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Supporting Information for

Sediment transport through self-adjusting, bedrock-walled waterfall plunge pools

Joel S. Scheingross[1†] and Michael P. Lamb[1]

[1]Division of Geological and Planetary Sciences, California Institute of Technology, Pasadena, California, USA
[†]Now at Helmholtz Centre Potsdam, German Research Center for Geosciences (GFZ), Telegrafenberg, 14473 Potsdam, Germany

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Introduction

The supporting information for this manuscript includes our methods for making field-measurements of waterfall plunge-pool depth, as well as two tables, a movie with caption, and MATLAB m-files to calculate plunge-pool sediment-transport capacity. Table S1 includes data from our field survey of waterfall plunge pools, Table S2 is data from waterfall plunge-pool sediment-transport capacity experiments. Movie S1 shows an example of sediment transport during one of our waterfall plunge-pool sediment-transport capacity experiments.

Waterfall field-survey methods

During our field surveys we measured the depth of waterfall plunge pools using a variety of methods. All our field measurements were made at low to moderate water discharges when plunge pools were safe to survey and accessible. For the vast majority of plunge pools surveyed, we made manual measurements of the depth to the plunge-pool floor. Most plunge pools were alluviated during our surveys such that the majority of our pool depth measurements reflect the depth to the sediment floor (i.e., $h_{pool} = z_{lip} - z_{sed}$), but for some cases (as denoted in Table S1), bedrock was exposed on the pool floor such that depth measurements reflect the distance to bedrock (i.e., $h_{pool} = z_{lip} - z_{BR}$). In some cases the distinction between a sediment and bedrock floor was not denoted, and we make no distinction as to whether the reported pool depth is to sediment or bedrock floors. We measured the vertical distance from the plunge-pool lip to the plunge-pool floor using either a stadia rod or plumb-bob attached to a tape measure.

Several plunge pools were completely filled with sediment (i.e., $z_{lip} - z_{sed} \approx 0$) and many were partially-filled during our field surveys. These shallow depths are likely a result of our surveying at low flow and perhaps additionally due to temporal variability in sediment supply (for example, many of our measurements in the San Gabriel Mountains, California occurred within 1-3 years of the 2009 Station Fire when sediment supply was likely elevated by up to an order of magnitude compared to background levels [*Lamb et al.*, 2011]). To mitigate this effect, for 16 out of 75 of our surveyed plunge pools we report pre-existing data that reveal larger depths than obtained during our survey. This data came from three separate sources. For Wailua Falls, Hawaii ("WF" in Table S1) we use the depth measured by Doughty [2010] made while SCUBA diving in the plunge pool. For upper Ho'opi'i Falls, Hawaii (HFU, Table S1), 3 separate falls on Arroyo Seco, California (MSF, LSF, ASP4 in Table S1), and 1 waterfall on Fall Creek, California (FCR1, Table S1), we estimate the minimum plunge-pool depth as 2 m based on observations and accounts of cliff-jumping from heights > 2 m. Finally, many depth-estimates of plunge pools within Little Santa Anita Canyon, CA, and one estimate from Fox Creek, CA, are unpublished data provided by Prof. Chris Brennen, California Institute of Technology, who assisted with field surveys. These data were collected by Prof. Brennen over many visits [*Brennen*, 2000], and the measurements should be treated as estimates with up to ~25% error. The measurement technique used for each surveyed plunge pool is denoted in Table S1.

Movie Captions

Movie S1. Video of plunge-pool sediment transport during Experiment 12 (Table S2). Plunge pool is 10.2 cm in diameter for scale. Movie taken with a high speed camera recording at 240 frames per second, resulting in a factor of 8 slow-down compared to real time.

References

Brennen, C. (2000), *Adventure hikes and canyoneering in the San Gabriels*, Dankat Publishing Company, Pasadena.

Doughty, A. (2010), *The Ultimate Kauai Guidebook*, 7th ed., Wizard Publications, Lihu'e, Hawai'i.

