Incorporating climate-induced hydro-meteorological extremes in global health security: A waterborne disease perspective

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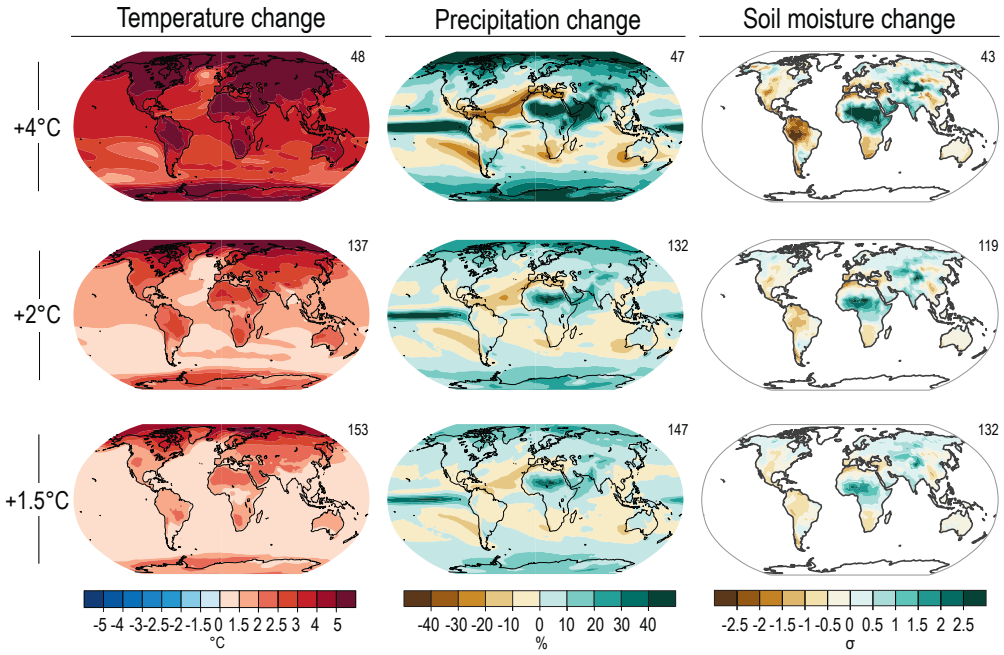
European Geosciences Union
General Assembly 2022

Vienna, Austria

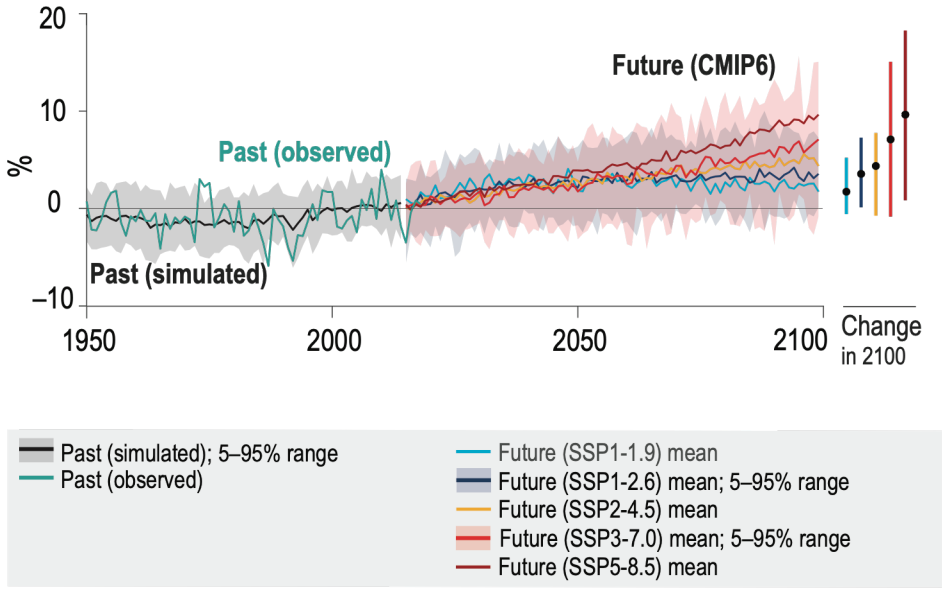
May 23, 2022

Climate change scenarios:
Air temperature, precipitation and soil moisture



Source: Technical Summary. In Climate Change 2021: The Physical Science Basis.
Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change

