River Monitoring

UNIVERSITÄT DES SAARLANDES

A High-Frequency Automated Online Monitoring in a Small Rural French/German Transborder Catchment

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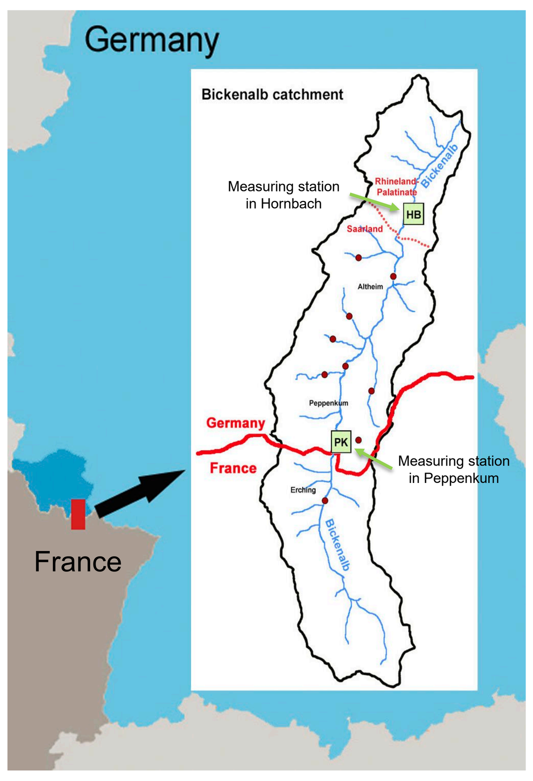
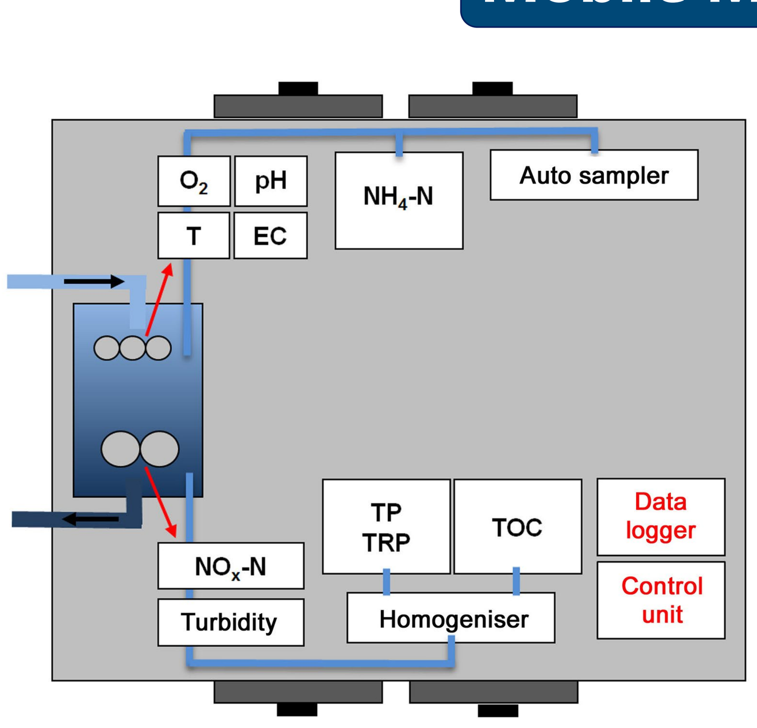
Great temporal and spatial variability of inputs make comprehensive monitoring in small and middle sized rivers difficult. In this study, relevant inputs in a small river were recorded with suitable online monitoring equipment in mobile water quality monitoring stations. The study area was the transborder catchment of River Bickenalb with French and German (Saarland federal state) subcatchments. In addition to a pronounced spatial variability necessitating a denser net of measuring points, this catchment has also to be assessed in the light of different national regulations. To identify individual pollution sources and weigh their relative importance, relevant parameters were recorded over a representative monitoring period of several months: phosphorus (P) as total phosphorus (TP) and total reactive P phosphorus (TRP), nitrate (NO_3–N), ammonium (NH_4–N), total organic carbon (TOC), temperature, oxygen (O_2), pH, turbidity, and electrical conductivity (EC). The recorded data were subjected to sophisticated interpretation together with other catchment-related factors. In order to retrieve maximum information from the data sets the relationships among certain parameter pairs were also analysed for both storm events and low flow periods. Comparison of loads at the different monitoring sites could reliably verify the majority of nutrient inputs originating from the French subcatchment. Our holistic approach allowed to comprehensively map multiple stressors in a small river and provides a valuable basis for adopting cost-effective measures to reduce pollution in small rivers. The situation described is also a striking example of the problems facing authorities in charge of transboundary river basin management as well as of the urgent need for cross-border harmonisation of environmental policies and the definition of transnational binding thresholds.

