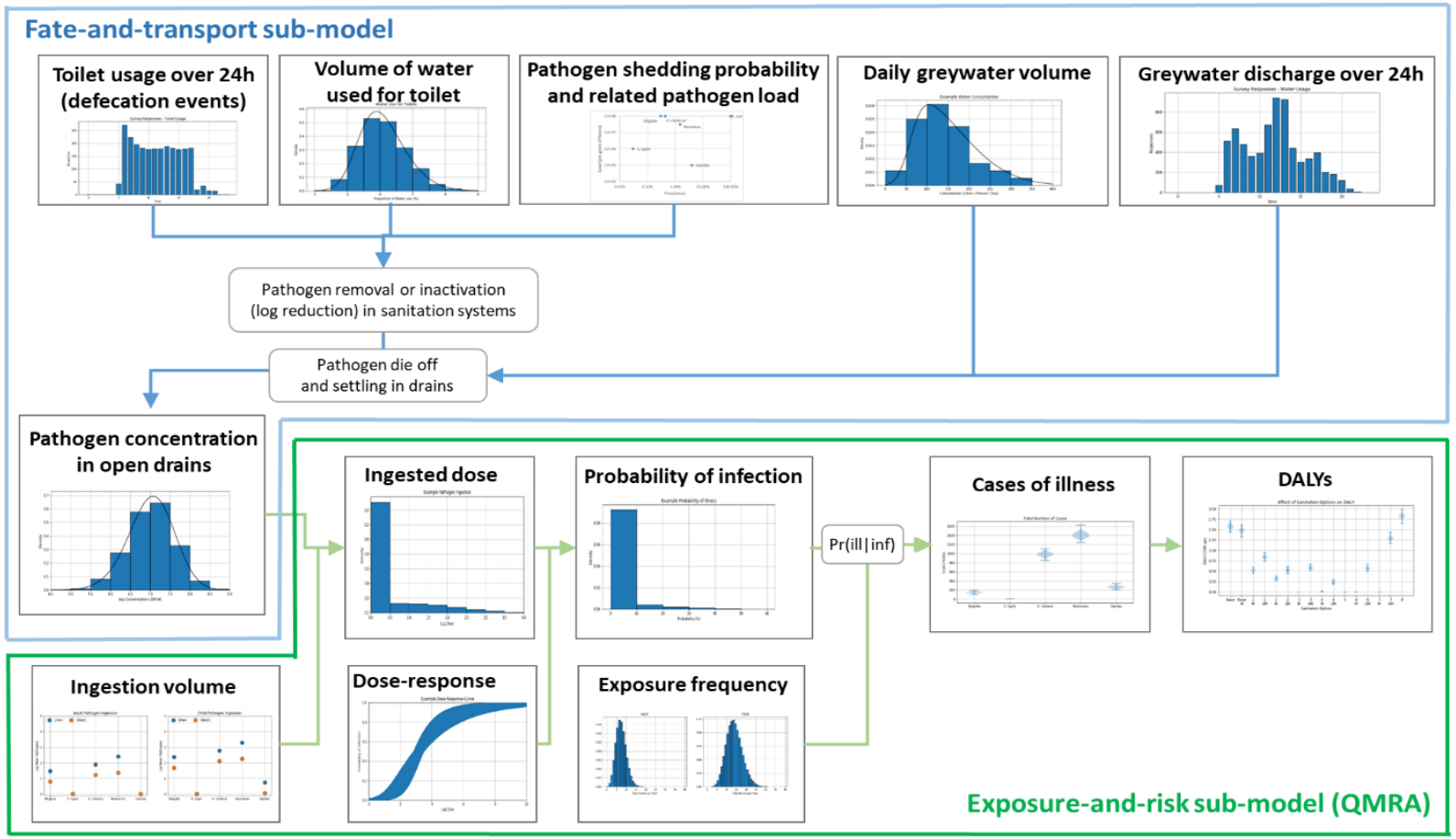
Model examined five pathogens and a FIB by coupling: (i) fate-and-transport and (ii) exposure-and-risk sub-models



