Nutrient dynamics in the River Swale RACS(R)

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A 55 km section of the River Swale, and its associated tributaries, has been studied over a period of 3 years to collect information that will help predict the flux of nutrients from a catchment.

A total of five intensive sampling events have now taken place. Each programme consisted of 100 h study in which samples were collected at 2 h intervals. The sites consisted of the two CORE monitoring sites on the River Swale at Catterick and downstream at Crakehill, along with sites on major tributaries, Bedale Beck, the River Wiske, and Cod Beck, and sixteen smaller tributaries in the section. Samples were analysed for nutrients including soluble reactive phosphorus (SRP), total dissolved phosphorus (TDP), total phosphorus (TP), nitrate, nitrite, ammonium, calcium and silicon.

Temporal changes in nutrient concentrations show that SRP is diluted by rises in discharge and nitrate concentrations generally increase under the same conditions. Depending on the source of nutrients and the existing conditions, the response of a river's chemistry to a storm event will vary. The inputs to a system may be characterised as broadly point source or diffuse source.

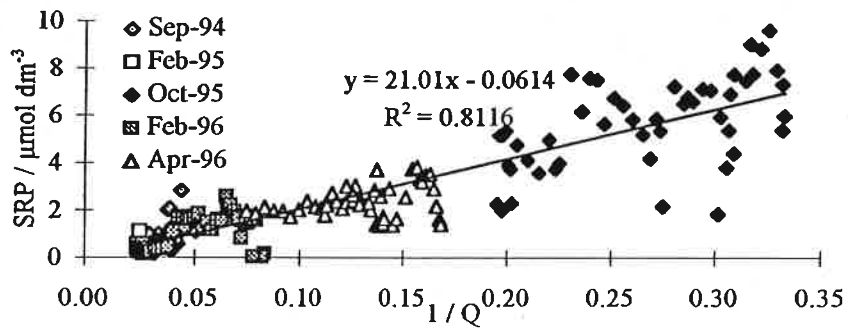
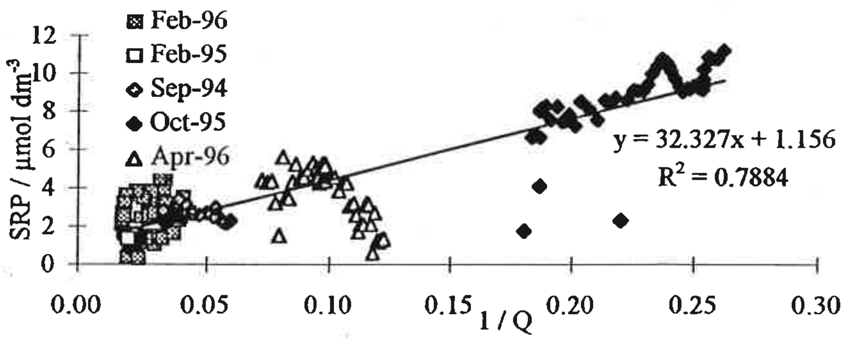


Fig. 1a Catterick

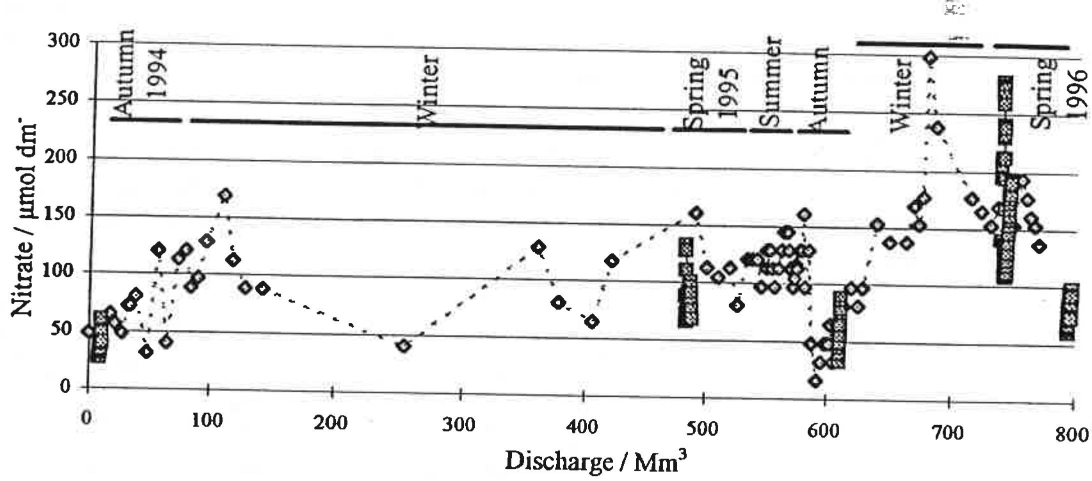
Fig. 1b Crakehill



The higher the R^2, the greater the importance of point sources of nutrients in the river. With an R^2 of 0.8 at Catterick (Fig. 1a), the driest periods show the highest concentrations and the wettest periods the lowest concentrations. This illustrates the importance of the effects of dilution. For Crakehill/Leckby (Fig. 1b) the graph shows more discrete and individual clusters for the five individual events with an R^2 of 0.79. This is probably due to influences from the nutrient-laden tributaries entering the 55 km section. SRP concentrations therefore appear to be very dependent on inputs from STW's - if there is no precipitation input to the system the diurnal changes in concentration are very marked, displaying a cyclical pattern of rising and falling concentrations. However, these patterns and relationships are not applicable to the behaviour of nitrate in this river section as nitrate is not dependent on river discharge alone. It is strongly influenced by antecedent conditions and the intensity and duration of a rainstorm as well as seasonal considerations.

Nutrient tracing shows patterns of hysteresis very clearly (House and Warwick, 1997) particularly in high flow conditions where there is a peak and trough in the discharge, generally following a pattern of increasing concentration with increasing discharge and exhibiting "clockwise hysteresis". An aid to understanding the behaviour of nitrate is to put the data from the intensive sampling into context with the CORE weekly monitoring data, shown in Fig. 2 for Catterick. Core monitoring results are shown using the diamond symbol, and intensive monitoring results with the shaded squares. The big gaps between weekly data points indicate a large increase in discharge.

Fig. 2.



To quantify the flux of a nutrient from a catchment a mass balance approach has been used. This helps to identify the importance of the contributions from all the known inputs. For the intensive sampling in February 1996 the importance of the major tributaries in nutrient contribution is very marked. Although they only form a small part of the water balance, typically 43% for February they are rich in nutrients and make a major contribution to the concentrations measured at Crakehill. For example, SRP contributions from the tributaries at Crakehill were 78% of the total load. Similarly for nitrate, the contributions were 84% of the total load. In-stream process have also been included in the mass balance calculations to determine whether there has been a net loss or gain to the system. Preliminary analysis indicates losses of all fractions of phosphorus and a gain in nitrate for this event.

Reference

W. A. House and M. S. Warwick, (1997). Hysteresis of solute concentrations and discharges in rivers during storms. *Water Research*, submitted.

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