Investigation Area



- lower and middle limestone
- 42% arable land, 40% pastures and grassland, 14% forests and 4% residential areas
- France: 9 km / 28.6 km² 1 sewage treatment work (STW) (4250 PE) and 2 CSOs (near the national border)
- Saarland: 13 km / 34.3 km², 8 decentralised STWs (70 - 650 PE) and 8 CSOs

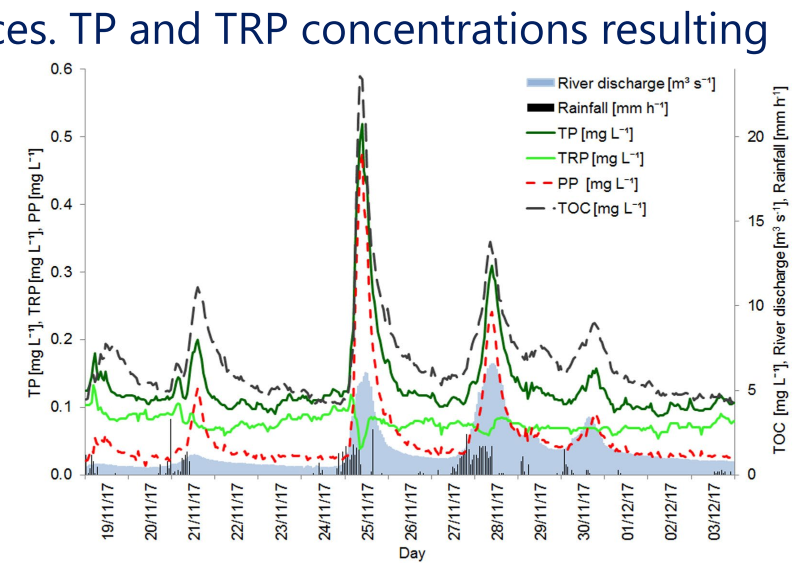
Mobile Measuring Station



The schematic diagram shows the equipment of a mobile measuring station. The black arrows indicate the direction of the waterflow which is transported by a pump in continuous operation installed in the river. Chemical-physical parameters such as temperature, O_2, pH, EC, nutrients such as TP and TRP, NO_3-N, NH_4-N and sum parameters such as TOC are recorded online at high frequency (5-10 min). Furthermore, the stations can be equipped with further measuring devices (e.g. for the analysis of chloride or sulphate) for specific issues. With the help of an auto sampler additional samples can be taken for analysis in the laboratory.

