

Reply to comment by Claude Michel on “A general power equation for predicting bed load transport rates in gravel bed rivers”

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[1] We thank *Michel* [2005] for the opportunity to improve our bed load transport equation [Barry *et al.*, 2004, equation (6)] and to resolve the dimensional complexity that he identified. However, we do not believe that the alternative bed load transport equation proposed by *Michel* [2005] provides either the mechanistic insight or predictive power of our transport equation.

[2] Although some bed load transport data exhibit nonlinear trends in log-log plots of transport rate versus discharge, a simple linear function is sufficient to describe our data [Barry *et al.*, 2004, paragraph 43]. The Figure 7 data of Barry *et al.* [2004] could be fit by a nonlinear function as suggested by *Michel* [2005], but we believe this to be an unnecessary complication, particularly given how well our simple equation predicts observed transport rates compared to other more complex equations, such as *Parker's* [1991] three-part bed load transport function [Barry *et al.*, 2004, Figure 11]. Furthermore, an important aspect of our equation, that is not preserved in *Michel's* alternative, is the between-site variation in the exponent of the transport function that results from supply related channel armoring (i.e., transport capacity in excess of bed load sediment supply) which provides a mechanistic understanding of the bed load transport process [Barry *et al.*, 2004]. *Michel* [2005] proposes a bed load transport equation that mimics our equation in terms of the range of exponents that we observe (i.e., 1.5–4 [Barry *et al.*, 2004, Figure 8a]) but lacks the mechanistic insight and consequent predictive power. Moreover, *Michel's* equation requires a sufficient number of bed load transport observations across a broad range of discharges to empirically calibrate his α and β values.

[3] *Michel* [2005] correctly points out a dimensional complexity of our transport equation that we resolve here by scaling discharge by the 2-year flood (Q_2)

$$q_b = \alpha \left(\frac{Q}{Q_2} \right)^\beta = 0.0008A^{0.5} \left(\frac{Q}{Q_2} \right)^{(-2.45\frac{A}{q} + 3.56)} \quad (1)$$

giving the coefficient of the equation constant dimensions of $\text{kg m}^{-1} \text{s}^{-1}$. In our revised equation, the relationship between β and supply-related armoring (q^*) remains the same as that of Barry *et al.* [2004]; however, the relationship between α and drainage area (A) changed substantially. The coefficient α represents the magnitude of bed load transport, which is a function of basin-specific sediment supply and discharge, both of which can be expressed as functions of drainage area. In our earlier work [Barry *et al.*, 2004] we proposed an inverse relationship between α and drainage area because discharge increases faster than sediment transport rate [Barry *et al.*, 2004, paragraph 51]. However, we hypothesize here that a direct relationship exists between α and drainage area when we scale discharge by the 2-year flow (Figure 1). This scaling incorporates basin-specific differences in water yield, causing the relationship between α and drainage area to be solely a function of how sediment yield increases with drainage area. We also find that equation (1) performs better than the original equation in terms of predicting the observed bed load transport rates at the 17 independent test sites (Figure 2). However, the performance of (1) is not statistically different from equation (6) of Barry *et al.* [2004], nor is it statistically different from the performance of the *Ackers and White* [1973] equation. Consequently, our original assessments of formula performance remain unchanged.

References

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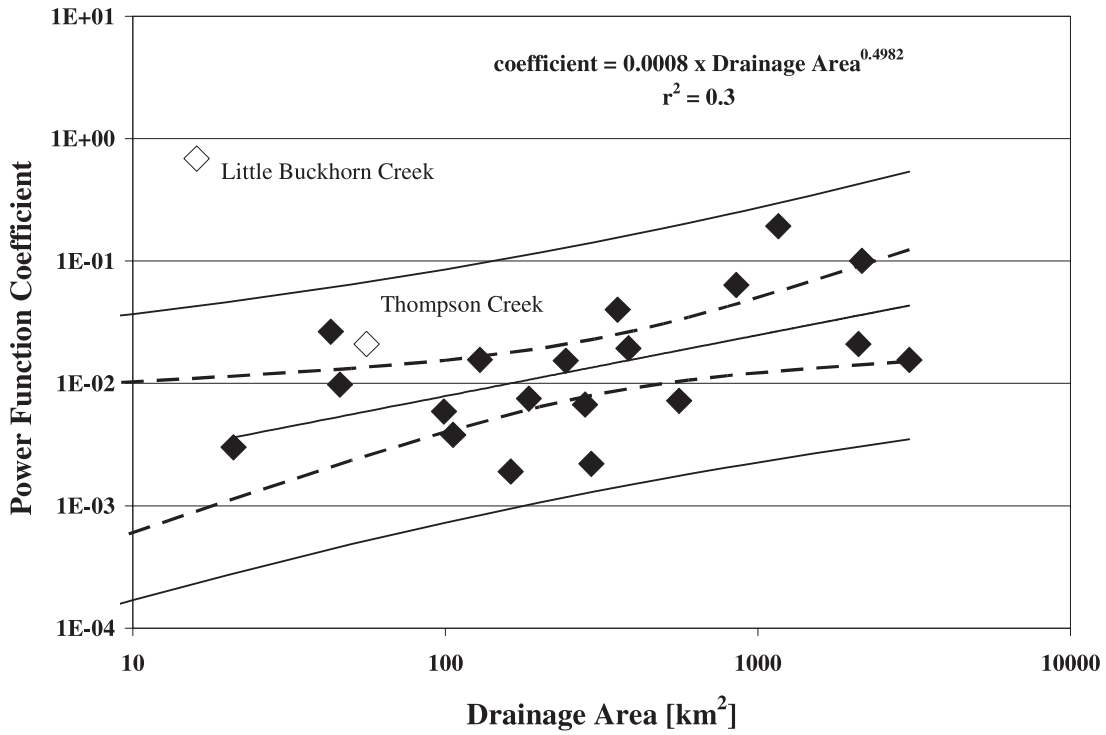


