Hampshire Avon DTC, River Ebble Water Quality: 2011-2013

The River Ebble, a sub-catchment of the Hampshire Avon DTC, is underlain by chalk and drains through a lowland landscape dominated by livestock grazing and cereal production. A constructed wetland lies at the sub-catchment outlet and has been assessed as a mitigation measure for diffuse agricultural pollution.

The hydro-chemistry of the Ebble upstream and downstream of the wetland was monitored between 2012-2013, providing an assessment of the impact of the wetland as a mitigation feature to reduce diffuse pollution from agriculture. Rainfall and runoff over the monitored period are shown in figure 2. Key features of river flow during this period include:

- Dry conditions through the latter part of 2011 and spring 2012 meant that the stream was dry until beginning of May 2012 (figure 2).
- A contrastingly wet period throughout the rest of 2012 caused rapid wetting up of the sub-catchment with flows peaking at ~1 $m^3 s^{-1}$.
- Flows during 2013 showed steady decline until the sub-catchment dried up in June 2013 and is yet to re-wet.
- Wetting and drying has had in impact on nutrient fluxes from the sub-catchment.

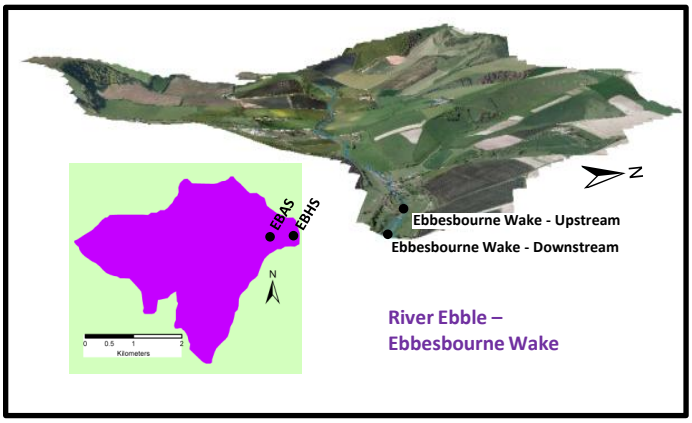


Figure 1: Location of the Ebble DTC sub-catchment. Black dots show sampling stations.

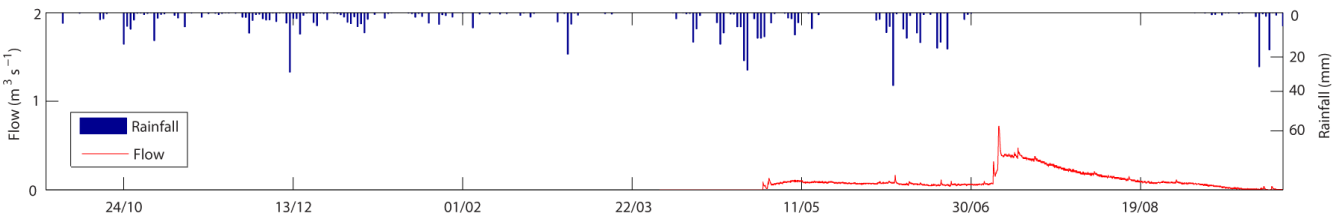


Figure 2: Plots showing example rainfall and discharge data for the Ebbesbourne Wake upstream field site during Water Year 2011-2012 (Oct 2011 - Sept 2012).

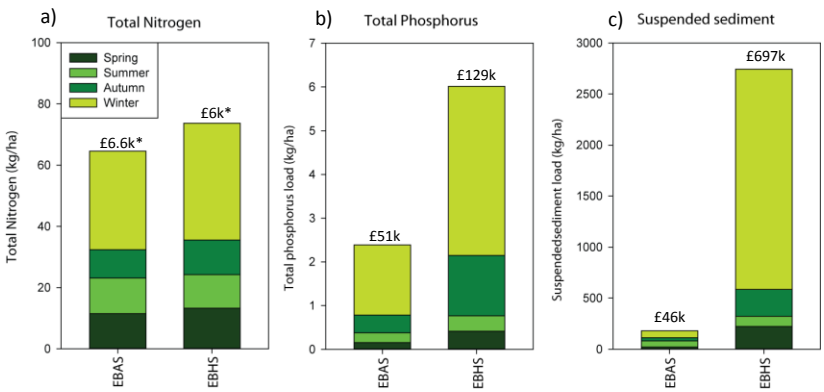
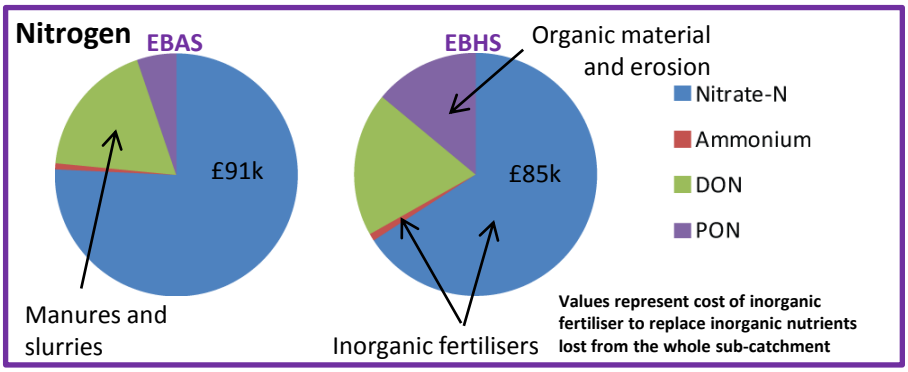


