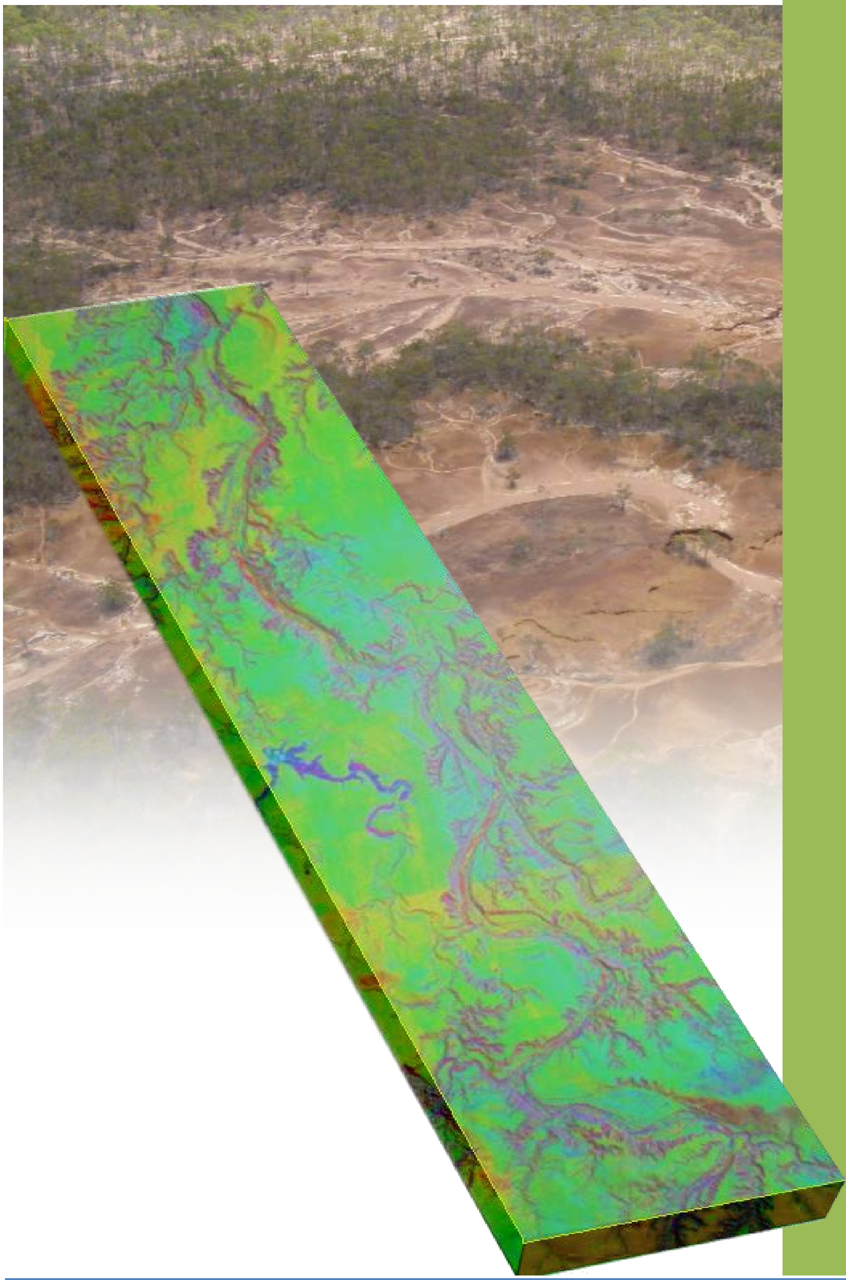

An Empirically-based Sediment Budget for the Normanby Basin

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Appendix 16: Road Erosion

IMPORTANT

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Griffith UNIVERSITY

CARING FOR OUR COUNTRY

Appendix to the Final Report prepared for the Australian Government's Caring for our Country - **Reef Rescue initiative**

CAPE YORK WATER QUALITY

Appendix 16: Road Erosion

Prepared by: Angela Gleeson* and Andrew Brooks
***Corresponding author: Honours Thesis**

1. Description

The impact sediment pollution from unsealed roads on the surrounding hydrological networks has been well documented in many parts of the world including Australia. However, to date, no such studies have been undertaken (to our knowledge) in the wet-dry tropics of northern Australia. Furthermore, sediment budget models such as SedNet or Source Catchments, do not recognise unsealed road networks as a major land use, nor do they quantify the threat that roads may potentially pose to the water quality of the 35 coastal catchments regulated under the Reef Plan (2009).

The overall aim of this study was to assess the extent that the unsealed road network within a wet-dry tropical catchment, such as the Normanby Catchment, is having on the suspended sediment supply discharged into the surrounding hydrological network.