Lamb, M. P., J. S. Scheingross, W. H. Amidon, E. Swanson, and A. Limaye (2011), A model for fire-induced sediment yield by dry ravel in steep landscapes, *Journal of Geophysical Research-Earth Surface*, *116*, doi:10.1029/2010jf001878.

Table S1. Measurements of field-surveyed plunge pools and calculation of non-dimensional variables[a]

River	ID	S	W (m)	H_{drop} (m)	r_{pool} (m)	h_{pool} (m)	D pool (m)	D river (m)	A (km^2)	Q_{2yr} (m^3/s)	Q_{sc_pool}/Q_w	τ_{*pool}/τ_{*c}	$(z_{lip} - z_{mixed})/L_d$	r_{pool}/L_d	δ/L_d	UTM Easting	UTM Northing	Pool floor	Depth meas.
Colby Canyon	CP1	0.06	5	2.5	2.3	0.9	0.01	0.15	2.62	1.03	0.10	7.56	0.52	1.39	0.32	395326	3792758	sed	1
Colby Canyon	CP2a	0.07	4	2	0.9	0.65	0.015	0.15	1.64	0.64	0.08	4.10	0.32	0.45	0.23	395467	3792855	sed	1
Colby Canyon	CP2b	0.07	4	0.6	1.9	0.4	0.015	0.15	1.64	0.64	9.2×10^{-4}	1.58	0.57	2.73	0.73	395467	3792855	sed	1
Colby Canyon	CP3	0.06	3	1.2	1.8	0.5	0.015	0.15	1.64	0.64	0.01	2.72	0.56	2.14	0.55	395463	3792879	sed	1
Colby Canyon	CP4b	0.05	3	3.2	1.5	1	0.02	0.15	1.61	0.63	0.03	4.69	0.96	1.52	0.41	395568	3792957	sed	1
Colby Canyon	CP4c	0.05	3	1.9	2.3	1	0.02	0.15	1.61	0.63	1.8×10^{-3}	2.94	1.23	2.92	0.57	395568	3792957	sed	1
Little Santa Anita	LR1	0.08	3.5	8.5	1.0	0.1	0.02	0.1	5.49	1.43	0.70	12.21	5.4×10^{-4}	0.15	0.07	403678	3782944	sed	1
Little Santa Anita	LR2	0.08	5	4	2.9	0.5	0.02	0.1	5.49	1.43	0.04	5.99	0.30	1.96	0.39	403681	3782993	?	2
Little Santa Anita	LR3	0.08	4	3.5	0.7	0.3	0.02	0.1	5.54	1.44	0.19	5.42	0[b]	0[b]	0[b]	403700	3782879	br	1
Little Santa Anita	LR4	0.08	5	8	2.0	1.5	0.02	0.1	5.55	1.45	0.22	11.38	0.71	1.01	0.25	403707	3782848	?	2
Little Santa Anita	LR5a	0.08	4	5.5	0.8	1.5	0.02	0.1	5.55	1.45	0.38	8.11	0[b]	0[b]	0[b]	403704	3782825	?	2
Little Santa Anita	LR5b	0.08	4	1.25	1.3	1.5	0.02	0.1	5.55	1.45	0.01	2.39	0.78	0.67	0.34	403704	3782825	?	2
