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Quantifying climate change impacts on runoff of zoonotic pathogens from land

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Several studies have shown a correlation between rainfall and waterborne disease outbreaks. One of the mechanisms whereby rainfall may cause outbreaks is through an increase in runoff of animal faeces from fields to surface waters. Faeces originating from wildlife, domestic animals or manure-fertilized fields, is considered an important source of zoonotic pathogens to which people may be exposed by water recreation or drinking-water consumption.

Climate changes affect runoff because of increasing winter precipitation and more extreme precipitation events, as well as changes in evaporation. Furthermore, drier summers are leading to longer periods of high soil moisture deficits, increasing the hydrophobicity of soil and consequently changing infiltration capacities.
A conceptual model is designed to describe the impacts of climate changes on the terrestrial and aquatic ecosystems, which are both directly and indirectly affecting pathogen loads in the environment and subsequent public health risks. One of the major outcomes was the lack of quantitative data and limited qualitative analyses of impacts of climate changes on pathogen runoff. Quantifying the processes by which micro-organisms are transported from fields to waters is important to be able to estimate such impacts to enable targeted implementation of effective intervention measures.

A quantitative model using Mathematica software will be developed to estimate concentrations of pathogens originating from overland flow during runoff events. Different input sources will be included by applying different land-use scenarios, including point source faecal pollution from dairy cows and geese and diffuse source pollution by fertilization. Zoonotic pathogens, i.e. Cryptosporidium and Campylobacter, were selected based on transport properties, faecal loads and disease burden. Transport and survival rates of these pathogens are determined including effects of changes in precipitation but also temperature induced changes on die-off. Moreover, besides climate and surface variables, changes in soil or vegetation and adjustments in agricultural policy are considered. Output of this model can be used to assess how expected climate changes could affect pathogen concentrations in surface waters. The long term aim is to include this information in a larger framework, to quantify the impact of climate change on the infection and eventual disease risks due to exposure to water transmitted pathogens.