Calculating the Average GRAIP Base Rate

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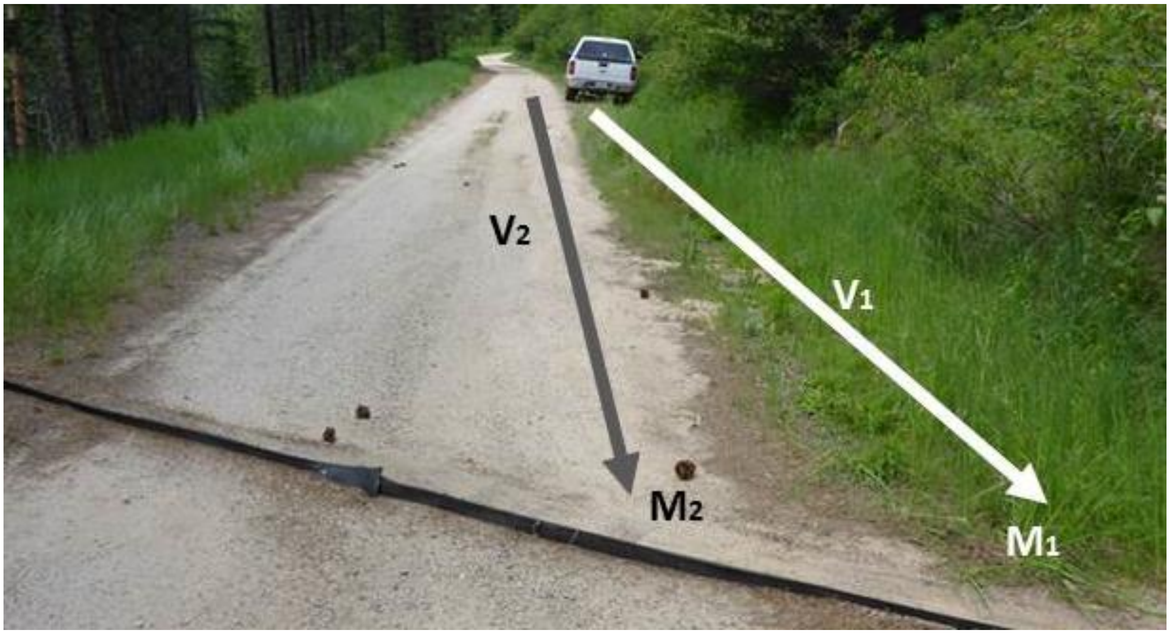
Base rate is the fundamental starting point for the GRAIP model. It is a variable that contains information on the erodability of the road surface and ditch for the specified location. The default value in GRAIP is 79 kg/meter of road elevation change. This value was measured from plot studies in the Oregon Coast Range in 1995 and 1996 and was reported by Luce and Black in 1999. This rate may be appropriate for western Oregon and Western Washington and other regions with high rainfall and high erosion rates. This default base rate can also be used as a placeholder until a more precise value is measured. In this case the GRAIP sediment production and delivery predictions can be used in a relative sense to identify locations with a relatively high risk compared to the rest of the inventoried population.

The base rate can determined using the road sediment plot methods from Black and Luce (2013), where actual observations are made at multiple plots for multiple years. A plot based approach has the advantage of capturing a local sediment production rate from roads under representative rainfall conditions. A representative set of plot measurements may also include the effects of other variables such as traffic, typical road construction and grading conditions. If plots are maintained for multiple years the distribution of values will yield information about the variance in erosion between years as a function of precipitation.

When local plots are not feasible to install, road erosion plot data are available from the literature for some areas (Amann 2004, Potyondy et al 1991, Luce and Black 1999, Luce and Black 2001a, 2001b, Coe 2006, Ketcheson et al 1999, Busteed 2004, Peranich 2005, Riedel and Vose 2002, Sugden and Woods 2007).

A third method is to use another model to estimate the base rate. WEPP Road can be used to generate a sediment production estimate for a site of interest (http://forest.moscowfsl.wsu.edu/fswepp/) by selecting a typical road length, width, slope, design and soil texture. This sediment production estimate can then be converted to a GRAIP base rate.

Base rate is calculated from field data as follows. Each road segment has two flow paths so the base rate includes the information from both sides of the road on plots that include two flow paths.



A typical road erosion plot on the Idaho Batholith with two flow paths producing masses M_1 and M_2. V_1 represents the fraction of the length with vegetation cover on the inside ditch. V_2 represents the fraction of the length with vegetation cover on flow path two, the road surface. In this example V1 has nearly 100% cover so the value is >25% and gets the value .14. The road surface has no live or rooted veg so it is less than 25% and gets a value of 1.
The road surfacing here is native material so R has a value of 5.

Where:

M_t is the total observed mass of sediment (kg)

M_1 is the mass eroded from the first flowpath of the road

M_2 is the mass eroded from the secondary flowpath of the road

B is the base rate (kg/meter of elevation change)

S is the average slope of the road surface (m/m)

L is the road centerline length of the flowpath (m)

V_1 and V_2 represent the vegetation factor for the two flow paths on the road surface. If the road is steeply insloped so that all the water ends up in the ditch, both flowpaths are assigned to the ditch. If the flowpath has greater than 25% live or rooted vegetation cover as measured by a point line transect, the multiplier is .14, otherwise the factor is 1.

R is the road surfacing factor for the road travel surface. If the road has no imported material on the surface, the multiplier is 5 for native. If the road has imported gravel, the multiplier is 1. If the road is paved the multiplier is .2.

The mass eroded from a road segment is equal to the sum of the mass eroded from each of the two possible flow paths.

$$M_t = M_1 + M_2$$

The mass eroded from each flow path is equal to the product of the base rate, plot length, slope, road surfacing factor and vegetation factor for each side of the road.

$$M_t = \frac{BLSRV_1}{2} + \frac{BLSRV_2}{2}$$

$$M_t = \frac{BLS(RV_1 + RV_2)}{2}$$

$$M_t = BLSR\frac{(V_1 + V_2)}{2}$$

The base rate can be determined as the total eroded mass divided by the length and slope and surfacing and multiplied by the average flow path vegetation for the two flow paths.

$$B = \frac{M_t}{(LSR\,\bar{V})}$$

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