Figure 1. Revised relationship between drainage area and the coefficient of equation (1) for the Idaho sites. Dashed lines indicate 95% confidence interval about the mean regression line. Solid lines indicate 95% prediction interval (observed values). Sites indicated by open diamonds are discussed by *Barry et al.* [2004].

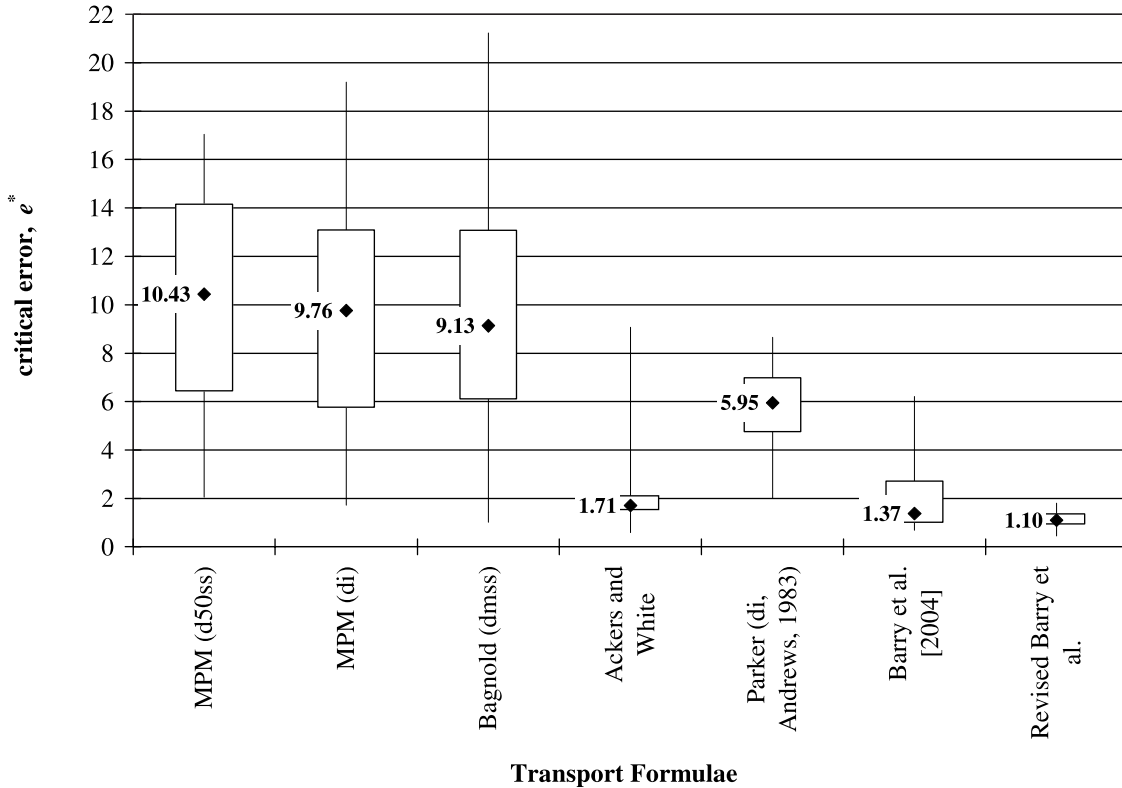


Figure 2. Box plots of the distribution of critical error, e^* [Barry et al., 2004], for the 17 test sites. Median values are specified, box end represent the 75th and 25th percentiles, and whiskers denote maximum and minimum values. See *Barry et al.* [2004] for equation citations, specific formulations used in our analysis, and definitions of the characteristic grain sizes (d values).