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RP178a Contribution of eroded soils to dissolved inorganic nitrogen export in Great Barrier Reef catchments

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The Great Barrier Reef (GBR) is threatened not only by climate change (i.e., global warming and acidification), but also by an excess of sediment, nutrients and pesticides delivered to the Reef in catchment runoff.

The extent of the impact of nutrient loads on the GBR is dependent on their bioavailability (a measure of how available nutrients are to biota). The emphasis of GBR water quality management has been on reducing sediment and dissolved inorganic forms of nitrogen (DIN) (Queensland Government, 2013), under the assumption that by targeting sediment, particulate nutrients would be targeted too. The role of particulate nutrients and organics associated with sediment in generating bioavailable nutrients, in particular DIN, at the end of GBR catchments and in the GBR has been largely overlooked (Bartley et al., 2017).

Recent research has shown that particulate nutrients exported from the GBR catchments are an important source of bioavailable nutrients to the reef system (Garzon-Garcia et al; 2017; Franklin et al., 2018; Garzon-Garcia et al., 2018). Although there have been significant advances in the understanding of the bioavailability of particulate nutrients in the GBR, the relative contribution of this source of DIN to marine eutrophication when compared to other catchment sources like fertilised agriculture, is unknown.

What issue was this project trying to resolve?

The key objectives were to 1) evaluate if DIN generation from eroded soil contributes a significant proportion of the total DIN measured at the end-of-catchment in a dry tropics grazing catchment (Bowen River catchment) and a wet tropics mixed land use catchment (Johnstone River catchment); 2) provide a framework for how DIN generation from sediment could be modelled; and 3) Analyse the Great Barrier Reef Catchment Load Monitoring Program's (GBRCLMP) existing particle size dataset to improve understanding of what size fractions of sediment reach the end of GBR catchments.

Cattle grazing in the Bowen River catchment

How did we go about it?

For objective 1 and 2, a method (Garzon-Garcia et al., 2018[1]) was developed to estimate the proportion

[1] Garzon-Garcia A, Burton J, Ellis R, Askildsen M, Finn L, Moody P, DeHayr R. 2018. Sediment particle size and contribution of eroded soils to dissolved inorganic nitrogen export in Great Barrier Reef catchments - Project RP178a. Brisbane: Department of Environment and Science, Queensland Government p46.

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of end-of-catchment DIN generated from eroded soils using:

- data from the soil and sediment bioavailable nutrient database (2015- 2018).
- the Paddock to Reef Source catchments modelling framework.

For objective 3, the particle size dataset extracted from the GBRCLMP database was analysed on a catchment by catchment basis.

What was the outcome?

DIN generation from eroded soil was found to be a key source of DIN to the end-of-catchment in the Bowen River catchment whilst fertiliser was the key source of DIN in the Johnstone River catchment.

In the Bowen River catchment pilot study all of the end of catchment DIN that is currently modelled could be accounted for by the DIN generated from eroded sediment that was modelled using the new method. In comparison, 'DIN generated from sediment' yields in the Johnstone River pilot study were higher than those in the Bowen River catchment, however, the large modelled yields of 'DIN from fertilizer' dominated the DIN source to end of catchment in the Johnstone. Given that the modelled quantity of DIN generated from eroded sediments was significant in grazing catchments it is likely that this source poses a significant risk to water quality and ecosystem health in the GBR.

The main sources of sediment in a catchment are not necessarily the main sources of particulate nitrogen (PN) or DIN-producing sediment.

For example, the modelling in the Bowen River catchment indicated that although **gully erosion is the main source of sediment,** hillslope erosion is the main source of PN and DIN generated from sediment (though there is variability of the main source between years). Hence, **in grazing lands the management of hillslopes is important to reduce end of system PN and DIN generated from eroded soils.** Spatial sources of PN and DIN generated from eroded sediment were also found to be different to those of sediments.