Little Santa Anita	LD1a	0.08	5	1	0.6	0.24	0.02	0.1	5.59	1.46	0.02	1.96	0[b]	0[b]	0[b]	403707	3782759	br	1
Little Santa Anita	LD1b	0.08	5	4	0.7	0.1	0.02	0.1	5.59	1.46	0.22	6.00	0[b]	0[b]	0[b]	403707	3782759	sed	1
Little Santa Anita	LR6	0.08	6	5.2	1.9	2	0.02	0.1	5.6	1.46	0.08	7.54	1.04	1.01	0.30	403719	3782712	?	2
Little Santa Anita	LR7a	0.08	6	4.5	1.0	0.3	0.02	0.1	5.6	1.46	0.26	6.60	0.03	0.12	0.07	403675	3782679	sed	1
Little Santa Anita	LR7b	0.08	6	0.75	1.5	1.5	0.02	0.1	5.6	1.46	1.9×10^{-3}	1.55	1.18	1.20	0.54	403675	3782679	?	2
Little Santa Anita	LDF	0.1	6	1.5	2.1	0.1	0.02	0.1	5.7	1.48	0.02	2.64	0.05	1.72	0.53	403693	3782583	sed	1
Little Santa Anita	LR8	0.11	6	4.5	2.0	0.1	0.02	0.1	5.72	1.49	0.17	6.72	0.02	1.15	0.32	403699	3782457	sed	1
Little Santa Anita	LR9	0.11	5	2.7	2.0	2	0.02	0.1	5.76	1.50	0.02	4.39	1.29	1.33	0.40	403722	3782369	?	2
Little Santa Anita	LR10	0.09	3	3	1.5	1	0.02	0.1	5.8	1.51	0.08	4.98	0.49	0.78	0.30	403870	3782433	?	2
Little Santa Anita	LR11	0.09	2.5	4.7	2.3	4	0.02	0.1	5.82	1.52	4.8×10^{-3}	4.99	2.87	1.64	0.58	403910	3782489	?	2
Rubio Canyon	RR1	0.13	4	23	1.9	0.25	0.01	0.1	2.26	0.88	0.52	63.30	0.05	0.66	0.11	397227	3785825	sed	1
Rubio Canyon	RR2	0.13	3	6.5	1.6	0.2	0.01	0.1	2.26	0.88	0.55	19.15	0.06	0.67	0.17	397226	3785809	sed	1
Rubio Canyon	RR3	0.13	4	4.6	1.5	0.1	0.01	0.1	2.27	0.89	0.58	13.75	0.02	0.69	0.20	397223	3787590	sed	1
Rubio Canyon	RR4	0.15	4	6.2	2.3	0.1	0.01	0.1	2.27	0.89	0.36	18.18	0.02	1.17	0.21	397178	3785777	sed	1
Rubio Canyon	RR5	0.15	3	7.5	2.0	0.1	0.01	0.1	2.27	0.89	0.44	21.99	0.02	0.95	0.18	397172	3785769	sed	1
Rubio Canyon	RR6	0.18	4	8.5	1.4	0.1	0.01	0.1	2.28	0.89	0.63	24.56	0.01	0.47	0.13	397152	3785725	sed	1
Daisy Canyon	DC1	0.1	2	1.5	0.8	0.3	0.01	0.11	0.75	0.29	0.10	4.92	0.27	0.80	0.31	395633	3792897	sed	1
Daisy Canyon	DC2	0.1	3	2.3	1.3	0.65	0.01	0.11	0.75	0.29	0.06	6.87	0.72	1.55	0.35	395615	3792880	sed	1