Observed, simulated and projected changes compared to the 1995–2014 average in global land precipitation through 2100



Source: Technical Summary. In Climate Change 2021: The Physical Science Basis.
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Linking climate and waterborne diseases

- Climate-induced hydro-meteorological extreme events such as the occurrence of heavy precipitations or lack thereof, intense continuous rainfall, flooding, and drought are increasing worldwide and will likely be escalating in the future
- Climate-induced hydrological and meteorological extreme events and tipping points may impact and increase the environmental transmission of pathogenic microorganisms in terrestrial and aquatic systems, waterborne disease outbreaks, and biological threats to human health
- Temperature and precipitation are impacting waterborne diseases transmission in the environment

Coincidences of climate change and waterborne diseases

- Spatial changes in distribution of waterborne diseases
  - Change in altitude and latitude
- Time changes in distribution of waterborne diseases
  - Change in seasons

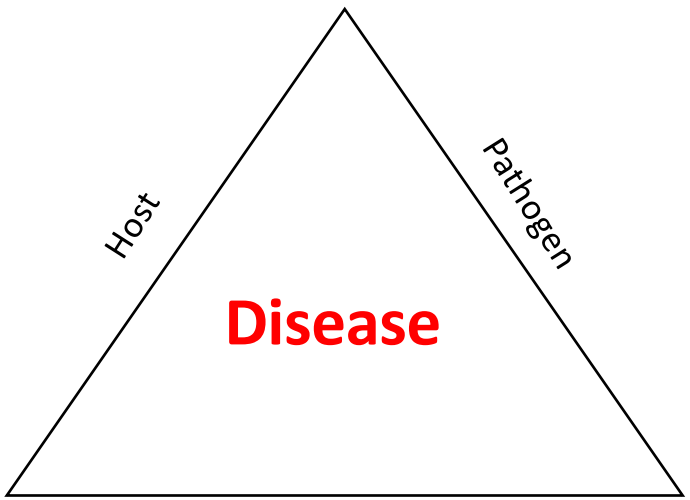
Impacts of climate on waterborne diseases

- Waterborne disease influenced by environmental conditions
  - Disease: Cryptosporidiosis, one of the most common waterborne diseases in the world, caused by *Cryptosporidium*
  - Environmental conditions: Wet
  - Extreme weather events: Precipitation and flooding

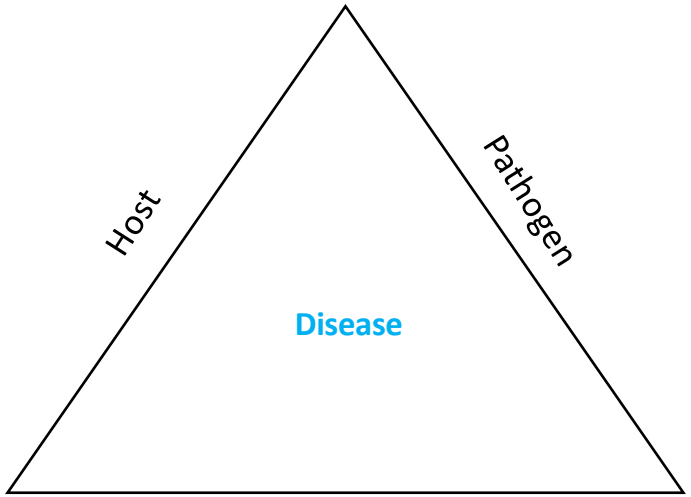
- Pathogen dissemination and transmission in the environment
  - Infiltration, runoff, and flooding may transport pathogens and contaminate soil, and surface and groundwater resources, resulting in waterborne diseases – e.g., diarrheal diseases such as Cryptosporidiosis

Hosts, pathogens, and the environment

- Climate interactions with factors – host, pathogen, the environment – impact waterborne disease outbreaks