In the Johnstone River catchment, although conservation and sugarcane dominated sediment export, and sugarcane alone dominated PN export, the new modelling results indicated that dairy may be an important source of DIN generated from eroded sediment at the end-of catchment (39% contribution) together with sugarcane (44% contribution).

Altogether the results indicate that:

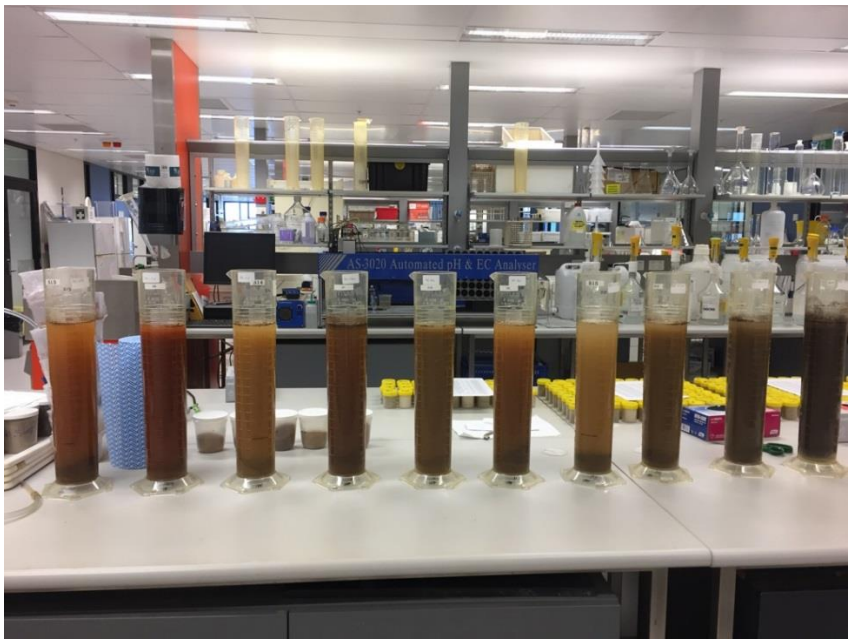
- The source of PN and DIN generated from sediment is a function of both the nutrient characteristics of the sediment (quality) and the load of sediment (quantity).
- There are additional benefits gained when PN and DIN generation from sediment are considered in conjunction with sediment management.
- As reductions in end-of-catchment DIN associated with erosion management are not currently being accounted for they are not included in progress towards the DIN reduction target.

The project demonstrated that PN modelling can be improved to account for the variability in fine sediment (<20 μm) characteristics in the catchments particularly the variability in enrichment ratios of particulate nutrients in sediment from that of their parent soils. It provides a framework/process to report on PN and DIN reductions associated with erosion management.

The analysis of the particle size dataset indicated that:

- Greater than 90% of sediment exported from the larger, predominately grazed dry catchments (Normanby, Burdekin, Burnett and Fitzroy) is <16 μm (clay and fine silt), although there is large variability between samples. This may be related to the timing of sampling during events, the variability of sampled flows and sediment source.
- In contrast, suspended sediment samples collected in the coastal wet catchments (Barron, Herbert, Tully, Haughton, Pioneer and Plane) have a lower fine silt (<16 μm) and clay (<2 μm) content and higher coarse fraction content (≥63μm).
- A considerable fraction of the fine sediment (i.e. <63 μm) leaving the GBR catchments at end-of-system is larger than 16 μm (from 5 to 29%), particularly in the Wet Tropics and Mackay-

Whitsunday regions. This is important to note as it has implications for the validation of the suspended sediment modelling which currently only models the <20 µm fraction. The fractions of fine sediment larger than 16 µm will have water quality effects (e.g. DIN generation) in the river estuaries that need to be assessed. Further understanding of particle aggregation and transport from catchment to the Reef is required to standardise methods.



Testing sediments for bioavailable nutrients at the Chemistry Centre - DES

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