Daisy Canyon	DC3	0.1	2	1.1	1.0	0.5	0.01	0.11	0.76	0.30	0.04	3.85	0.60	1.19	0.40	395604	3792828	sed	1
Daisy Canyon	DC4	0.1	2	1.5	1.0	0.1	0.01	0.11	0.8	0.31	0.10	4.96	0.08	1.14	0.36	395581	3792807	sed	1
Daisy Canyon	DC5	0.1	2	4	1.0	0.1	0.01	0.11	0.85	0.33	0.52	11.73	0.04	0.82	0.23	395508	3792735	sed	1
Arroyo Seco	USF	0.035	5	12	7.3	0.5	0.01	0.21	12.08	4.73	0.20	34.06	0.08	1.47	0.17	393659	3791349	sed	1
Arroyo Seco	MSF	0.035	5	3	4.0	3	0.01	0.21	12.28	4.81	0.22	9.83	0.48	0.99	0.26	393855	3791207	?	3
Arroyo Seco	LSF	0.035	5	5	4.4	2	0.01	0.21	12.28	4.81	0.30	15.22	0.43	0.98	0.22	393855	3791207	?	3
Arroyo Seco	ASP1	0.014	4	1.21	3.0	0.3	0.01	0.21	12.53	4.90	0.12	4.75	0.07	0.73	0.28	394148	3790733	sed	1
Arroyo Seco	ASP2	0.049	3	1.45	3.0	0.5	0.01	0.21	12.51	4.90	0.21	6.85	0.11	0.74	0.24	394085	3790816	sed	1
Arroyo Seco	ASP3	0.052	5	2.18	3.0	0.3	0.01	0.21	12.49	4.89	0.31	8.03	0.05	0.63	0.22	394042	3790846	sed	1
Arroyo Seco	ASP4	0.035	5	2.32	3.0	3	0.01	0.21	12.49	4.89	0.23	8.02	0.40	0.61	0.22	394048	3790853	?	3
Arroyo Seco	ASP5	0.016	4	1.23	3.0	0.1	0.01	0.21	12.48	4.88	0.13	4.85	0.02	0.73	0.28	394066	3790866	sed	1
Fall Creek	FCR1	0.05	3	10.5	1.9	2	0.02	0.025	5.68	0.26	7.5×10^{-4}	7.35	3.46	3.46	0.72	392877	3796770	?	3
Fall Creek	FCR2	0.05	4	12	3.7	0.7	0.02	0.025	5.68	0.26	2.5×10^{-3}	16.34	0.75	4.69	0.25	392885	3796758	sed	1
Fall Creek	FCR3	0.05	3	7	3.9	0.55	0.02	0.025	5.68	0.26	7.7×10^{-4}	9.64	0.68	5.68	0.33	392890	3796746	sed	1
Fall Creek	FCR4	0.05	4	23	3.9	0.5	0.02	0.025	5.68	0.26	0.01	31.15	0.37	4.17	0.18	392895	3796728	sed	1
Classic Canyon	CC1	0.12	4	1.5	1.5	0.4	0.03	0.05	1.42	0.07	0.00	1.42	1.97	7.96	0.86	392893	3796323	sed	1
Classic Canyon	CCR1	0.12	3	6.5	2.3	0.8	0.01	0.05	1.49	0.07	4.8×10^{-4}	13.15	1.79	5.49	0.38	392684	3796459	sed	1
Classic Canyon	CCR2	0.12	3	9	2.3	0.5	0.02	0.05	1.49	0.07	4.1×10^{-4}	12.26	1.08	6.11	0.29	392675	3796474	sed	1
Classic Canyon	CCR2a	0.12	3	2	1.4	1.3	0.02	0.05	1.49	0.07	0.00	1.69	6.46	6.96	1.32	392675	3796474	br	1
Classic Canyon	CCR2b	0.12	3	2	1.6	0.3	0.01	0.05	1.49	0.07	1.4×10^{-3}	5.67	0.74	4.47	0.43	392675	3796474	sed	1
Fox Creek	FXR1	0.05	2	3	2.3	1	0.005	0.03	22.75	7.27	0.70	26.31	0[b]	0[b]	0[b]	391431	3797425	br	1
Fox Creek	FXR2	0.05	5	13	3.5	0.75	0.005	0.03	22.75	7.27	0.67	75.54	0.03	0.16	0.04	391467	3797391	sed	1
Fox Creek	FXR3	0.05	3	3.5	3.5	1	0.03	0.03	22.75	7.27	0.06	4.43	0.31	1.17	0.37	391482	3797388	sed	1
Fox Creek	FXR4	0.05	3.6	7.5	3.4	0.85	0.03	0.03	22.75	7.27	0.24	7.88	0.19	0.86	0.27	391495	3797399	sed	1
Fox Creek	FXR5	0.05	4	3.5	2.8	0.7	0.03	0.03	22.75	7.27	0.09	4.21	0.16	0.71	0.30	391501	3797420	sed	1
Fox Creek	FXR6	0.05	7	27	2.0	0.5	0.03	0.03	22.75	7.27	0.69	24.98	0.02	0.11	0.05	391565	3797461	sed	1
Fox Creek	FXR7	0.05	4	6	3.0	2	0.03	0.03	22.75	7.27	0.14	6.45	0.47	0.74	0.27	391582	3797472	?	2
Fox Creek	FXR8	0.05	4	3.5	3.5	0.7	0.03	0.03	22.75	7.27	0.06	4.21	0.21	1.15	0.38	391611	3797487	sed	1
Fox Creek	FXR9	0.05	5	16	3.5	0.5	0.03	0.03	24.6	7.86	0.54	15.33	0.07	0.70	0.19	391524	3796514	sed	1
Millard Canyon	M1	0.075	5	17	2.9	0.3	0.01	0.05	5.1	2.00	0.49	47.24	0.05	0.73	0.12	394833	3787038	sed	1
Wolfskill Canyon	W1	0.1	6	9	5.0	1.2	0.01	0.17	5.2	0.55	0.01	24.88	0.76	3.36	0.20	430738	3781897	sed	1
Dry Meadow Ck	STC1	0.05	12	2.66	6.2	3.9		0.1	93.5	3.66	-	-	-	-	-	366139	3984275	?	1
Dry Meadow Ck	STC2	0.05	12	3.74	4.8	2		0.1	93.5	3.66	-	-	-	-	-	366143	3984266	?	1
Dry Meadow Ck	STC3	0.05	12	5.34	9.2	5	0.01	0.1	93.5	3.66	0.01	13.34	1.56	2.89	0.32	366146	3984250	sed	1

Dry Meadow Ck	STC4	0.05	12	3.89	5.9	4.62	0.01	0.1	93.5	3.66	0.05	11.45	1.39	1.79	0.28	366155	3984237	sed	1
Dry Meadow Ck	STC5	0.05	12	1.24	4.9	2.21		0.1	93.5	3.66	-	-	-	-	-	366159	3984225	br	1
Dry Meadow Ck	STC6	0.05	12	2.85	7.4	2.53		0.1	93.5	3.66	-	-	-	-	-	366166	3984219	?	1
Dry Meadow Ck	STC7	0.05	12	2.36	4.5	2.55	0.01	0.1	93.5	3.66	0.06	7.33	0.83	1.48	0.33	366175	3984206	sed	1
Dry Meadow Ck	STC8	0.05	12	11	4.4	1.35		0.1	93.5	3.66	-	-	-	-	-	366191	3984207	?	1
Dry Meadow Ck	STC9	0.05	12	13.99	6.4	3.57		0.1	93.5	3.66	-	-	-	-	-	366246	3984191	?	1
Kapaa Stream	HFU	0.007	12	6	4.0	3		0.15	16.8	111.73	-	-	-	-	-	464537	2444738	?	3
SF Wailua River	WF	0.006	12	49	40.0	10		0.1	62	412.33	-	-	-	-	-	460951	2436662	?	4
Huleia Stream	KP	0.003	10	5.6	22.3	7.5		0.2	47	177.76	-	-	-	-	-	456876	2427414	?	1
Kaulaula Valley	KA	0.13	6	39	3.7	0.2	0.01	0.3	3.2	2.31	0.48	107.01	0.01	0.73	0.09	425986	2442220	?	1
Hanakapiai Stream	HF	0.4	10	120	22.0	4.7		0.3	4.5	27.19	-	-	-	-	-	438743	2453474	?	1

[a] S and W refer to reach-averaged channel slope and width upstream of the waterfall. Plunge-pool grain size measurements (D) reported are typically from visual estimates, and reach-averaged grain sizes are a mixture of visual estimates and random-walk pebble counts. Pool depth (h_{pool}) refers to the vertical distance from the downstream plunge-pool lip to the pool floor (i.e., $h_{pool} = z_{lip} - z_{sed}$) which was typically sediment but for some pools the bedrock floor was exposed (as indicated in the "pool floor" column where "sed" indicates a sediment floor, "br" indicates a bedrock floor, and "?" indicates no distinction between bedrock versus sediment floor was made). Two-year recurrence interval discharge estimates (Q_{2yr}) are made from USGS gage 11098000 for plunge pools on Arroyo Seco, Colby Canyon, Millard Canyon, and Rubio Canyon, from gage 11100500 for pools on Little Santa Anita, from gage 11095500 for pools on Classic Canyon and Fall Creek, from gage 11095000 for pools on Fox Creek, from data provided by the US Forest Service Forest San Dimas Experimental Forest for plunge pools on Wolfskill Canyon, from gage 11186000 for plunge pools on Dry Meadow Creek, from gage 16060000 for pools on Kapaa Stream and S Fork Wailua River, and from gage 16055000 for Huleia Stream, from gage 16130000 for Kaulaula Valley, and from gage 16115000 for Hanakapiai Stream. Non-dimensional variables were calculated using the median grain diameter of sediment deposited in the plunge pool, discharge equal to Q_{2yr}, and $Cf_{\_river}$ set to 0.01. We did not calculate non-dimensional variable values for streams in which we did not make a measure of the plunge-pool grain size and denote such cases with '-'. "Depth meas." column reports the technique used for depth measurements, 1 - manual measurements of pool depth with tape measure or stadia rod, 2 - depths estimates from C. Brennen, 3 - depth estimate based on observation of cliff jumpers, 4 - reported in Doughty [2010], see Supplementary Material text for more details. H_{drop} - waterfall drop height, r_{pool} - plunge-pool radius, A - drainage area upstream of waterfall, Q_{sc_pool}/Q_w - plunge-pool sediment-transport capacity normalized by water discharge. τ_{*pool}/τ_{*c} - plunge-pool transport stage, $(z_{lip} - z_{mixed})/L_d$ – approximate plunge-pool depth (for deep pools) normalized by turbulent mixing length scale, r_{pool}/L_d – plunge-pool radius normalized by turbulent mixing length scale, δ/L_d - jet-descending region radius normalized by turbulent mixing length scale, z_{lip} - elevation of the plunge-pool downstream lip, z_{mixed} - elevation of the top of the well-mixed layer of sediment near the plunge-pool floor, z_{sed} - elevation of the top of the sediment deposited on the pool floor.

