Bedload Transport in Braided Rivers

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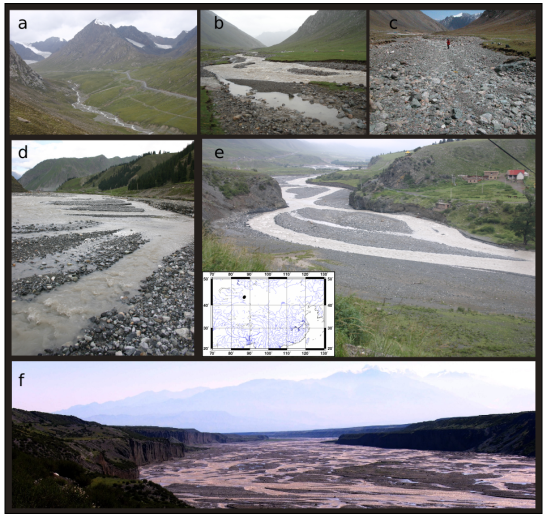
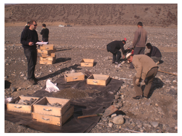
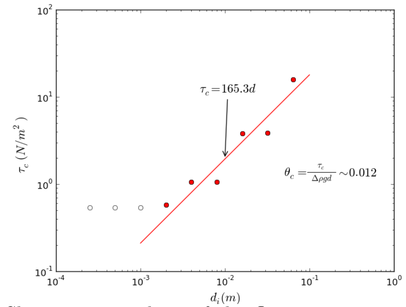
In laboratory experiments, most transport relationships are expressed with respect to the bed shear stress and incorporate a power law regime with a 3/2 exponent above a critical value for motion inception. Nevertheless, in gravel bed streams, available studies seemed to show that conditions for this asymptotic regime to be observed are only rarely achieved. Using an extensive survey during three years along a mountain gravel bed stream in China, we show that,

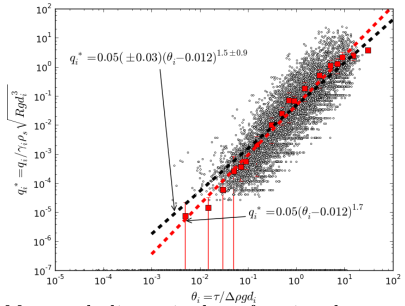
1. Observed threshold for motion inception suggest a strong linear size dependence.
2. Mean fractional transport rates can be modeled using a simple Meyer Peter and Mueller formalism.
3. Mean transport of fractions can therefore be modeled from the knowledge of both the PDF of shear stress and the PDF of surface grain size distribution.
4. Mean overall bedload fluxes occur far from any of the individual fractions threshold and can be modeled using a simple power law of shear stress.
5. Only the PDF of shear stress is needed to predict mean overall bedload fluxes.







Shear stress values of the first non zero catch with respect to grain size. White dots correspond to grain size whose critical shear stress cannot be correctly detected due to sampling time limits. Critical shear stress rises linearly with grain size



Measured dimensionless fractional transport rates q_i^* plotted against dimensionless shear stress θ_i. zero fluxes are plotted as 10^{-7}.

A simple power law for the overall transport

For the grains whose measured threshold of motion is within detection limit :

$$\theta_c \sim 0.012. \tag{1}$$

The dimensionless rate of sediment transport can then be recast as

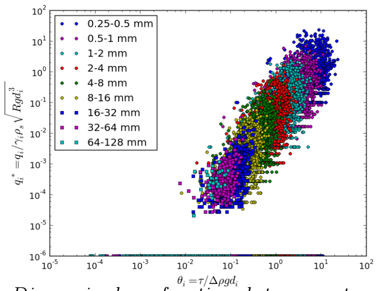
$$q_i^* = \frac{q_i}{\gamma_i \rho_s \sqrt{Rgd_i}} = (0.04 \pm 0.02)(\theta_i - 0.012)^{1.5\pm0.9}. \tag{2}$$

Most of sediment transport takes place largely above θ_c hence

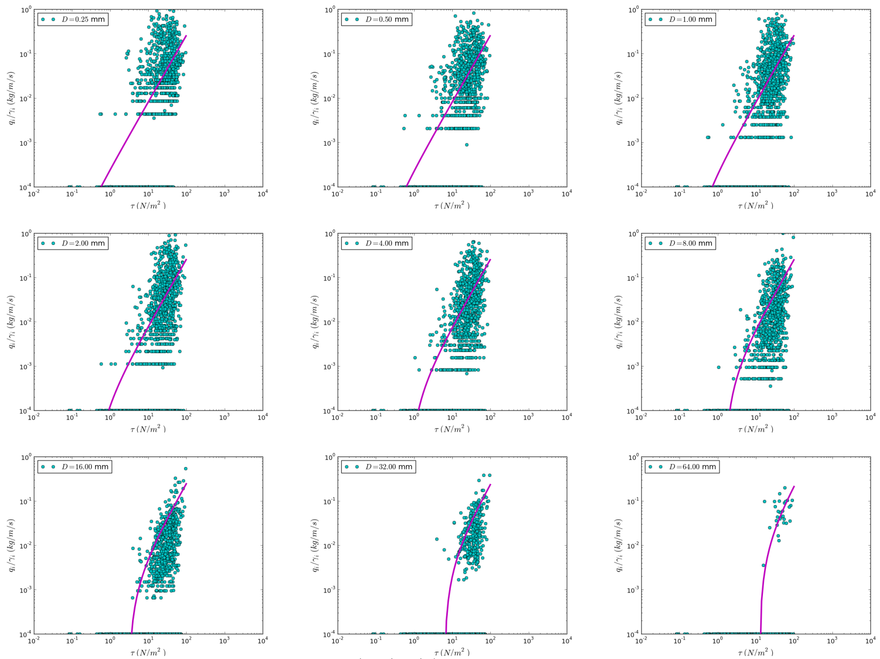
$$\frac{q_i}{\gamma_i \rho_s \sqrt{Rgd_i}} \sim (0.04 \pm 0.02)\theta_i^{1.5\pm0.9}. \tag{3}$$

When the overall flux is calculated sediment transport reduces to

$$q_b = (2 \pm 1) \cdot 10^{-4} \tau_b^{1.5\pm0.9}. \tag{4}$$



Dimensionless fractional transport rates for the nine size fractions



Measured fractional transport rates (kg/m/s) normalized to the proportion of particles on the bed q_i/γ_i against shear stress τ_b. The curve represents the average transport predicted by equation (2).