Supplementary Materials for

Persistently high bedload flux in ephemeral channels

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Table S1

Location, climate, setting, and principal citation for each of the nine ephemeral channels analyzed.

channel	Location	climate	channel morphology	annual rainfall (mm)	watershed area (km^2)	citations
Arroyo de los Pinos	Southwest U.S.	semiarid	alternating braided and meandering	237	32	Stark et al., 2021
Nahal Eshtemoa	Southern Israel	semiarid	bar/flat sequences	280	125	Laronne and Reid, 1993; Cohen et al., 2010
Nahal Yatir	Southern Israel	semiarid	bar/flat sequences	250	19	Reid et al., 1995; Laronne et al., 1992
Nahal Rahaf	Southern Israel	hyper-arid	bar/flat sequences	90	78	Cohen and Laronne, 2005
Nahal Qanna'im	Southern Israel	hyper-arid	narrow, steep, straight	90	7	
Barranca de los Pinos	Northern Spain	Mediterranean	steep, planar bed	783	0.012	Lucía et al., 2013
Poveda Gully	Eastern Spain	temperate	vertical banks; planar bed	680	0.028	Zapico et al., 2018
Gereb Oda River	Northern Ethiopia	temperate	flat, planar bed	768	68	Billi, 2011
Moulin Ravine	Southeast France	Medi-terranean	riffle-pool-bar	900	0.089	Liebault et al., 2016 & 2022

Table S2

List of perennial rivers within the perennial river database.

Site Name	*Country*	*Principal Citation*
Oak Creek	USA	Milhous [1973]
Sagehen		Andrews [1994]
Goodwin Creek	USA	Kuhnle and Willis [1992], data from Almedeij [2002]
Jacoby Creek	USA	Lisle [1986], Lisle [1989], data in Almedeij [2002], Wilcock and Kenworthy [2002] for diameters
Virgin River	USA	Andrews [2000]
Dupuyer Creek	USA	Whitaker and Potts [2007]
Arbucies	Spain	Batalla [1997]
Elbow River	Canada	Hollingshead [1971]
East Fork River	USA	Years 1973-75 [Leopold and Emmett, 1976], year 1976 [Leopold and Emmett, 1977], year 1978 [Leopold and Emmett, 1997]
Borgne d'Arolla	Switzerland	Gomez [1988]
Wind River	USA	Smalley et al. [1994]
Snake and Clearwater River 1972-1979	USA	Jones and Seitz [1980]
Little Granite Creek, Saint-Louis Cr., Fool Cr., Hayden Cr.	USA	Ryan et al. [2002]
Ebro River	Spain	Vericat et al. [2006]
Multiple Rivers[a]	USA	Williams and Rosgen [1989]
Multiple Rivers[b]	USA	King et al. [2004]
Multiple Rivers[c]	USA, Canada	Hinton et al [2017]

a: Susitna River near Talkeetna, Talkeetna River near Talkeetna, Chulitna River below Canyon near Talkeetna, Susitna River at Sunshine, Tanana River at Fairbanks), Washington (Toutle River at Tower Road near Silver Lake, North Fork Toutle River near Kid Valley), Wyoming (Muddy Creek near Pinedale), Colorado (Yampa River at Deerlodge Park, Fourmile Creek near Fairplay, Mad Creek near Empire, Middle Fork Boulder Creek at Nederland, Jefferson Creek at Jefferson, Craig Creek near Bailey, Pony Creek near Antero Reservoir, Trail Creek near Westcreek, Blue River below Green Mountain Reservoir, Williams Fork near Leal, Upper South Fork Williams near Leal, Lower South Fork Williams Fork near Leal, Kinney Creek near Leal, Rich Creek near Weston Pass), Wisconsin (Wisconsin River at Muscoda, Black River near Galesville, Chippewa River near Caryville, Chippewa River at Durand, Chippewa River near Pepin).

b: Big wood, Blackmare, Boise, Cat, Dollar Creek, Eggers Creek, Fourth of July, Hawley Creek, Herd Creek, Johns Creek, Johnson Creek, Little Buckhorn, Little Slate, Lochsa, Lolo Creek, Main Fork, Marsh Creek, Middle Fork, North Fork Clearwater Rapid river, SR below Yankee, S R Near Obsidian, SR near Shoup, Squaw Creek USGS, Selway, SF Red River, SF Salmon, South Fork, Fork Payette, Squaw Creek USFS, Thompson Creek, Trapper Creek, Valley creek, West Fork Buckhorn

c: Cache Creek near Jackson, Little Granite Creek, Wind River, Elbow River, Goose Creek #1, Goose Creek #2, Goose Creek #3, Goose Creek #4, Fall Creek, West Fork San Juan at Bridge, West Fork San Juan Lower, Wolf Creek at Bridge.

