Source Oriented Quantification of Microbial Contamination to Support Adapted Surface Water Catchment Management

C. Schreiber, A. Rechenburg, C. Kistemann, and T. Kistemann

Institute for Hygiene and Public Health, University of Bonn, Sigmund-Freud-Str. 25, D-53105 Bonn, Germany
christiane.schreiber@ukb.uni-bonn.de

The European Water Framework Directive aims to achieve good ecological and chemical surface water quality. But nowadays, the anthropogenic use of surface water is often limited by microbial contamination which poses health risks. To gain a deeper knowledge of the importance of different types of sources for the microbial contamination of surface waters, a point balance of the total microbial emissions in the catchment area of the river Swist in Germany (285 km²), south-west of Cologne, was calculated. Annual mean rainfall in the catchment is 650-700 mm and average annual temperature 9–10 °C. Seven sewage treatment plants with three different degrees of purification are located in the area. The majority of settlement areas with sealed surfaces is drained by combined

A model for calculation of microbial loads within a catchment area was developed and tested at the river Swist in Germany.

Methods

- Water samples were taken year-round at different sampling sites all over the catchment.
- Samples were analysed for several bacteria using standard methods, e.g. ISO.
- Spatial analysis (ArcGIS®) was used to quantify different land use areas.
- Median microbial concentrations from discharge from sewage treatment plants (STP), combined sewer overflow (CSO) and surface and subsurface run-off from non-sealed areas were used to calculate annual microbial loads (Fig. 2).

$$L = L_{STP} + L_{CSO} + L_{RO}$$

with $L = C*V$ and $V_{STP} = V_{WW} - V_{CSO} - V_{RO}$

L = Annual load
C = Median concentration
STP = Sewage treatment plant
V = Annual volume
MQ = Mean river discharge
CSO = Combined sewer overflow
R = Run off from non-sealed areas

Figure 2: Equation for calculating annual microbial loads at area resulting from STP, CSO discharge and diffusive run-off.

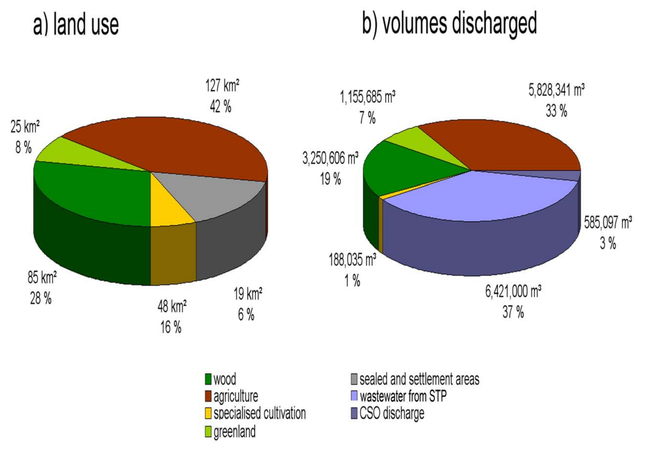

Figure 3: a) Land use in the catchment
b) Proportional annual volumes discharged into the river Swist, resulting from point sources and diffuse run-off of different land use

Results and Discussion

- Predominant land use in the catchment area of river Swist is agriculture (Fig. 1).
- Different types of sources have different impact on the microbial water quality.
- The impact of different types of sources differs from catchment to catchment because of varying proportions of point sources, land use types and intensity of river Swist.
- Calculating a point balance is a simple but effective method for the identification of major contamination factors and helps to identify which water management activities seem to be the best to improve the microbiological water quality successfully.
- This point balance can be seen as the first step towards a microbial risk assessment of the catchment area.
- Depending on the microbial parameter viewed, the impact of diffuse sources on the load vary between 5-74 %, the impact of CSO was 21-88 % and the STP effluent 1-20 % (Fig. 3).

Conclusions

- The management of the catchment area has an important impact on the hygienic and microbiological quality of the water.
- In the catchment of river Swist CSO as a point source of high proportion of total annual load provides optimal conditions for technical-constructional improvement.
- Minimizing diffuse impact seems necessary but difficult. Less intensification and adapted cultivation methods in agriculture could be helpful and natural buffer strips can reduce surface run-off directly.

References

Kistemann, T. et al. (2005): Mikrobielle Fließgewässerbelastungen durch abwassertechnische Anlagen und diffuse Einträge. Düsseldorf, Ministry for Climate Protection, Environment, Agriculture, Nature Conservation and Consumer Protection of the German State of North Rhine-Westphalia, Germany. URL: www.umwelt.nrw.de/umwelt/wasser/abwasser/mikro/index.php (German titel only)

Funded by: