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Water quality impacts of forest roads at the catchment scale: measurement and modelling

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Unsealed roads have been identified as the major anthropogenic source of sediment (and possibly nutrients) from forested areas. Forests occupy 65% of the 20,000 km^2 Gippsland Lakes catchment in south-eastern Australia, and are the dominant source of sediment to the lakes. Consequently, small reductions in the total loads from forests *may* yield significant water quality benefits in the Gippsland Lakes. The aims of this research were to;

1. Improve our understanding of unsealed forest roads as a source of sediment and nutrients to the Gippsland Lakes.
2. Estimate the magnitude of the contribution of forest roads, in the context of natural background loads from forests.
3. Evaluate the effectiveness of road-related remedial measures for sediment and nutrient load reductions.

The Upper Tyers Catchment, in the headwaters of the La Trobe River, was selected as a research catchment and a range of research methods were used to achieve the above aims, including;

- instrumentation of forest roads to measure sediment and nutrient generation rates as a function of road type and traffic level
- instrumentation of forest streams to measure total exports from forested catchments
- rainfall simulation on forest roads to measure sediment and nutrient generation rates from different road types

- sediment tracing and size analysis to determine the source of sedment (within the road area) and the “transportability” of the sediment
- nutrient analysis to determine the relationship between nutrient concentration and sediment concentration from roads
- mapping of road crossings to identify the properties of roads, and the linkage of these sediment sources with streams
- data analysis and modelling to estimate the proportional contribution of roads to the total load from the catchment
- modelling to evaluate the effectiveness of sediment reduction methods

The major findings from this study are;

- The unsealed road network delivered an estimated 50 t of the 475 t of TSS exported from the 13,451 ha catchment, or about 11 % of the total load from the forest.
- The unsealed road network delivered a maximum of 22 kg of the 807 kg of TP from the catchment, or about 2 to 3% of the total load from the forest.
- Variability between individual crossings was high with 50% of the total sediment and nutrient load coming from the highest yielding 10% of crossings
- Most of the sediment from the established unsealed road network comes from the road surface (as opposed to table drains or batters), indicating that remedial treatments should focus on runoff from this element of the road area.
- The level of TP per unit of TSS was very high for gravel surfaced roads compared to soil roads, indicating that improved surfacing, while effective at reducing sediment loads, may not necessarily lead to reduced nutrient loads.
- More than 90% of the sediment from roads is fine suspended material that is easily transported, and small retention devises (eg. sediment ponds and silt fences) are ineffective in reducing sediment and nutrient loads of road runoff water.
- Modelling showed that the installation of additional road drainage (discharging to the forest floor) was a highly effective stream protection measure, with additional drains located 10 along the road from the stream crossing yielding 90% reduction in runoff directly reaching the stream.