Table S3

Mann-Whitney U Test Results summary

	Data subset	**Median data shift**	**p-value**
$\log_{10}$ transformed data	All data	3.98 $\log_{10}$ units	$< 2.2 \times 10^{-16}$
	< 40 mm	2.09 $\log_{10}$ units	$< 2.2 \times 10^{-16}$
	< 40 mm + phase 3 only	1.03 $\log_{10}$ units	$< 2.2 \times 10^{-16}$
Non-log transformed data[1]	All data	0.298	$< 2.2 \times 10^{-16}$
	< 40 mm	0.252	$< 2.2 \times 10^{-16}$
	< 40 mm + phase 3 only	1.4	$< 2.2 \times 10^{-16}$

1 - The median of the combined dataset is 0.000806, so shifts of this magnitude are significant shifts of the non-log transformed data.

Table S4

multiple linear regression analysis and the relative contribution of different independent variables.

Data Subset	Parameter	Relative contribution to total R^2 (log-transformed)	Relative contribution to total R^2 (non log-transformed)
full	total fit	0.82	0.26
	shear stress	0.45	0.22
	ephemeral vs. perennial	0.34	0.02
	D_{84}/D_{16} ratio	0.02	0.002
	watershed size	0.01	0.0003
D_{50} < 40 mm	total fit	0.73	0.246
	shear stress	0.53	0.22
	ephemeral vs. perennial	0.19	0.01
	watershed size	0.01	0.0003
	D_{84}/D_{16} ratio	0.01	0.005
Phase 3 and D_{50} < 40 mm	total fit	0.44	0.141
	shear stress	0.21	0.12
	ephemeral vs. perennial	0.15	0.008
	D_{84}/D_{16} ratio	0.04	0.01
	watershed size	0.03	0.002
Phase 1+2 and D_{50} < 40 mm	total fit	0.54	0.20
	shear stress	0.23	0.04
	ephemeral vs. perennial	0.25	0.04
	D_{84}/D_{16} ratio	0.03	0.01
	watershed size	0.02	0.001

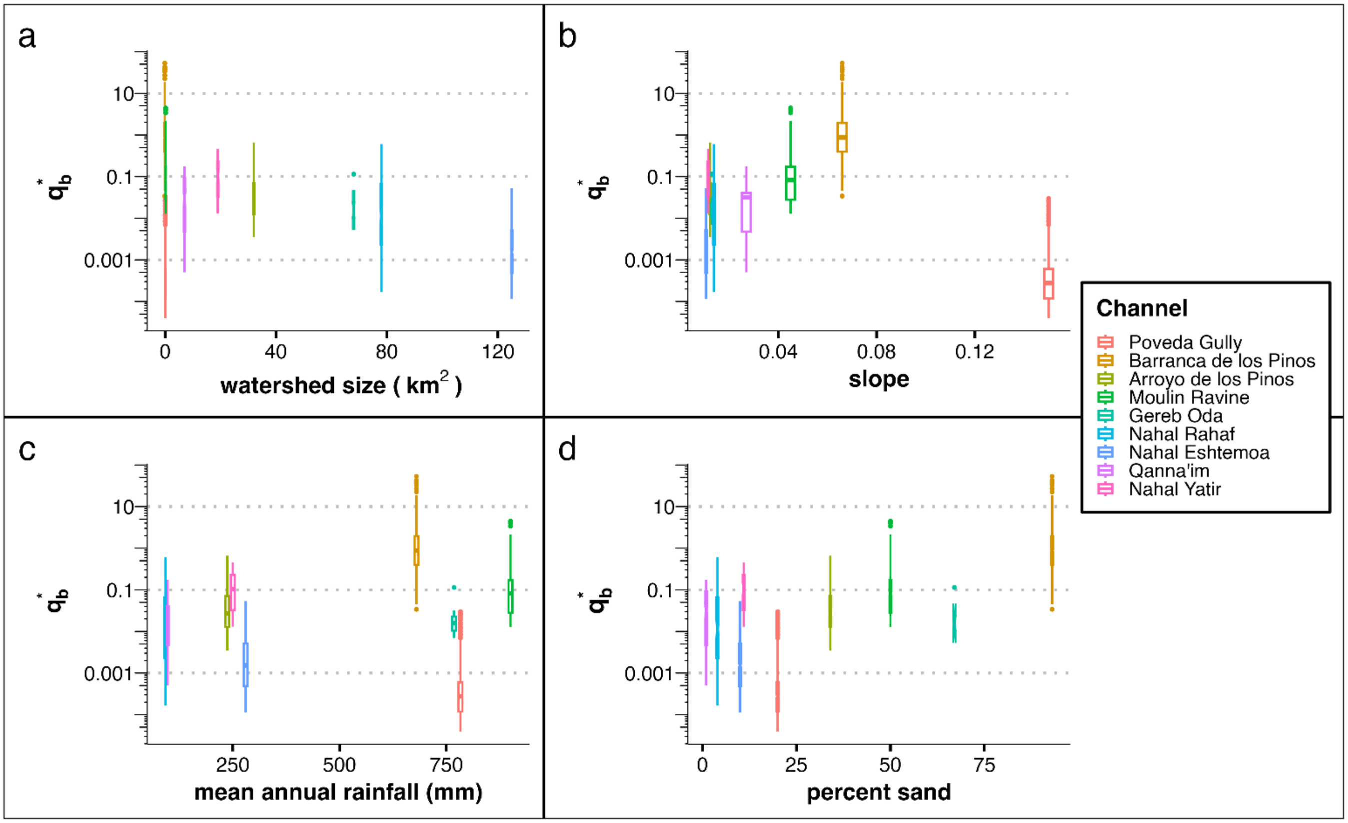

Figure S1

Average nondimensional bedload flux vs. parameters of interest: (A) watershed size, (B) mean annual rainfall, (C) channel bed slope, (D) percent of channel bed material sand-sized. Data were nondimensionalized with D_{84} as the characteristic length.

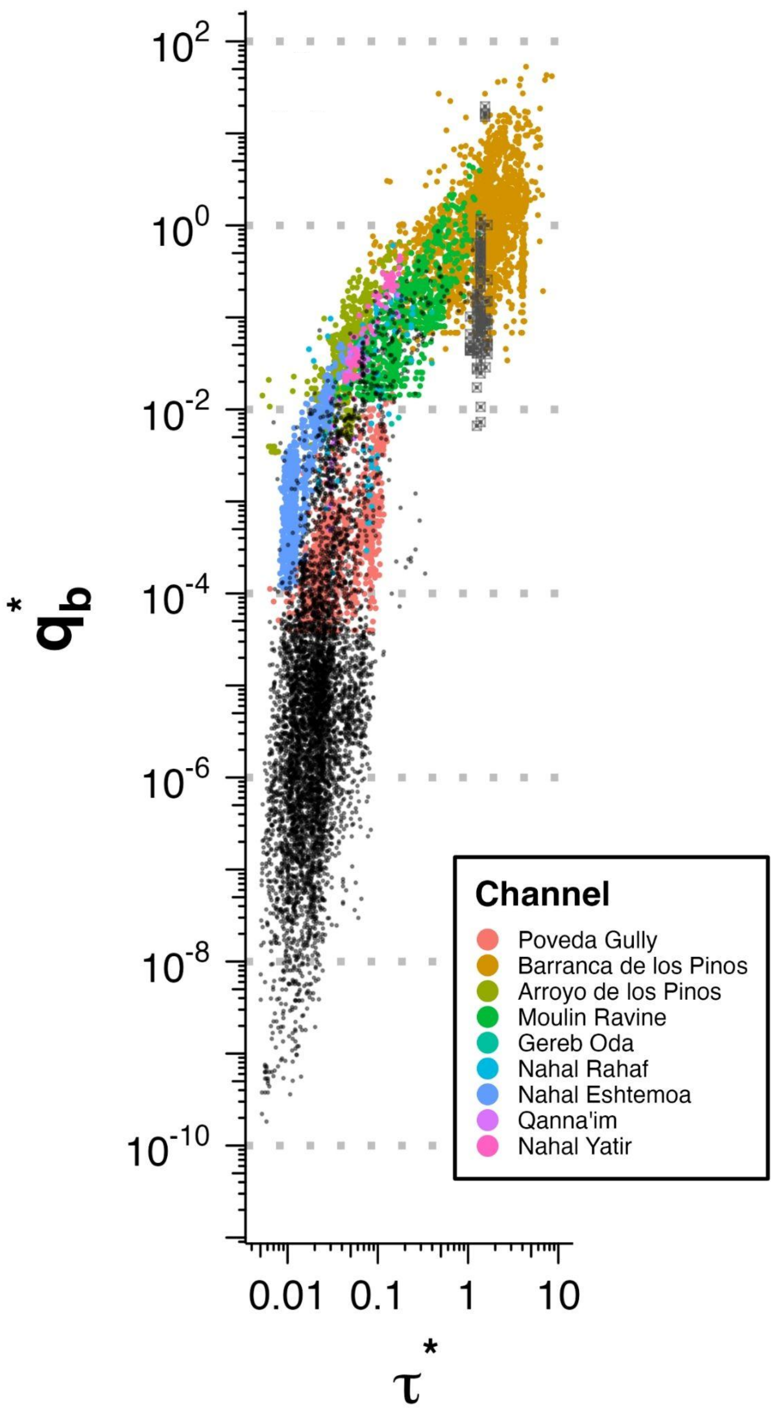

Figure S2

Bedload flux vs. shear stress. Colored points are data from the ephemeral database - black data points are from the perennial database. The large black squares are the Mississippi River dataset. Data were nondimensionalized with D_{84} as the characteristic length.

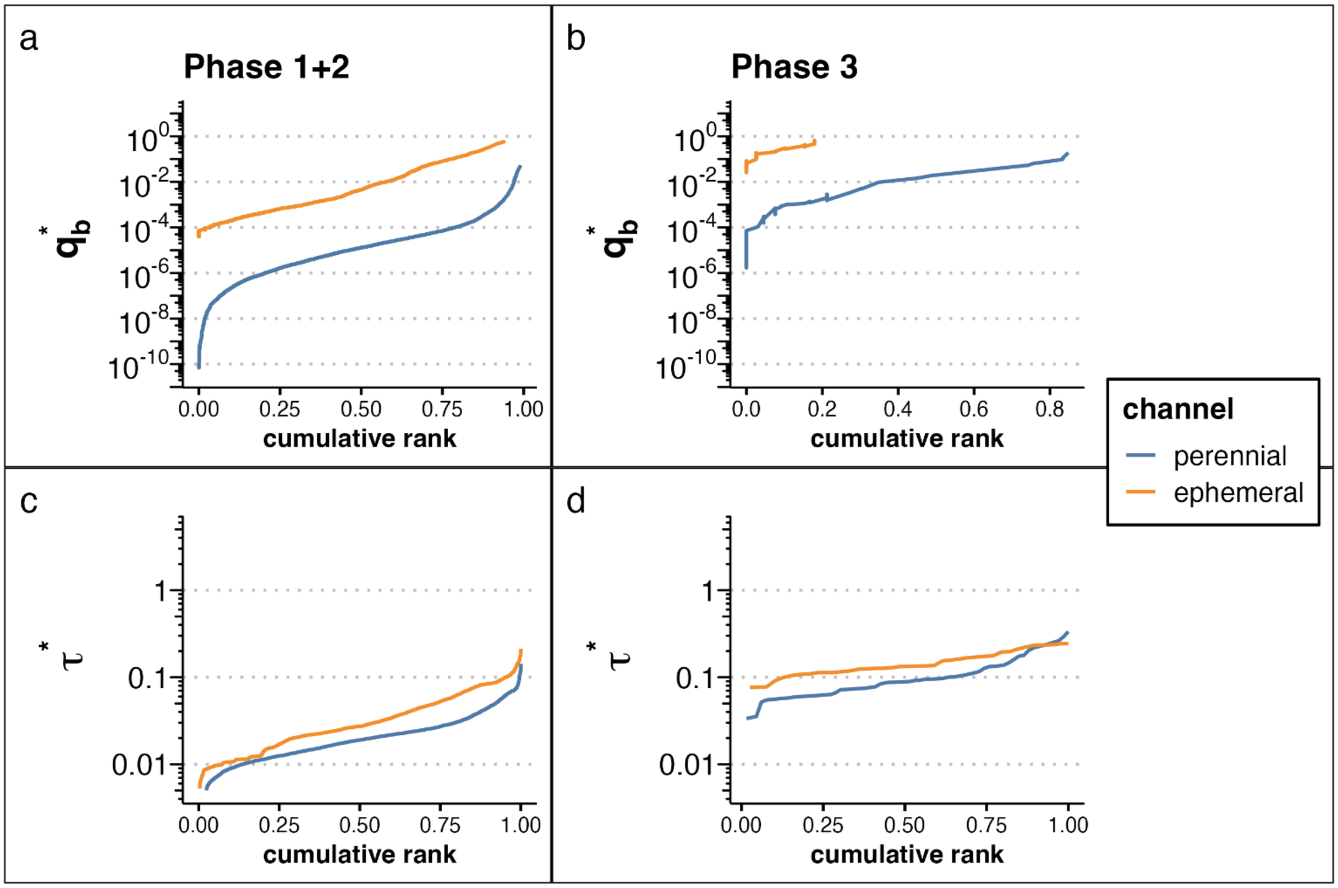

Figure S3

Empirical CDF plots of nondimensional bedload flux and shear stress for gravel-bed rivers (D_{50} > 2 mm) during Phase 1 + 2 transport (A & C) and Phase 3 transport (B & D). Each dataset is ordered such that 0 represents the smallest qb* and τ* values and 1 represents the largest. Phase 3 transport is defined using a threshold τ* value of 0.4, after Ancey & Recking (2023). Data were nondimensionalized with D_{84} as the characteristic length.

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