Shigella

V. cholerae

S. Typhi

Giardia

Norovirus

E. coli

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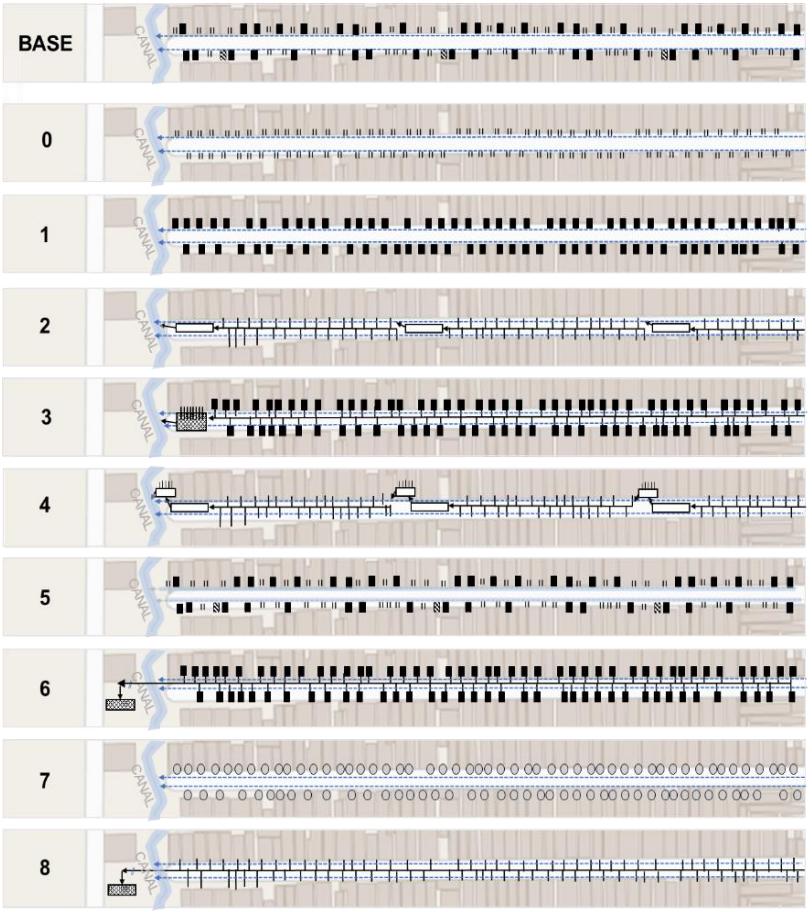
Aimed to model health risks associated with different sanitation options and management performance



Status quo: Mix of septic tanks & direct-to-drain

Direct-to-drain

Septic tanks

Communal primary treatment (ABRs)

Communal primary & secondary treatment (ABRs + constructed wetlands)

Septic tanks with secondary treatment (constructed wetlands)

Deepen & cover drains

Septic tanks with centralised tertiary treatment (offsite)

Fully sealed vaults

Sewerage to centralised treatment

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Predictions from fate-and-transport sub-model compared with observed pathogen concentrations

