Health damage due to microbes
developing characterization factors for use in life cycle impact assessment

Level: Master
Start: Anytime
Project form: Data collection and modeling
Supervision: Rosalie van Zelm

Background and short content of the project
Exposures relating to drinking, nonpotable, and wastewater systems can lead to contact with various pathogens (viral, bacterial, and parasitic protozoan). Both enteric and environmental pathogens may result in health outcomes when ingested or inhaled, ranging from acute illness to chronic disease and mortality (Schoen et al. 2014). As intensity and frequency of water related events such as storms and floods increase in some regions as a consequence of climate change induced by human activities, human exposures to vector-borne, food-borne, water-borne, water-based and sewage borne pathogens are likely to increase as well, making the effects of pathogens more important. While the burden of pathogen related infections can be quantified in disability-adjusted life years (DALYs) as commonly being done in quantitative microbial risk assessment, it is mostly disregarded in life cycle assessment methods so far. The efforts that were made to include the effects of microbial risks in life cycle assessment (LCA) up to now (e.g. Kobayashi et al. 2015) do not systematically address the full cause effect chain to make it possible to systematically include life cycle impact assessment factors in an LCA.

Therefore, the **goal** of this research is to investigate how to include fate and effects of microbes in life cycle assessment and quantify characterization factors for health damage due to microbes originating in streams from wastewater treatment plants.

In a first step, the occurrence of a number of pathogens in wastewater streams will be quantified and coupled to a wastewater treatment model (see e.g. Ottoson 2004). In a second step, effect factors will be derived, expressed as DALY, a metric quantifying and combining the impact of premature death and non-fatal health outcomes resulting from disease, per unit of concentration.

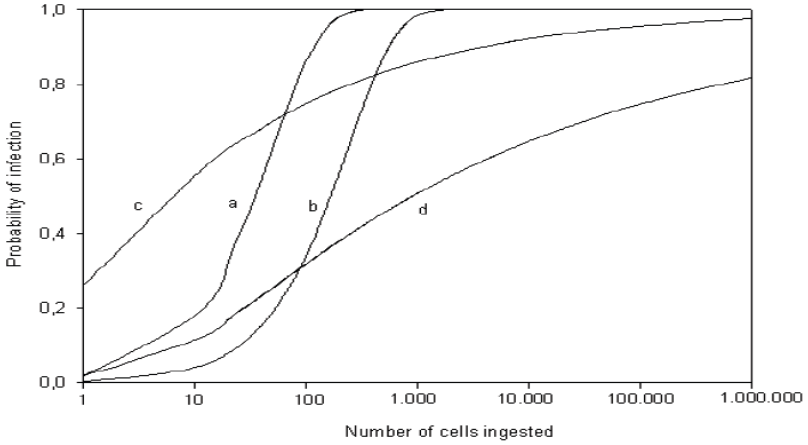

Fig. 6. The probability of infection from the ingestion of pathogenic cells in different dose-response relationships: Exponential models for (a) *Giardia*, (b) *Cryptosporidium* and Beta-Poisson models for (c) rotavirus and (d) *Campylobacter*.

[Ottoson 2004]

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References:
Ottoson J. 2004. Comparative analysis of pathogen occurrence in wastewater – management strategies for barrier function and microbial control. Department of Land and Water Resources Engineering. Royal Institute of Technology (KTH). Stockholm, Sweden. PhD thesis.

Kobayashi Y; Peters GM; Ashbolt NJ; Heimersson S; Svanström M; Khan SJ. 2015. Global and local health burden trade-off through the hybridisation of quantitative microbial risk assessment and life cycle assessment to aid water management. Water Research 79,26 - 38.

Schoen ME, Xue X, Hawkins TR, Ashbolt NJ. 2014. Comparative human health risk analysis of coastal community water and waste service options. Environ. Sci. Technol. 48, 9728−9736.