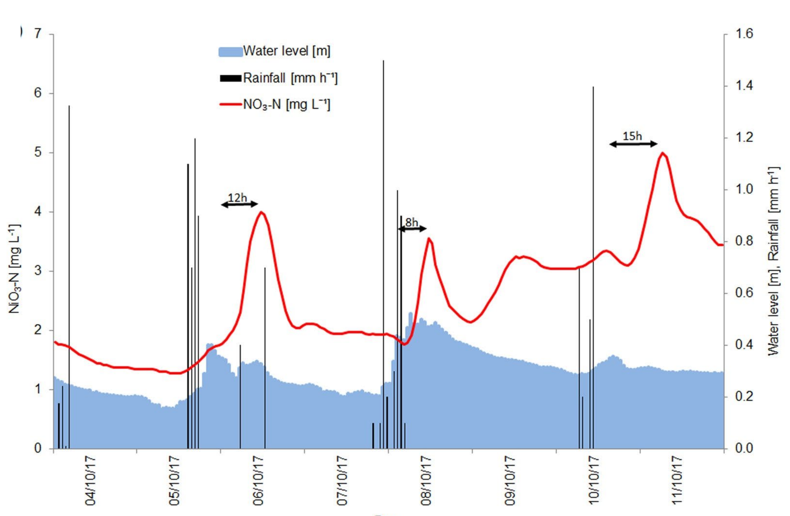
Impacts from Diffuse Sources I

In particular, diffuse source pollution via both erosion and interflow is extremely difficult to detect without recording high-frequency data sets. In the Bickenalb catchment there is a vast array of inputs from agricultural sources. TP and TRP concentrations resulting from such inputs often do not parallel: Despite TP levels increasing, TRP levels stagnate or even decrease, so that the portion of particle-bound phosphorus (PP) – being TP minus dissolved TRP – increases. This P fraction mainly originates from applied fertilisers, as P accumulates on soil particles and is transported into the river by erosion in rainfall events.



Impacts via Erosion at Peppenkum (PK)

Impacts from Diffuse Sources II

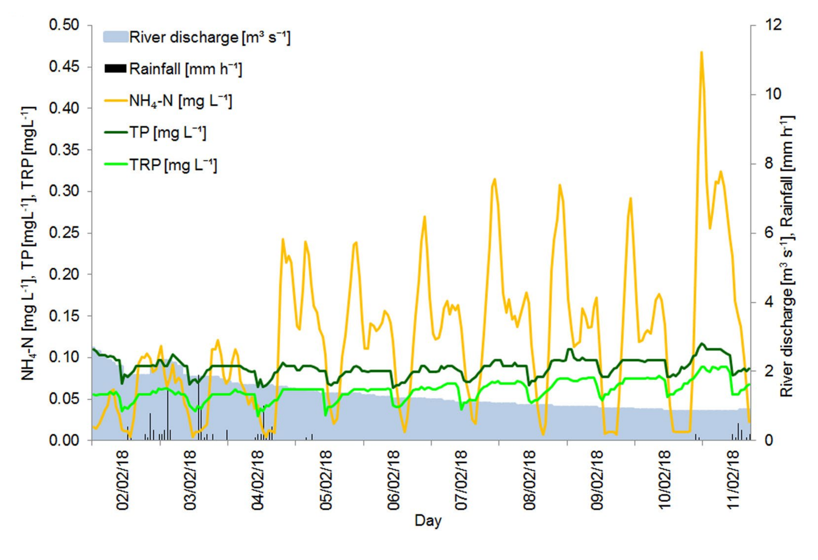


Impacts from via Interflow at Peppenkum (PK)

The impact of agricultural diffuse sources is also evident in NO_3–N concentrations. The transport mechanism differs very much to the one of PP: the transport via interflow. The interflow as a lateral part of the subsurface runoff, transports dissolved substances like NO_3–N through the soil so that it enters the river with a certain time lag. Therefore, the recorded concentration may increase several or many hours after the discharge maximum. At Peppenkum this time lapse was between 8 and 15 h showing sharp peaks, at Hornbach between 12 and 41 h decreasing over a longer time period. NO_3–N leaching and PP erosion from agricultural sources occur mainly in late autumn and winter after the end of the vegetation period and the fields have been harvested.