1.1 Study

The suspended sediment concentration of the runoff generated from three main unsealed road segments was monitored over a period of three months, from late November 2011 to early February 2012. Using rising stage samplers and a DH48 hand held sediment sampler it was determined that over the sampling period the suspended sediment generated from the surface of all three roads ranged from 113mg L^{-1} to 13,509 mg L^{-1}, with a mean production of 1779 mg L^{-1}. Comparing these results with the findings in previous literature, it is clear that the sediment concentrations from unsealed roads is comparable with other intensive land uses, and is only exceeded by mining (Figure 1). The concentrations measured in this study are likely to be an underestimate of the real mean supply of suspended sediment from the surface of the roads as a result of all experimental sub-catchments receiving well below the long term mean rainfall per month (Figure 2).

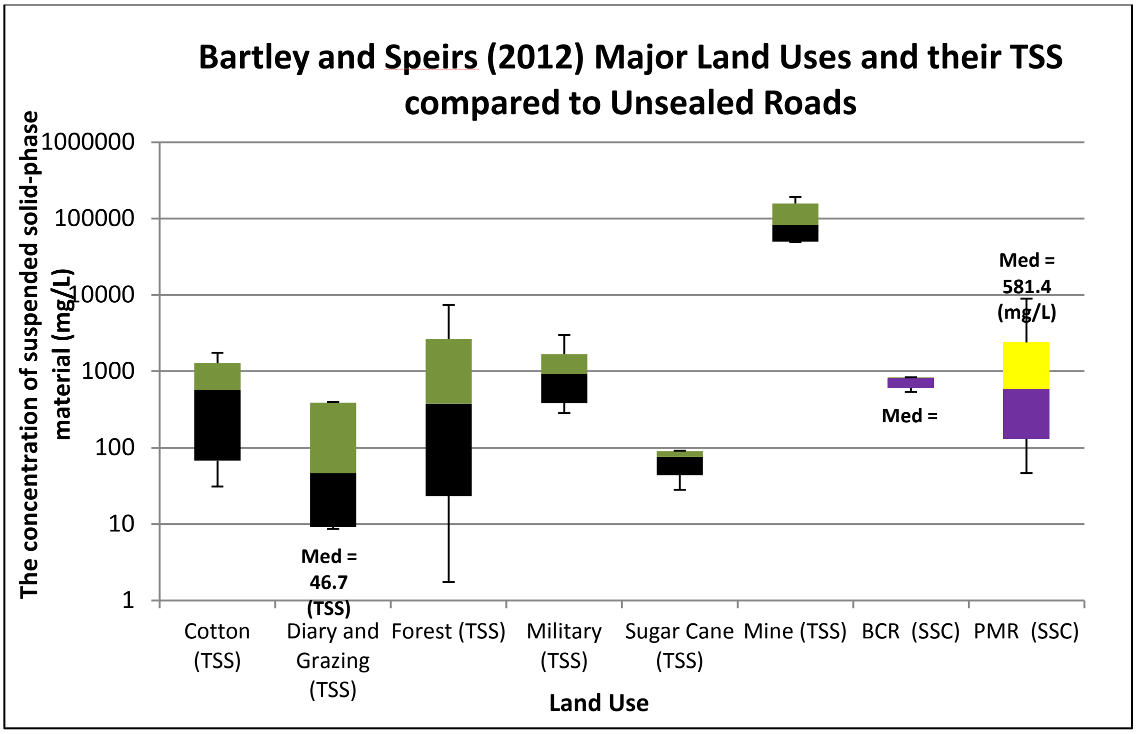

Figure 1 Comparison of SSC data (<63um fraction) for unsealed roads in the Normanby Catchment compared to TSS data from other land-uses in similar wet-dry savannah catchments, as summarised by Bartley and Spiers (in press).