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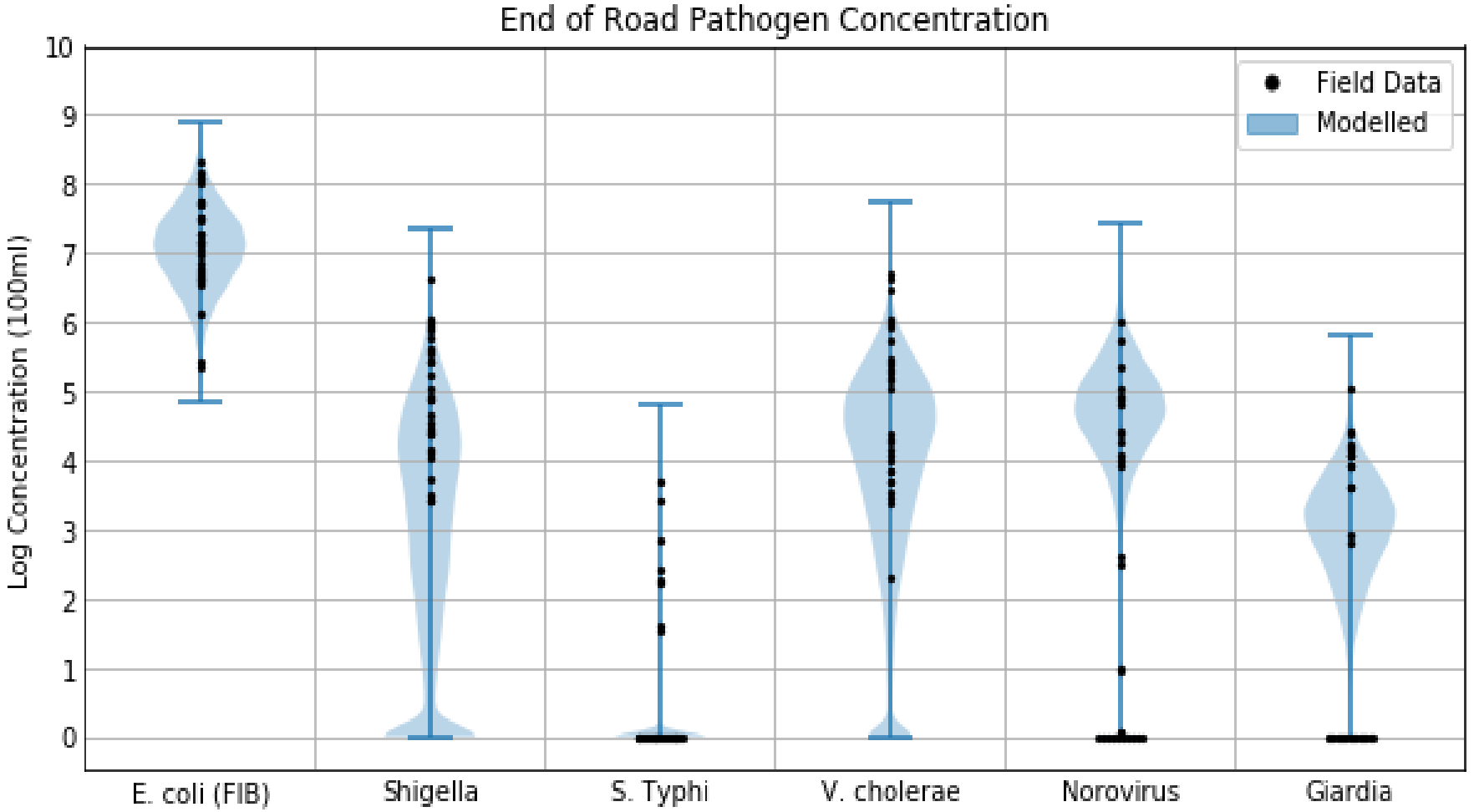
Measured concentrations fell within range of modelled concentrations



