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Erosion, Sediment Delivery, and Consequence from Roads in Foothills Watersheds in West-Central Alberta: A Case-Study in the Simonette | Part 2: Gully Erosion

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Resource road networks are essential infrastructure for remote areas in western Canada. They are used to explore for, manage, and transport resources off the land base. Road networks are also costly to maintain, and have potentially high environmental liabilities, particularly when fine sediment from road surface erosion reaches watercourses. Resource roads in Alberta are particularly vulnerable to gullying in the ditchline, which can increase grading costs, undermine the road prism, and undermine drainage relief structures that prevent soil and water from roads discharging into streams.

During a larger study of resource road erosion and consequences in the Simonette we encountered several instances of severe gully erosion (examples shown below). We examined how the area upslope of a gullied road section may affect the amount of erosion.

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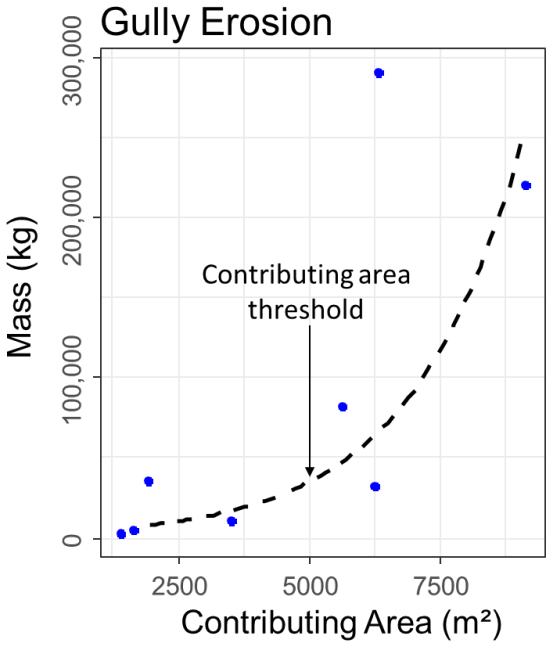
Results

Although rill erosion is present in many road segments, we found that upslope areas greater than 5000 m^2 had particularly severe gullying. Several of these gullied road segments were the result of culvert failures, which may have pushed upslope area over a threshold value that significantly increased the erosion rate. Road surface erosion in the Simonette at instrumented stations generated between an average of 0.9 – 4.8 kg/m^2 of sediment, whereas gullies with low contributing area generated around 6.6 kg/m^2, and gullies with contributing area greater than 5000 m^2 generated an average of 22.5 kg/m^2. Large gullies generated about four and a half times as much erosion per unit area and had one of the highest levels of erosion documented in western Canada and the United States.



Road surface area thresholds

Geomorphic conceptual models often use thresholds to describe how land surface processes change. Following on this concept, the area of the road surface and contributing right-of-way can be used to prioritize potential problematic road areas using the 5000 m^2 threshold. This area threshold can be translated into different lengths for roads in a network based on the width of road and presence of cutslopes or through-cuts. For example, a small crowned road could have 500 m of length before there is enough water to produce gullying, however a wide through-cut may only need 167 m.

Cross-drain culvert failure during large events was often observed to the be the root cause of this dramatic order of magnitude increase in erosion rates and destructive ditch gullying. This highlights the need for careful location, installation, maintenance, and inspection of road crossing approaches in addition to the watercourse crossings.

Maximum Management Area (m^2)		**5000**			
Road segment type	**Camber**	**Ditch Width (m)**	**Cutslope (m)**	**Contributing Roadway (m)**	**Max. Length (m)**
Raised, well-drained road segment	Crowned	5	N	5	500
	Insloping	5	N	10	333
Cut-and fill segment	Crowned	5	5	5	333
	Insloping	5	5	10	250
Through-cut or wind-rowed	Either	5	5	10	167

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