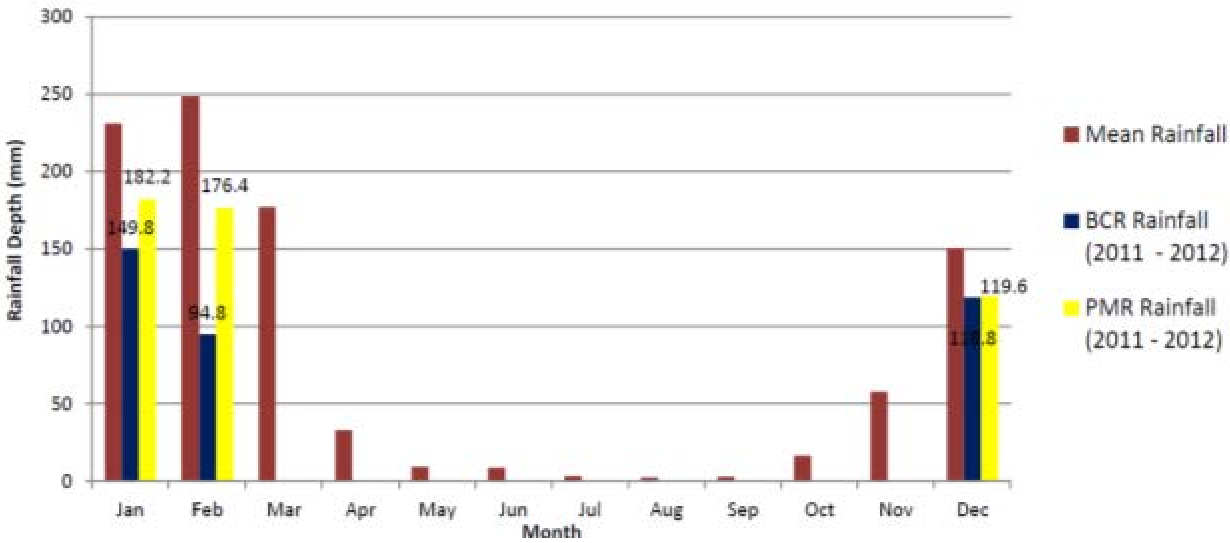

Figure 2 Rainfall recorded at the study site compared with long term monthly averages from Laura Post Office (BOM stn 028000)

In total the unsealed road network of the Normanby Catchment intersects (direct connectivity) 1190 times with the surrounding drainage network (Figure 3). This is almost certainly an underestimate due to the resolution of the GIS derived stream network. Due to the low number of samples collected the impact of these road and creek crossings on the downstream water quality was not able to be determined in a statistically significant manner.

Similarly, it was not possible to adequately determine the key explanatory variables influencing the production of sediment from the surface of the roads, given that an insufficient range of rainfall intensities was sampled through the study. Nevertheless, the weight of evidence is that unsealed roads contribute significant amounts of sediment to the stream network, particularly in light of the total area of roads in this relatively sparsely populated catchment.

