New Zealand's National Rivers Water Quality Network – adding suspended sediment to add value.

D. J. Ballantine, R. J. Davies-Colley

NIWA, P.O. BOX 11115, Hamilton, New Zealand 3215

Keywords: suspended sediment, water quality, rivers

New Zealand's National Rivers Water Quality Network (NRWQN) has been running since January 1989 (Davies-Colley et al. 2011). Monthly sampling for 14 water quality variables is carried out by NIWA field staff at 77 river sites throughout New Zealand. The NRWQN targets big rivers (by NZ standards) and the aggregate catchment area is approximately 50% of the country's land area. The NRWQN is noteworthy internationally for having been stable in its operation and design throughout its 20-year history. The dataset has been valuable for a wide range of applications. For example, the Ministry for the Environment (MfE) has relied on the NRWQN for international (OECD) and national state of environment reporting, including trends over up to twenty years. NRWQN data is used by regional councils and other environmental agencies, to support scientific research and for addressing practical problems of river water quality management.

Patterns of water quality in the NRWQN strongly indicate an increasing dominance of diffuse sources in NZ of key contaminants including nutrients, faecal microbes, and light-attenuating materials. Modelling of TN and TP using SPARROW (Elliott et al. 2005) suggests that only 1.8% of TP and 3.2% of TN flux to the sea from NZ is accounted for by point sources. The most important diffuse source is pastoral agriculture covering 40% of the country's land area. Percentage of catchments in pasture is strongly correlated (Spearman rho values) with total nitrogen (0.85), total phosphorus (0.70), *Escherichia coli*, (0.80), and visual clarity (-0.45).

The NRWQN has never included suspended sediment (SS) concentrations in the range of variables measured because, at the outset, it was considered too expensive to measure indefinitely and cheaper surrogates (turbidity and visual clarity) were included. Other water quality networks in New Zealand (mainly Regional Council State of Environment monitoring) also lack routine SS measurements. Special studies of sediment mass fluxes are traditionally done independently of water quality as add-ons to hydrometric work – targeted at stormflows when sediment fluxes are high. As a result there has been very limited crossover between the related disciplines of sediment research and water quality and there is a dearth of national and regional datasets suitable for examining sediment-associated constituents and aspects of water quality related to sediment.

The effects of suspended sediment on water quality and the aquatic environment are well known. Settled sediment causes a range of damages including smothering of benthos. Fine suspended sediment scatters light strongly, reducing water clarity, drinking water quality and recreational suitability. Fine suspended sediment also acts as a vector for a range of contaminants and nutrients, e.g. phosphorus, particulate organic carbon and *E. coli*.

In order to advance national-scale modelling of both SS and sediment-associated contaminants, and for assessing their impacts in rivers and downstream waters, datasets pairing water quality variables with SS are needed. This information will help advance (1) our understanding of suspensoids in rivers and the impacts of turbid plumes and their associated contaminants in downstream waters (lakes, estuaries and coastal waters), and (2) modelling of concentrations and fluxes of water constituents, which either associate with particles or are themselves particles, and

tend to be transported predominantly in stormflows (notably phosphorus, carbon and *E. coli*).

To meet these research and modelling needs, SS and related variables is being added to the NRWQN for a 5 year period, starting January 2011. Sediment and sediment-associated constituents are mainly transported in high flows - which we plan to target in this research. Through the first 12 months we are sampling SS on all flows encountered during regular monthly NRWQN visits, and thereafter only high flows will be sampled over a further 3 years. A limited amount of special sampling will be conducted in order to intercept storm flows.

As an example of the kind of analysis that will be enabled by the pairing of SS and water quality variables (visual clarity, turbidity), Figure 1 shows the relationships of visual clarity, turbidity and SS to flow in one particular river (Grey River at Dobson, near Greymouth).

We expect that this deliberate pairing of SS and water quality will 'add value' to the NRWQN, by allowing certain water quality variables to be inter-related with suspended sediment. The resulting datasets will provide an improved basis for modelling sediment, visual clarity (and inversely related light attenuation), and other particulate variables and fluxes of materials including nitrogen and carbon.

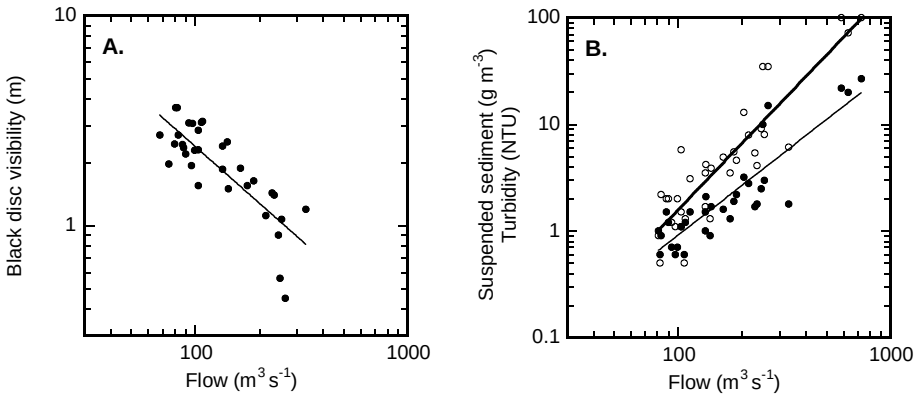

Figure 1. Strong inter-relationships of black disc visibility, turbidity and suspended sediment concentration with flow in the Grey River at Stillwater.

References

Davies-Colley, R. J. 2009. Land use and water quality in New Zealand – an overview. *Water 162*: 32-35.

Davies-Colley, R. J.; Smith, D. G.; Ward, R.; Bryers, G. G.; McBride, G. B.; Quinn, J. M.; and Scarsbrook, M. R.; 2011 (*in press*). Twenty years of New Zealand's National Rivers Water Quality Network: benefits of careful design and consistent operation. *Journal of the American Water Resources Association* (accepted for publication, March 2011).

Elliott ,A. H.; Alexander, R. B.; Schwarz, G. E.; Shankar, U.; Sukias, J. P. S.; McBride, G. B. 2005. Estimation of nutrient sources and transport for New Zealand using the hybrid physical-statistical model SPARROW. Journal of Hydrology (NZ) 44: 1-27.