[b] These are cases with large discharges relative to pool diameter and grain size such that $w_{net} < 0$ and, as a result, L_d is infinite.

Table S2. Measurements from waterfall plunge-pool sediment-transport capacity experiments and calculation of non-dimensional variables[a]

Exp #	Q_s (g/s)	Q_w (L/s)	H_{drop} (cm)	r_{pool} (cm)	D (mm)	u_{brink} (m/s)	h_{brink} (cm)	Minimum equilibrium pool depth (cm)	Maximum equilibrium pool depth (cm)	Average equilibrium pool depth (cm)	Q_{sc_pool}/Q_w	τ_{*pool}/τ_{*c}	$(z_{lip} - z_{mixed})/L_d$	r_{pool}/L_d	δ/L_d
1	0 ± 0	0.76	66	5.1	2.4	0.59 ± 0.1	1.3 ± 0.2	21.7	27.4	24.9	0	3.31	3.33	0.70	0.68
1	3.14 ± 0.33	0.76	66	5.1	2.4	0.59 ± 0.1	1.3 ± 0.2	18.2	23.4	20.8	0.0024	3.97	2.52	0.64	0.52
1	5.12 ± 0.44	0.76	66	5.1	2.4	0.59 ± 0.1	1.3 ± 0.2	17.2	22.9	20.3	0.0039	4.06	2.43	0.63	0.50
1	8.84 ± 0.63	0.76	66	5.1	2.4	0.59 ± 0.1	1.3 ± 0.2	13.8	21.5	18.4	0.0068	4.48	2.09	0.60	0.43
1	13.26 ± 0.93	0.76	66	5.1	2.4	0.59 ± 0.1	1.3 ± 0.2	12.8	21.5	17.5	0.01	4.71	1.93	0.59	0.40
1	16.88 ± 1.24	0.76	66	5.1	2.4	0.59 ± 0.1	1.3 ± 0.2	13.8	21.5	18.1	0.013	4.56	2.03	0.60	0.42
2	0 ± 0	0.58	66	5.1	2.4	0.59 ± 0.1	1.0 ± 0.2	20.7	25.9	23.6	0	3.07	4.48	0.99	0.91
2	3.14 ± 0.33	0.58	66	5.1	2.4	0.59 ± 0.1	1.0 ± 0.2	16.2	20.0	18.5	0.0031	3.91	3.08	0.88	0.64
2	5.12 ± 0.44	0.58	66	5.1	2.4	0.59 ± 0.1	1.0 ± 0.2	14.3	20.0	17.9	0.0051	4.04	2.93	0.86	0.61
2	8.84 ± 0.63	0.58	66	5.1	2.4	0.59 ± 0.1	1.0 ± 0.2	13.3	19.0	16.6	0.0088	4.36	2.60	0.83	0.54
2	16.88 ± 1.24	0.58	66	5.1	2.4	0.59 ± 0.1	1.0 ± 0.2	9.8	17.0	14.7	0.017	4.94	2.13	0.78	0.45
4	0 ± 0	0.76	63	7.7	2.4	0.59 ± 0.1	1.3 ± 0.2	23.6	25.1	24.2	0	3.30	4.73	1.54	0.97
4	3.14 ± 0.33	0.76	63	7.7	2.4	0.59 ± 0.1	1.3 ± 0.2	19.2	21.2	20.3	0.0024	3.94	3.60	1.41	0.74
4	5.12 ± 0.44	0.76	63	7.7	2.4	0.59 ± 0.1	1.3 ± 0.2	18.7	20.2	19.5	0.0039	4.09	3.40	1.38	0.70
4	8.84 ± 0.63	0.76	63	7.7	2.4	0.59 ± 0.1	1.3 ± 0.2	17.7	19.2	18.9	0.0068	4.23	3.22	1.36	0.67
4	13.26 ± 0.93	0.76	63	7.7	2.4	0.59 ± 0.1	1.3 ± 0.2	16.2	18.7	17.5	0.01	4.56	2.86	1.31	0.59
4	16.88 ± 1.24	0.76	63	7.7	2.4	0.59 ± 0.1	1.3 ± 0.2	15.8	18.7	17.0	0.013	4.70	2.73	1.29	0.57
5	0 ± 0	0.76	61	10.1	2.4	0.59 ± 0.1	1.3 ± 0.2	20.7	23.1	22.1	0	3.53	4.56	2.15	0.94
5	3.14 ± 0.33	0.76	61	10.1	2.4	0.59 ± 0.1	1.3 ± 0.2	18.7	20.2	19.6	0.0024	3.97	3.80	2.02	0.78
5	5.12 ± 0.44	0.76	61	10.1	2.4	0.59 ± 0.1	1.3 ± 0.2	17.7	19.7	18.9	0.0039	4.13	3.58	1.99	0.74
5	8.84 ± 0.63	0.76	61	10.1	2.4	0.59 ± 0.1	1.3 ± 0.2	17.2	18.7	17.8	0.0068	4.37	3.27	1.93	0.68
5	13.26 ± 0.93	0.76	61	10.1	2.4	0.59 ± 0.1	1.3 ± 0.2	15.3	17.2	15.9	0.01	4.89	2.74	1.82	0.57
5	16.88 ± 1.24	0.76	61	10.1	2.4	0.59 ± 0.1	1.3 ± 0.2	11.8	13.3	12.6	0.013	6.20	1.88	1.62	0.40
6	0 ± 0	0.76	37	7.7	2.4	0.59 ± 0.1	1.3 ± 0.2	18.7	19.7	19.4	0	2.78	3.65	1.49	0.75
6	3.14 ± 0.33	0.76	37	7.7	2.4	0.59 ± 0.1	1.3 ± 0.2	13.8	15.8	14.8	0.0024	3.64	2.40	1.30	0.50
6	5.12 ± 0.44	0.76	37	7.7	2.4	0.59 ± 0.1	1.3 ± 0.2	12.8	14.8	13.6	0.0039	3.95	2.11	1.25	0.44
6	8.84 ± 0.63	0.76	37	7.7	2.4	0.59 ± 0.1	1.3 ± 0.2	11.8	13.8	12.2	0.0068	4.36	1.79	1.19	0.38
6	13.26 ± 0.93	0.76	37	7.7	2.4	0.59 ± 0.1	1.3 ± 0.2	10.8	11.8	11.5	0.01	4.36	1.67	1.19	0.38
6	16.88 ± 1.24	0.76	37	7.7	2.4	0.59 ± 0.1	1.3 ± 0.2	10.8	12.8	11.4	0.013	4.36	1.66	1.19	0.38
7	0 ± 0	0.76	17	7.7	2.4	0.59 ± 0.1	1.3 ± 0.2	11.3	15.8	13.5	0	2.12	2.50	1.46	0.54