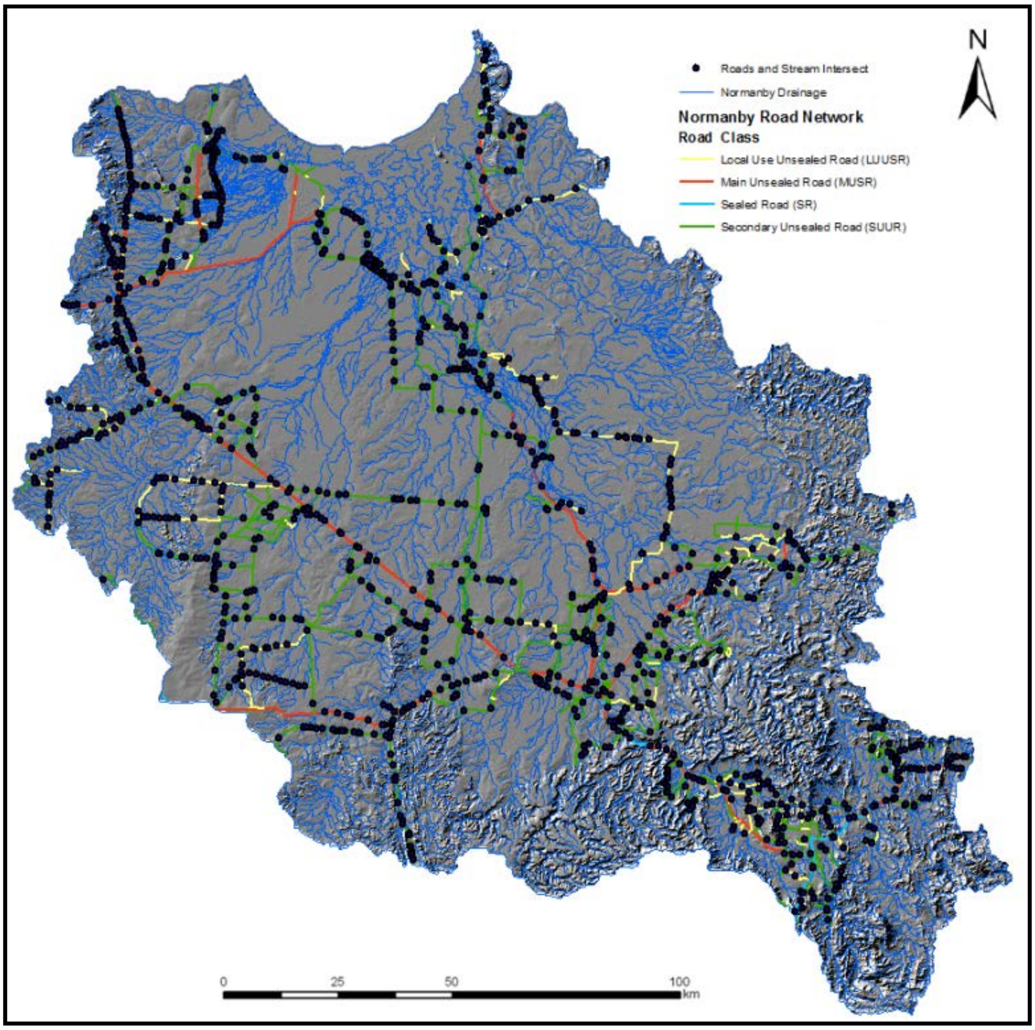

Figure 3 Map of the Normanby catchment showing the points of intersection between the unsealed road network and the stream network.

The total area of roads within the Normanby catchment is around 2.5 times greater (5676 ha *cf* 2185 ha) than the area of intensive agriculture for the Cook Shire Local Government area (which encompasses the whole Normanby catchment and much of Cape York) (ABS 2010 data).

The delivery of road surface runoff and suspended sediment was also observed to occur via gully pathways originating from road drainage outlets. It was estimated that a mean volume per drain of 132 m^3 of soil has been displaced due to the formation of gullies at the outlet of 42% of the all V-Drains analysed in the study (Figure 4). This represents an additional contribution to sediment yield over and above the sediment sourced from the road prism. Average V-Drain spacing for the study area is 144m (on both sides of the roads), hence there is potentially around 1800 m^3 of road induced gully erosion per km of main unsealed road (MUSR) that could be contributing to elevated sediment loads within the stream network. It is not known however, over what time span these V drain induced gullies have formed. The presence of exposed roots and active headcuts suggest that these gullies are fresh and active – and it would be safe to assume that at the most we are likely to be talking a decade as the upper limit.

Figure 4 Examples of gullies emanating from road drains within the study area. 42% of road drains in the study area were found to have gullies like this associated within them

It was found that the average suspended sediment concentration measured over the sampling period from the surface runoff of all the experimental roads (Battle Camp Road; the Palmerville Road and the Peninsula Development Road), was between 2 – 4 orders of magnitude greater than the suspended sediment generated from hillslope erosion within the catchment's major land use, open range cattle grazing.

In summary, this study has highlighted the significant threat that unsealed road networks potentially pose to the water quality of wet-dry tropical catchments, such as the Normanby Catchment.

1.2 Extrapolation to catchment Scale

As a means of providing a first order estimate of the likely contribution of all road erosion on the total sediment budget for the Normanby catchment, we have used the mapped road network to determine the average road surface dimensions combined with average contributing road area and event mean concentration data to estimate mean annual sediment loads from road runoff (Gleeson 2012). From these data it was shown that streams intersected the road network 1190 times throughout the Normanby catchment. Based on a limited data set collected as part of this honours thesis, we have estimated the mean contributing road surface area for each road crossing to be2344 m^2, which equates to a total effective contributing surface area of 279 ha road feeding directly into the stream network at the catchment scale.

1.3 Conclusion

Based on these data, we have than modeled the total annual sediment concentration using the event mean concentration data and the daily rainfall data set.

Previous studies have identified a threshold of around 12mm per hour to initiate road runoff (Reid and Dunne, 1984; Croke et al., 2006; Thompson, et al., 2009). In this case given that we only had daily rainfall data available in raster format at the catchment scale, we have assumed a runoff threshold of 20mm/day to initiate suspended sediment runoff from road surfaces. In this case the runoff volume is calculated for the excess runoff for all daily rainfall > 20mm/day. These data are calculated for each sub-catchment in the sediment budget model and included as a sediment input along with all other sediment sources.

Table 1 Unsealed road dimensions and event mean SSC values for road runoff in the Normanby catchment (Gleeson, 2012)

	average	1 stdev
average contributing length (m)	182.8	180.2
average width (m)	12.8	
total stream crossings	1190	
Average contributing area per crossing(m^2)	2344	
total contributing area (m^2)	2789830	
total area (ha)	279.0	
average conc. (mg/l)	1029	1961
av events >11mm/yr	35	
av RF/event (mm)	29.7	
av RF/event/crossing (l)	69629	
av sed/event/Xing (kg)	71.6	
Mean annual rd surface erosion	**2984**	**5687**

References

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