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Global modelling of Cryptosporidium in surface water

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Introduction
Waterborne pathogens that cause diarrhoea, such as Cryptosporidium, pose a health risk all over the world. In many regions quantitative information on pathogens in surface water is unavailable. Our main objective is to model Cryptosporidium concentrations in surface waters worldwide. We present the GloWPa-Crypto model and use the model in a scenario analysis.
A first exploration of global Cryptosporidium emissions to surface waters has been published by Hofstra et al. (2013). Further work has focused on modelling emissions of Cryptosporidium and Rotavirus to surface waters from human sources (Vermeulen et al 2015, Kiulia et al 2015). A global waterborne pathogen model can provide valuable insights by (1) providing quantitative information on pathogen levels in data-sparse regions, (2) identifying pathogen hotspots, (3) enabling future projections under global change scenarios and (4) supporting decision making.

Material and Methods
GloWPa-Crypto runs on a monthly time step and represents conditions for approximately the year 2010. The spatial resolution is a 0.5 x 0.5 degree latitude x longitude grid for the world. We use livestock maps (http://livestock.geo-wiki.org/) combined with literature estimates to calculate spatially explicit livestock Cryptosporidium emissions. For human Cryptosporidium emissions, we use UN population estimates, the WHO/UNICEF JMP sanitation country data and literature estimates of wastewater treatment. We combine our emissions model with a river routing model and data from the VIC hydrological model (http://vic.readthedocs.org/en/master/) to calculate concentrations in surface water. Cryptosporidium survival during transport depends on UV radiation and water temperature. We explore pathogen emissions and concentrations in 2050 with the new Shared Socio-economic Pathways (SSPs) 1 and 3. These scenarios describe plausible future trends in demographics, economic development and the degree of global integration.

Results and Conclusions
GloWPa-Crypto is the first global model that can be used to analyse dynamics in surface water pathogen concentrations worldwide. Global human Cryptosporidium emissions are estimated at 1 x 10^{17} oocysts/ year for the year 2010.We estimated future emissions for SSP1 and SSP3. Preliminary results show that for SSP1human emissions are approximately halved by 2050. The SSP3 human emissions are 1.5 times higher than the 2010 emissions due to increased population growth and urbanisation. Livestock Cryptosporidium emissions are expected to increase under both SSP1 and SSP3, as meat consumption continues to rise. We conclude that population growth, urbanization, changes in sanitation systems and treatment, and changes in livestock consumption and production systems are important processes that determine future Cryptosporidium emissions to surface water.

References
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