The emission potential of different land use patterns for the occurrence of coliphages in surface water

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In the context of sustainability and multidisciplinarity the European Water Framework Directive focused on water management of whole catchment areas. As there are various relations between health protection and water protection in terms of synergy effects and conflicts, it has to be asked whether the goal of a "good ecological condition" of water bodies is always suitable for human health, too.

This could be done by estimation of microbial water quality, although there is no hygienic-microbiological parameter given in the European water framework directive yet. While the influence of point sources is investigated quite well, the knowledge about pollution by non-point sources is still quite limited, especially of viruses.

Wastewater is known as point source of phages in surface water, but how important is the potential of different land use patterns as non-point source of viral emission?

Methods

Study site

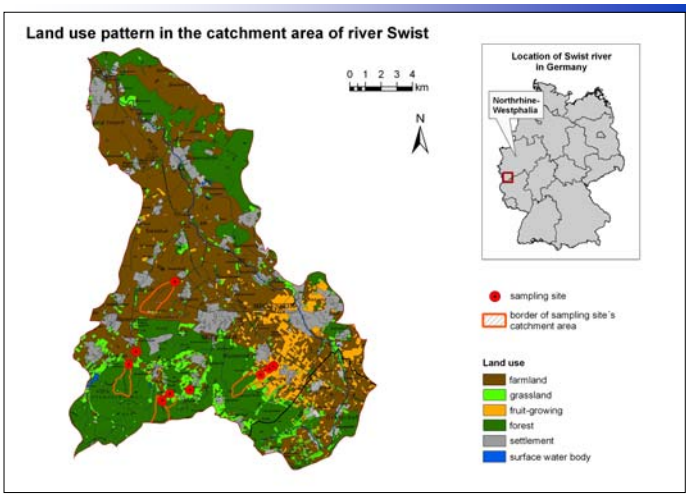
- Location: River Swist, Germany (catchment: 289 km²)
- Five different land use types in the catchment area.
- Upper reaches not affected by settlements or wastewater discharge.

Water samples

- Five river water sampling sites.
- Four surface and subsurface run-off sampling sites.

Microbiological parameters

- Somatic coliphages, F⁺-specific RNA-bacteriophages.
- *E. coli,* coliform bacteria, heterotrophic plate count, faecal streptococci and clostridia spores.



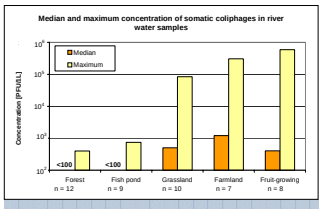


Figure 1: Median and maximum concentrations of somatic coliphages in river water samples

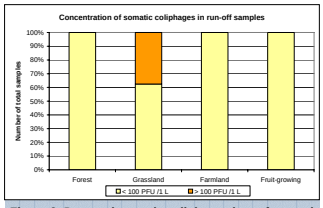


Figure 2: Detected somatic coliphages in surface and subsurface run-off samples

Results

River Water

- Rank correlation r = 0.548 ($p < 0.001$) between land use types and concentration of somatic coliphages (Figure 1).
- Virus concentrations do not show any seasonal variations.
- Highly significant relationships between somatic coliphages and *E. coli* (r = 0.511), coliform bacteria (r = 0.504) and HPC at 20 °C and 36 °C (r = 0.544 and 0.547).

Surface and subsurface run-off

- Surface and subsurface run-off contains quite low virus loads (Figure 2).
- Neither surface nor subsurface run-off show a significant rank correlation with bacterial parameters, season or land use patterns.

Conclusions

- Virus loads in river water vary by land use patterns of the catchment with maximum concentrations of 106 PFU/1L (Figure 1).
- However, surface and subsurface run-off show only low concentrations of somatic and F⁺-specific coliphages.
- As the virus concentrations in the river water can not be explained by the run-off, erosion seems to have significant influence. As a consequence, the type of land cover has an impact on virus load because it determines the erosion intensity.
- Viruses are mainly adsorbed onto soil particles and washed out marginal by bulk water (surface and subsurface run-off).
- Less intensively used and non-eroding areas like forests or fish ponds have a relatively low impact for virus load in river water, whereas intensively farmed agricultural areas cause high concentrations of virus load in river water.
- Health risk can not be excluded even when using surface water for recreational activities from rivers that are not polluted by wastewater discharges.

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