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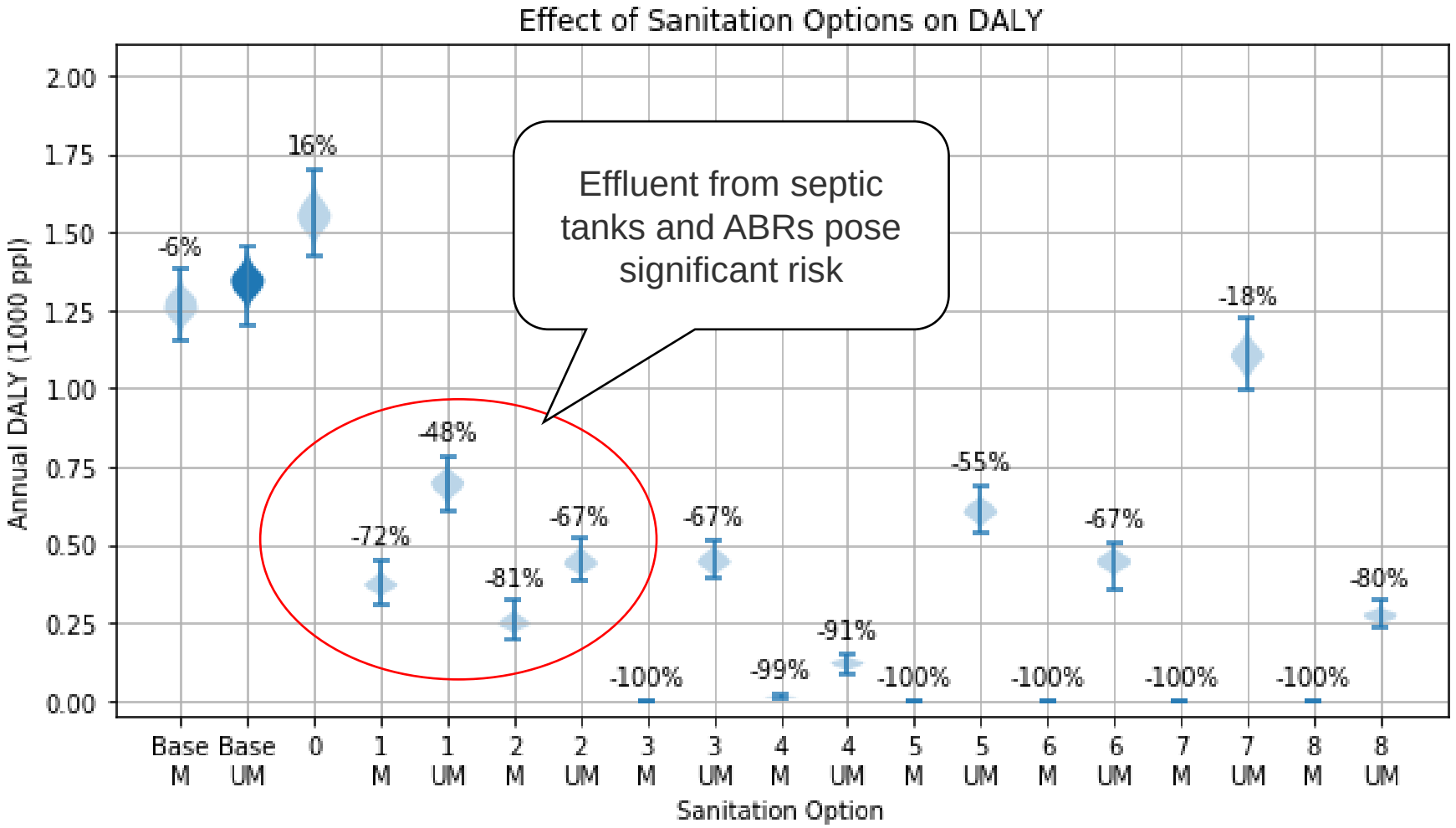
Sanitation options predicted to reduce DALYs by 72-100% when well managed, and 18-91% when poorly managed