Figure 3: Seasonal comparison of the measured load of a) total nitrogen, b) total phosphorus and c) suspended sediment. Costs show total damage costs for nutrient losses from the whole sub-catchment based on impact on drinking and bathing water quality and biodiversity loss.
*** costs for nitrate fraction only.**

- Total nitrogen loads are similar at both field sites; >68% of the total load occurred in the winter months.
- Autumn and winter are important seasons for total phosphorus losses; particularly at the downstream site, resulting in damage costs of £51-129k.
- The drying and re-wetting of the wetland has resulted in remobilisation of sediment from the stream channel resulting in damage costs of up to ~£¾ million.

What are the sources of the nutrients?



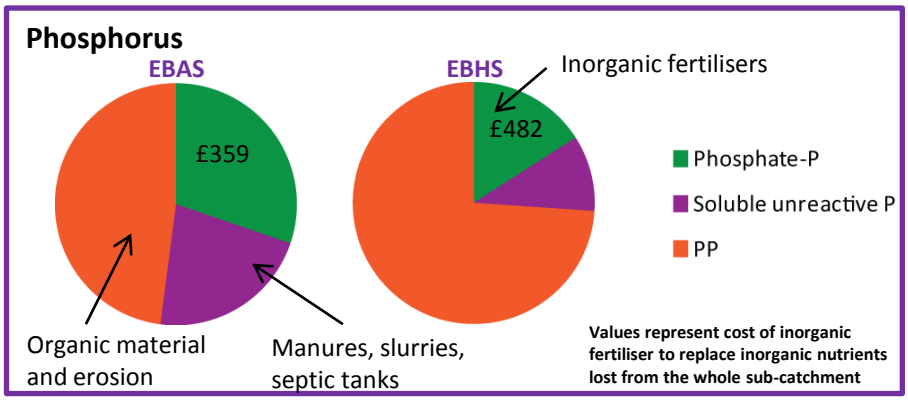


Figure 4: Pie charts showing the fractionation of the nitrogen and phosphorus and the potential sources.

- Between 65-75% of the N at Ebbesbourne Wake is in the form of nitrate.
- Dissolved organic N contributes ~20% of the N flux, likely to derive from inputs from slurries and manures.
- N in particulate form is important at the downstream site comprising 14% of the total load.
- 15-30% of the P is in the form of phosphate.
- The remainder of the P is in organic or particulate forms; downstream of the wetland 75% of the P is attached to sediment.
- A large increase in sediment flux has been observed after the sub-catchment dried and was re-wetted, allowing re-mobilisation of stored bed sediments.

When is pollution transported?

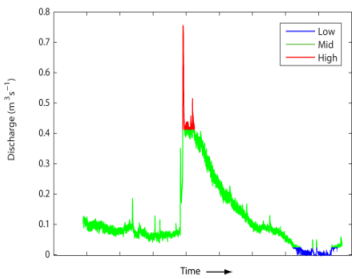


Figure 5: Example of time series showing flow, where low represents lowest 10% of flow duration record and high the top 10% of the flow duration record.

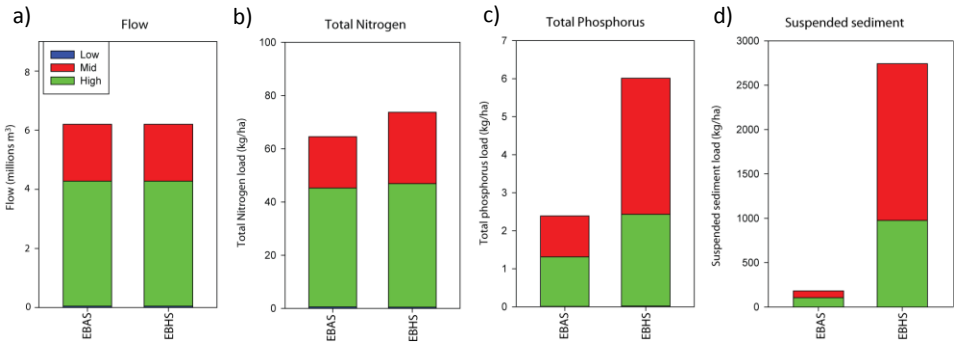


Figure 6: Bar charts showing the proportion of a) flow, b) total nitrogen, c) total phosphorus and d) suspended sediment moved during low, mid and high flows.

Key messages

- Nitrate-N is important at Ebbesbourne Wake due to the influence of groundwater inputs on the stream chemistry.
- Sediment and particulate phosphorus are of concern at Ebbesbourne, particularly downstream of the wetland, which has become a source of material that can be readily transported during high flow events.
- Wetting and drying is a likely cause of the remobilisation of sediment, in addition to cattle poaching at stream edges, resulting in extremely large damage costs totalling ~£¾ million.

- Mid-flow events are important for nitrate-N transport as dilutions are seen in particularly high flows.
- High flow events are important for transporting sediment and associated phosphorus.
- Fluxes of sediment and phosphorus increase downstream due to cattle grazing and management of the sward.

Figure 7: Wetting and drying influences nutrient transport within the sub-catchment.