Runoff sediment characteristics of four Fitzroy Basin grazing soils in semi-arid Queensland, Australia

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Background

Sediment generated from grazing land in the Great Barrier Reef (GBR) catchments poses a significant threat to the Great Barrier Reef lagoon. Approximately 1,500 kt/year of fine sediment (<20 µm) is exported from the Fitzroy Basin, Central Queensland, into the GBR from grazing-specific land use[1].

This study investigated sediment export characteristics of four different grazed soil types in the Fitzroy Basin, where 75% (>117,000 ha) of the catchment is utilised for grazing.

Soil erosion is affected by intrinsic characteristics including texture, structure, chemistry, and hydraulic properties. Water-driven erosion, such as from raindrop impact or runoff, is exacerbated by land use practices where changes in vegetative cover, soil hydrology, soil structure, or chemistry increases the detachment and transport potential of soil particles[2]. Grazing, deforestation and excessive cultivation are three leading causes of accelerated soil erosion[3].

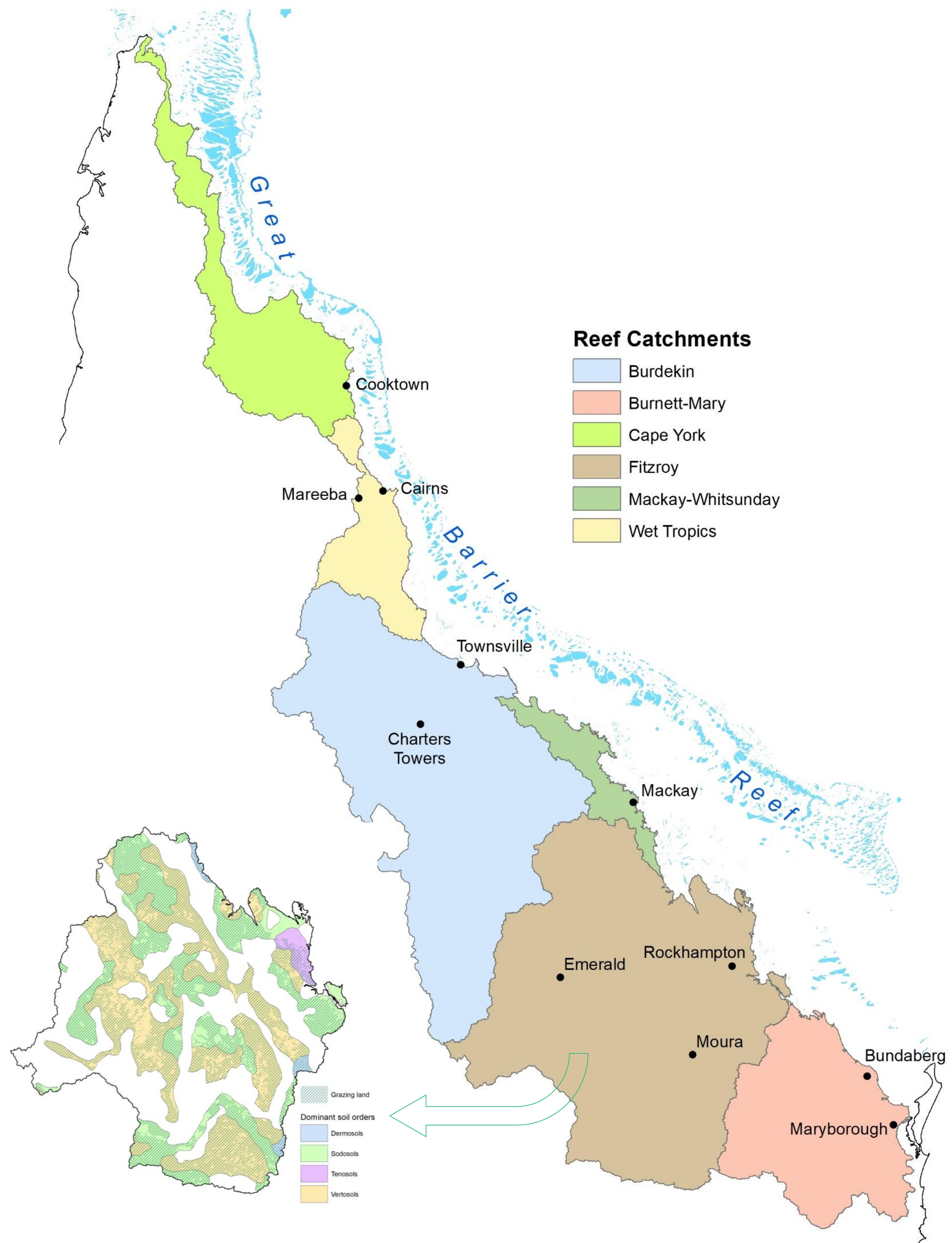

Figure 1. Great Barrier Reef catchment regions. Fitzroy catchment is 156,102 km^2 in size.[1] Source: Kaitlyn Andrews & Kevin Roots, Department of Resources.

Research questions

- What proportion of **fine sediment** (<20µm) is exported from each soil type?
- Which soil type presents the greatest fine sediment export risk?

Method

Rainfall simulation was applied over four bare soil types (Tenosol, Black Vertosol, Brown Sodosol and Black Dermosol) to determine erosion parameters for modelling sediment loss with the Revised Universal Soil Loss Equation. These four soil types are representative of 75% of the grazed Fitzroy Basin (Vertosol 28%, Sodosol 28%, Dermosol 11%, Tenosol 3%)[4] (Figure 1). Two vegetated treatments were also used for soil loss comparison on the Vertosol and Sodosol.

Hydrology parameters were observed through the simulated rainfall event. Runoff water quality was collected at 5-minute intervals throughout the 30-minute rainfall event. Total and suspended solids and particle size distribution by laser diffraction were analysed.

Data collected provided an understanding of detachment properties and particle size distribution of eroded sediment