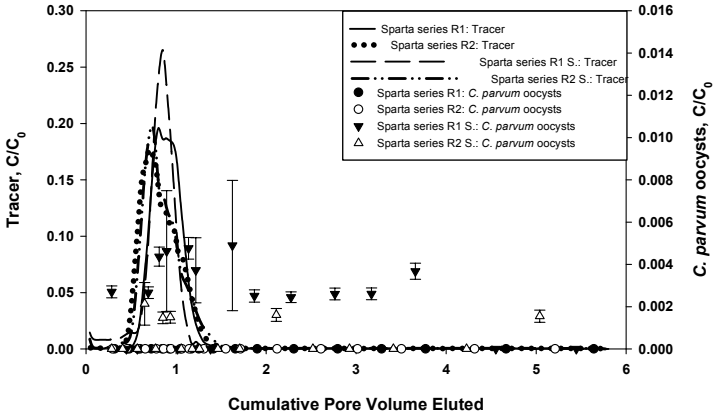
Favorable environment



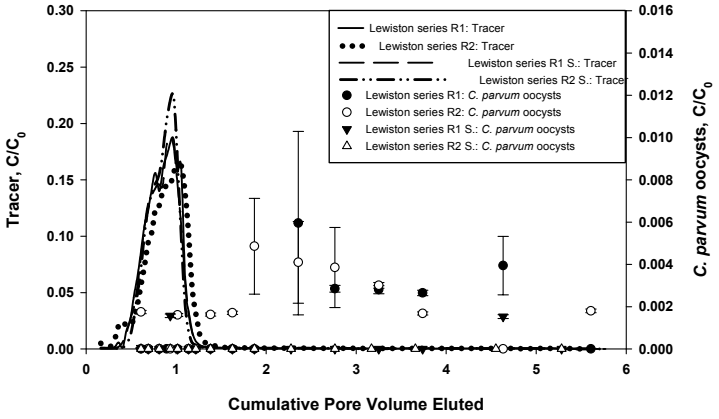
Unfavorable environment

Fate and transport of pathogens in the environment

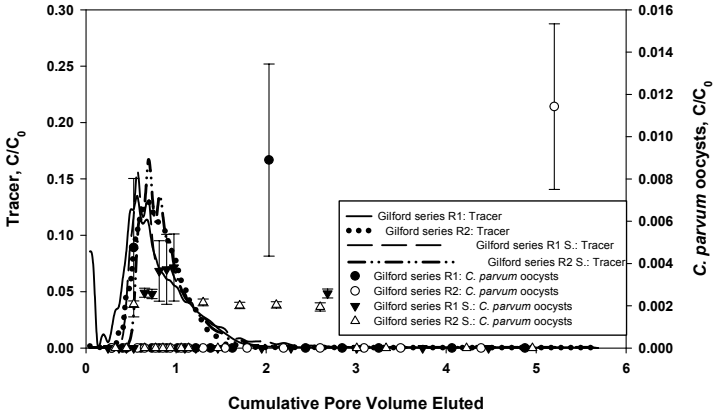
Breakthrough curves of *Cryptosporidium parvum* oocysts and bromide tracer in loamy sand and sandy loam soils from the four series of soils examined – Sparta, Lewiston, Gilford, and Greenson – during simulated rainfall in the absence (Darnault et al., 2017) and presence of Aerosol®22 surfactant.



