Nutrient cycling in lowland permeable wetlands: the role of residence time

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Key questions

- Do riparian wetlands significantly modify surface water chemistry in lowland permeable catchments?
- To what extent are these wetlands bypassed under high and low flow conditions by rapid flow through the underlying gravels?
- Do we need to include riparian wetlands in catchment scale models of nutrient flux to waters in lowland permeable catchments

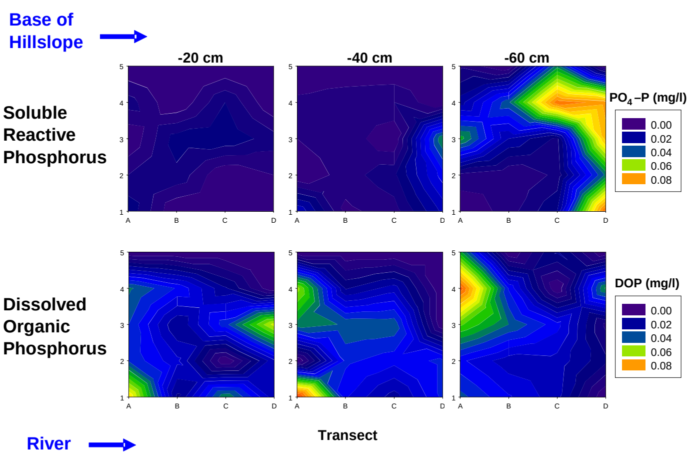
Riparian wetlands are hotspots for nutrient transformation

In many catchment management strategies, riparian wetlands are seen as potential buffer zones between land and water, reducing nutrient loading on waters.

Wetland nutrient cycling can promote the transformation of aqueous N exported from agricultural sources to gaseous N_2 (denitrification) and export of this matter to atmospheric sources, effectively reducing N flux from agriculture to water.

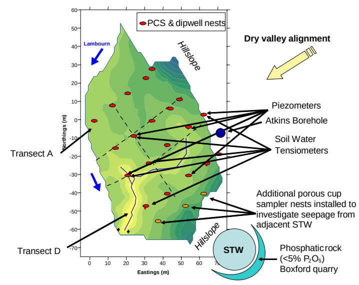
Theory also suggests that P exported from agricultural sources will enter a long-term store in the wetland soils and plant community, thus reducing P flux from agriculture to water

In this study, a full N and P budget was constructed for a wetland underlain by permeable bedrock. This demonstrated highly efficient nutrient cycling, with transformation of the chemical forms of N and P entering the wetland from inorganic bioavailable forms (NO_3^- dissolved organic fractions in the water retained in the wetlai

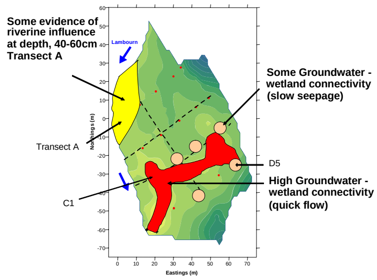


The wetland acted as a nutrient store under low flow conditions, with most of the nutrients stored in the soil porewaters, the plant and the microbial communities

Site instrumentation

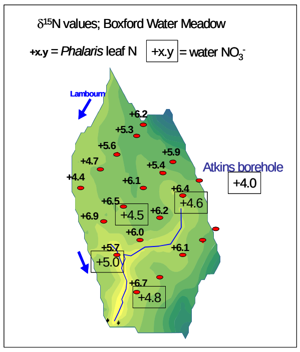


Wetland functional zones



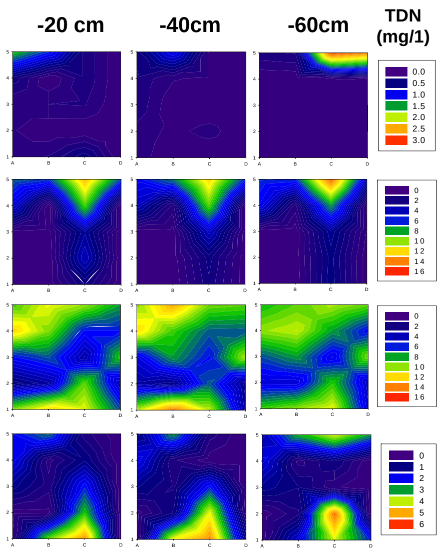
Clear functional zones were identified with the majority of water bypassing the wetland transformation capacity by flowing through the underlying gravels or along the proto-stream channel

Denitrification potential is low, and controlled by residence time



- Soil porewater d[15]N values only slightly higher than in groundwater (0.5 – 1 ‰) implying a maximum 10% loss of nitrate due to denitrification
- Plant d[15]N values are only about 1‰ higher than for soil porewater, implying a maximum of 25% loss of nitrate due to denitrification of nitrate in soil porewaters.
- No isotopic evidence of substantial denitrification of nitrate delivered to the wetland by groundwater

Riparian wetlands flush N & P rich waters to rivers during storms



16/11/96
Total Dissolved N (TDN) concentrations in soil porewaters before the storm, at 20, 40 and 60cm below the soil surface.

18/11/96
A wave of nitrate rich water enters the wetland from the direction of the dry valley at all depths as the storm develops

19/11/96
At the height of the storm N concentrations are 5 times higher than beforehand. Most of the N is Dissolved Organic N

23/11/96
The remainder of the DON rich porewaters are flushed out to the river following the line of the proto-stream channel

Find out more…

Prior & Johnes (2002) *Science of the Total Environment* 282/283, 159-174
Evans & Johnes (2004a, 2004b) *Science of the Total Environment* 329, 145-163 & 165-182
Wheater, Peach, Neal, Johnes, Whitehead (2006) *Hydrogeochemical functioning of lowland permeable catchments.* Final Report. NERC LOCAR Programme NER/T/S/2001/00942

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