Figure 2. Fitzroy Basin grazed hillslope (top). Rainfall simulation plot 1.4m by 2m long prepared as a scald plot (left). Rainfall simulation in action over a vegetated plot (right).

Key findings

- The **Tenosol** and **Dermosol** exported the highest proportion of fine sediment (<20 µm) at the plot scale.
- The **Tenosol** had the highest event sediment load (t/ha) than other soils at the plot scale.
- **Vertosols** and **Sodosols** are the most prevalent soils (54% of the Fitzroy catchment) and pose greater risk to fine sediment contribution in sediment loads.
- **Vegetated plots** (>50% cover) had **>42% lower fine sediment** fraction (<20 µm) and **>72% lower sediment load** highlighting the importance of ground cover.

Soil type	Treatment	Event mean infiltration	Event mean sediment concentration	Event mean sediment transport rate	Percent <20um	Sediment load	Proportion of grazed soil type in Fitzroy	*Potential fine sediment load to catchment**
		mm/hr	g/L	g/min	%	t/ha	%	kt
Black Dermosol	Scald	11.2	4.6	18.0	43.5	2.5	11%	*750*
Black Vertosol	Scald	8.3	8.7	33.3	38.8	1.4	28%	*920*
	Vegetated	**52.6**	7.4	7.6	20.4	0.3		*40*
Brown Sodosol	Scald	5.1	8.6	36.4	23.0	2.5	28%	*1500*
	Vegetated	24.8	6.6	18.7	12.6	0.7		*220*
Tenosol	Scald	6.4	**12.8**	**51.4**	**47.0**	**7.2**	3%	*700*

**Rudimentary demonstration multiplying steady state sediment load by hectares of each soil type present in the Fitzroy Basin then by proportion of observed <20µm fines to highlight resultant potential soil type risks and contributions to fine sediment if ground cover was a consistent 50%.*

Implications

Hydrological properties, sediment loss and particle size distribution differed depending on soil type. Data from vegetated plots exhibited higher infiltration rates, lower runoff rates (data not shown), and markedly less sediment loss. Management of ground cover is a critical component of reducing sediment loss in Reef catchments, where **ground cover targets of 50%**[5] are recommended in the late dry season. **Improving our understanding of fine sediment budgets across GBR soils improves catchment models** used to develop sediment exports. These findings are applicable for grazed lands both in the GBR and rangelands outside the GBR catchment.

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