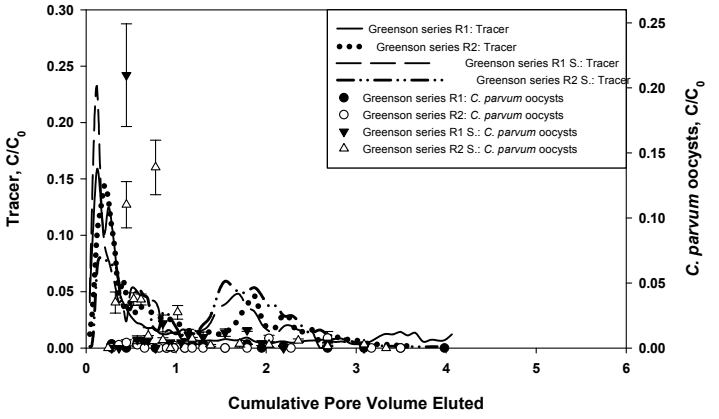
Sparta series



Lewiston series



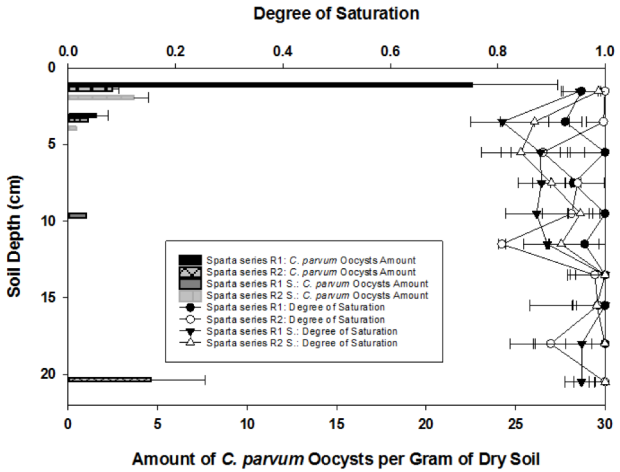
Gilford series



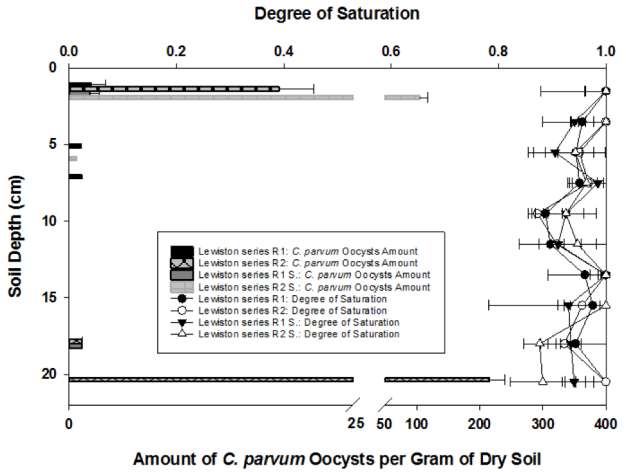
Greenson series

Fate and transport of pathogens in the environment

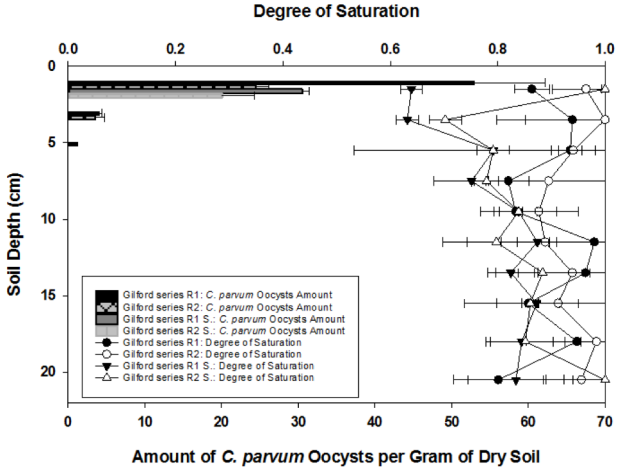
Spatial distribution of *Cryptosporidium parvum* oocysts recovered from soil columns and degree of saturation in soil profiles in loamy sand and sandy loam soils from the four series of soils examined – Sparta, Lewiston, Gilford and Greenson – following the application of rainfall treatments in the absence (Darnault et al., 2017) and presence of Aerosol®22 surfactant, and six pore volumes.



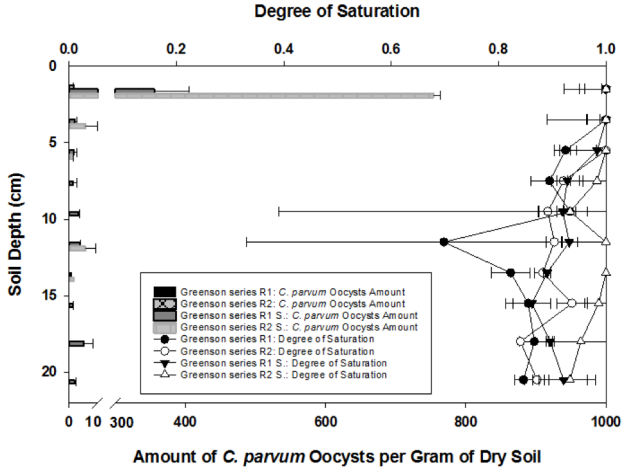
Sparta series



Lewiston series



Gilford series



Greenson series

Research needed

- Investigate past linkages between climate variability, waterborne disease outbreaks, and human health
- Determine climate (change) impacts on the transmission of pathogenic microorganisms and waterborne diseases in the environment, over spatial and temporal scales
- Develop scenarios and models to assess the impacts of climate change on the fate and transport on pathogenic microorganisms in the terrestrial and aquatic systems, and the occurrence and transmission of waterborne diseases in the context of environment-host system

- Research on the effects of climate induced hydro-meteorological extremes on the incidence of infectious diseases will allow the development of climate-driven early warning systems and risk forecasting to reduce infectious diseases threats to human populations.

Thank you.