Reflection on health-environment research in the light of emerging infectious diseases Modelling water quality and health

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Reflection on health-environment research in the light of emerging infectious diseases: modelling water quality and health

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Introduction

In the past years, we have published three health-environment research papers on modelling microbial water quality and health risk in COSUST [1–3]. These papers proposed the use of a systems approach for waterborne diseases. This approach employs models to study the microbial water quality and related health risk. It also uses these models with scenarios to evaluate the influence of socioeconomic development and climate change on the water quality and health risk and to evaluate the value of interventions. Such a systems approach is important, because waterborne diseases still have a large global burden of disease [4] and the approach helps understanding the problem and can advocate effective interventions [5–8].

Recently, the COVID-19 pandemic has emerged. The outbreak has immediately highlighted the importance of the relation between human health and the environment, as the SARS-CoV-2 virus likely originated from wild animals [9]. Water has thus far not been found to play a major role in the spread of the virus [10].

COVID-19 is an emerging infectious disease (EID). The number of EID events has increased over time [11], which implies that we will see more pandemics in the future. Preparedness for EIDs, that could in the future also be waterborne diseases, is essential [12]. EID preparedness, or the state of being ready for EID outbreaks, involves activities to enhance prevention and control of high-impact EID events [13]. The systems approach proposed in the earlier COSUST papers is valuable in the light of this preparedness.

The objective of this commentary is to reflect on the use of a systems approach in health-environment research in the light of EIDs. In this paper, we will reflect on the usefulness of waterborne pathogen modelling for COVID-19 and for EID preparedness studies. We will also highlight several

other emerging opportunities for health-environment research concerning EIDs.

Usefulness of waterborne pathogen modelling for COVID-19

The systems approach developed in the microbial water quality and health risk model studies focused on sources, transport and fate of waterborne pathogens in the urban and rural water cycle. As a significant percentage of the COVID-19 cases shed high concentrations of SARS-CoV-2 with their stool [14–20], this virus also enters the water cycle. The model elements developed for identifying hotspot areas with high pathogen loads, and the model processes that simulate how pathogen loads are captured and transported in different types of sanitation systems can help to understand SARS-CoV-2 sources and transport in sewered and unsewered urban areas and prioritise sites for SARS-CoV-2 sampling in wastewater. Such environmental surveillance of SARS-CoV-2 in wastewaters has increasingly been recognised to be important as an early warning tool for SARS-CoV-2 presence in a population [21–24], as it has done for other viruses previously [25,26]. This is highlighted by the uptake of sewage sampling in the Dutch national coronavirus dashboard used to inform decision making and the public about the development of the coronavirus in the Netherlands (see e.g. https://www.dutchwatersector.com/news/nationwide-covid-19-sewer-surveillance-at-all-dutch-wwtps).

Usefulness of waterborne pathogen modelling for preparedness studies

The systems approach discussed and proposed in the earlier COSUST publications comprises modelling and scenario analysis. We discuss the relevance of both approaches for preparedness research. Traditionally, preparedness has focussed on surveillance. However, with more understanding of the systems and increased data availability, opportunities have emerged to incorporate models and scenario analysis in the preparedness activities [13,27].

Modelling

To be prepared for EIDs, understanding the spread of pathogens in the environment is essential [13]. Modelling microbial water quality requires understanding of the processes for the spread of pathogens in the environment. The pathways are known, underlying data on, for example, population, sanitation, agricultural management, hydrology and climate are available and inactivation processes during transport are understood. The models can, therefore, reasonably easily be adapted for new waterborne pathogens.

The models that simulate microbial water quality integrate human and livestock data. This is very important, as many EIDs are zoonotic [28,29]. Even though the origin of EID is often wildlife, livestock could act as a reservoir. This can be exemplified by SARS-CoV-2 outbreaks in mink [30,31]. A One Health approach [32] is, therefore, vital for preparedness research.

Scenario analysis

EIDs are driven by socio-economic, environmental and ecological factors [11,13,27]. Risk factors include, for example, urbanisation and climate change. Scenario analysis, using future change, exploratory scenarios, uniquely suits preparedness research. In the scenarios, potential future developments and situations are evaluated. Additionally, the value of interventions can be analysed. Already in 2011, we proposed the use of comprehensive scenarios that include future socio-economic development in addition to climate change [1]. However, still only a limited number of studies uses this approach to simulate future water quality and health risk. There are still significant opportunities in utilising scenarios to better understand potential future change and enhance the preparedness.

Emerging opportunities for health-environment research

The current pandemic has made clear that preparedness for EIDs is insufficient in many countries [33] and there has been a call for more prioritisation and funds to enhance preparedness [12]. This reinforces the value of and need for systems approaches and provides opportunities for health-environment research.

The (re)discovery of environmental surveillance as valuable information source in the fight against COVID-19 is bridging the gap between traditional health surveillance and studies on pathogen sources and occurrence in the environment. The current boost in sewage surveillance studies as a response to the pandemic will provide a wealth of data on environmental occurrence of SARS-CoV-2 and is likely to spark the use of environmental surveillance for other pathogens that are shed via urine and stool. This is already seen in the area of AMR [21]. Data are collected across environmental media. This surveillance will generate a large amount of data that is potentially very valuable for model development and scenario studies, areas that are currently hampered by limited data availability. More data will also enable thorough validation and help improve the models, and thereby our understanding of pathogen sources and transmission pathways, as well as effective mitigation options.

Environmental surveillance, modelling and scenario analysis are integrating our current knowledge in the health-related water microbiology field, and are providing valuable opportunities to improve our preparedness to EID. This health-environment research field can still learn from other communities, such as climate change, hydrology and disease spread modelling to develop and fulfil its promise.

Conflict of interest statement

Nothing declared.

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