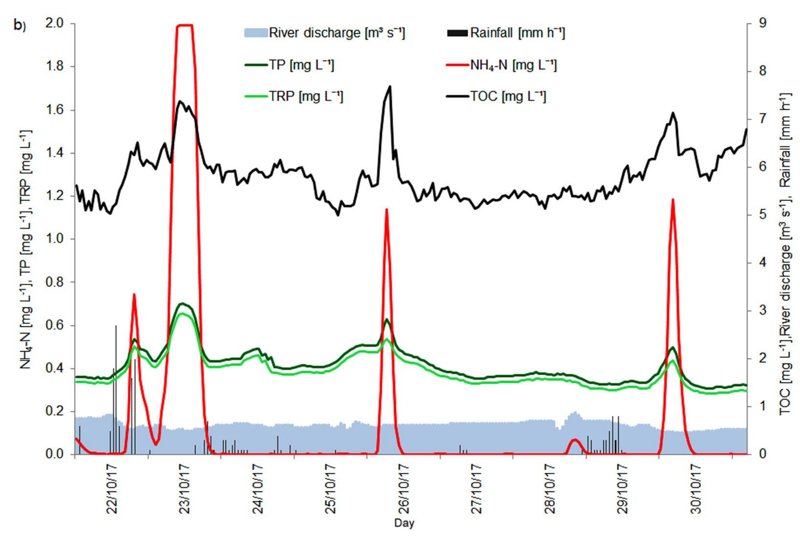
Impacts from Sewage Treatment Works (STWs)

Inputs from municipal or industrial STWs can be best recorded during low flows. Those inputs - especially from small STWs - typically show a diurnal double peak, which is a result of more household wastewater being discharged in the morning and evening. TP and TRP concentrations were exactly parallel, the difference between the two being very small, so P inputs consisted almost completely of dissolved TRP. In the NH_4-N contents the diurnal cycles can be seen, too. Due to falling water levels the concentration trends are rising. In general, in Peppenkum (PK) the average contents of P and NH_4 are much higher than the ones in Hornbach (HB).



Inputs from the Erching STW in France (approx. 2 km upstream PK)

Impacts from Combined Sewer Overflows (CSOs)

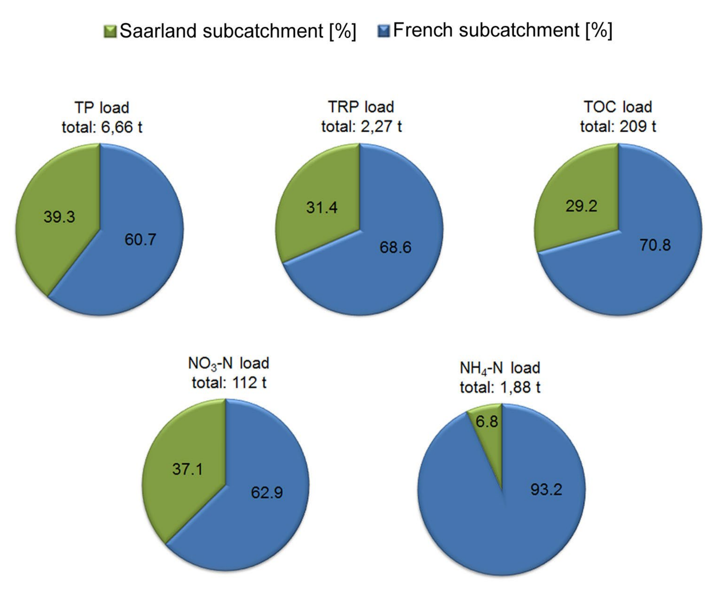


Impacts from CSOs at Hornbach (HB)

Inputs from municipal CSOs pose major risks to aquatic ecosystems not only in densely populated areas. They are generally characterised by steep increases of dissolved TRP, TOC and, in particular, NH_4–N concentrations. Such pollution inputs pose a high ecological risk especially to small rivers, the more so as the hydraulic stress on the ecosystem is accompanied by heavy organic pollution causing serious O_2 depressions. During the monitoring period, 19 CSO input events were recorded in PK and 13 in HB.

Comparison of the Loads

When comparing the loads recorded of both measuring sites it can be seen that the majority of the nutrient quantities are already present in the watercourse when it crosses the border, only 30 to 40% of the loads originate from the Saarland (Germany) part of the catchment. In the French part of the catchment area, the percentage of P and N from STWs is significantly higher than in the Saarland sub-catchment area. In both sub-catchment areas, large quantities are also impacted by erosion or interflow, while the loads from CSOs are rather low.



Comparison of the Loads of the Saarland (Germany) and French subcatchment

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