M = managed, UM = unmanaged

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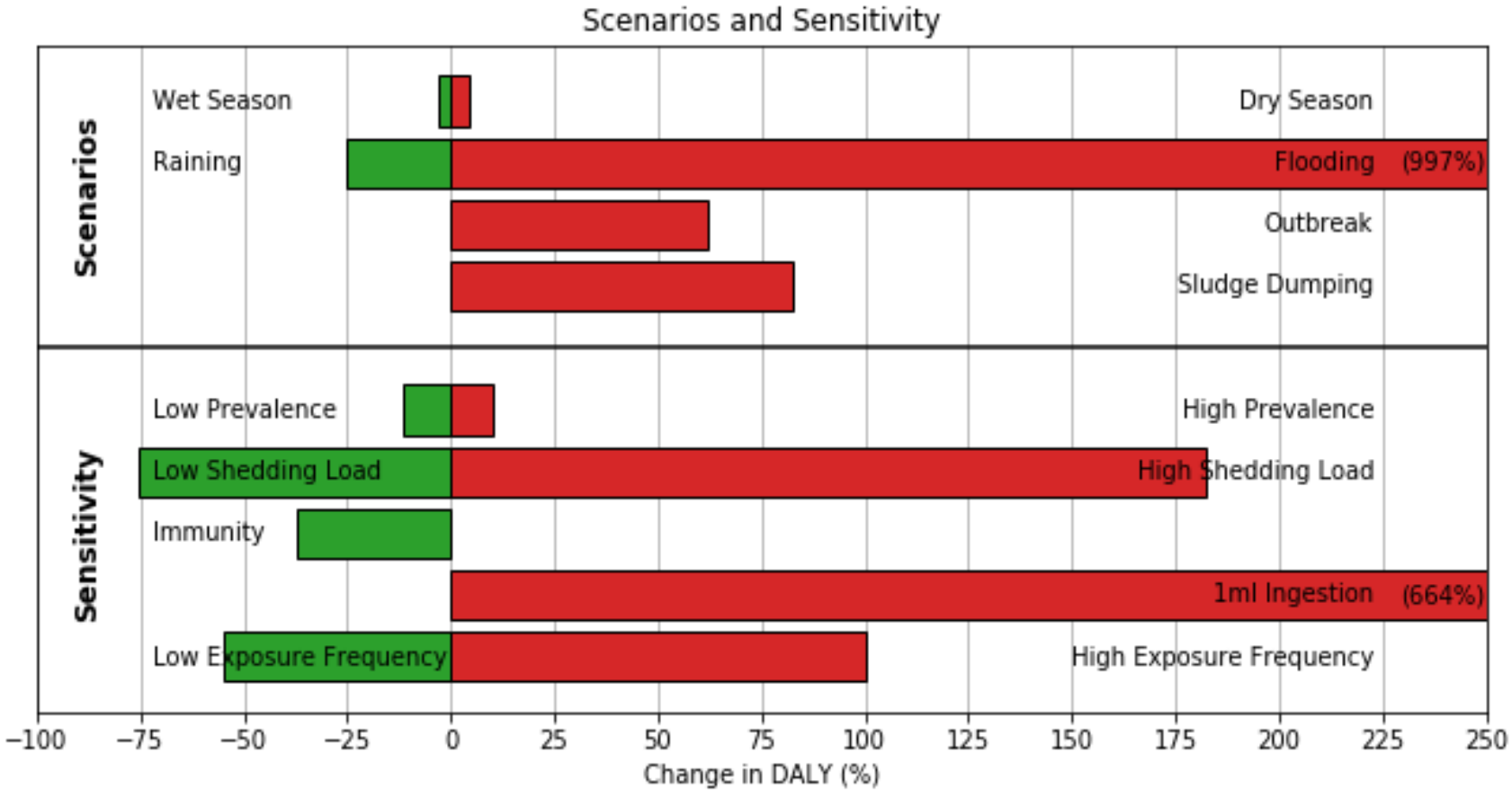
Flooding increased health risk by an order of magnitude, while results sensitive to shedding and ingestion assumptions



Range of limitations which future applications of systems modelling should seek to address

- Model parameters
- Model validation
- ‘Exported’ pathogen risk
- Additional transmission routes

Some implications & conclusions

Systems modelling	Feasible approach for examining health risks
Effluent from septic tanks and ABRs	Significant health risk, further treatment needed
LRVs for on-site sanitation	Major evidence gap that needs to be addressed
Pathogen export & other transmission routes	Key considerations for future model application

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