7	3.14 ± 0.33	0.76	17	7.7	2.4	0.59 ± 0.1	1.3 ± 0.2	7.9	9.8	8.8	0.0024	2.12	1.60	1.46	0.54
7	5.12 ± 0.44	0.76	17	7.7	2.4	0.59 ± 0.1	1.3 ± 0.2	6.9	9.4	8.0	0.0039	2.12	1.46	1.46	0.54
7	8.84 ± 0.63	0.76	17	7.7	2.4	0.59 ± 0.1	1.3 ± 0.2	5.9	8.9	7.2	0.0068	2.12	1.30	1.46	0.54
7	13.26 ± 0.93	0.76	17	7.7	2.4	0.59 ± 0.1	1.3 ± 0.2	5.9	8.4	6.9	0.01	2.12	1.24	1.46	0.54
7	16.88 ± 1.24	0.76	17	7.7	2.4	0.59 ± 0.1	1.3 ± 0.2	5.4	7.4	6.2	0.013	2.12	1.11	1.46	0.54
9	0 ± 0	0.76	66	5.1	7	0.59 ± 0.1	1.3 ± 0.2	16.7	22.0	19.6	0	1.45	5.53	1.50	1.15
9	2.36 ± 0.26	0.76	66	5.1	7	0.59 ± 0.1	1.3 ± 0.2	11.8	18.5	15.1	0.0018	1.88	3.63	1.31	0.77
9	3.75 ± 0.38	0.76	66	5.1	7	0.59 ± 0.1	1.3 ± 0.2	10.8	17.5	15.1	0.0029	1.88	3.63	1.31	0.77
9	5.9 ± 0.43	0.76	66	5.1	7	0.59 ± 0.1	1.3 ± 0.2	6.9	15.6	11.4	0.0045	2.49	2.26	1.14	0.51
9	8.22 ± 0.12	0.76	66	5.1	7	0.59 ± 0.1	1.3 ± 0.2	0.5	4.5	2.5	0.0063	2.61	0.27	1.11	0.47
10	0 ± 0	0.76	63	7.7	7	0.59 ± 0.1	1.3 ± 0.2	0.5	4.5	2.5	0	2.50	0.33	2.03	0.58
12	0 ± 0	0.58	64	5.1	5.6	0.59 ± 0.1	1.0 ± 0.2	19.2	19.7	19.4	0	1.56	6.29	1.71	1.30
12	2.32 ± 0.65	0.58	64	5.1	5.6	0.59 ± 0.1	1.0 ± 0.2	15.8	16.7	16.2	0.0023	1.87	4.72	1.56	0.99
12	3.33 ± 0.33	0.58	64	5.1	5.6	0.59 ± 0.1	1.0 ± 0.2	11.3	12.8	12.1	0.0033	2.52	2.91	1.34	0.63
12	5.67 ± 0.13	0.58	64	5.1	5.6	0.59 ± 0.1	1.0 ± 0.2	7.9	8.9	8.4	0.0056	3.17	1.68	1.20	0.45
12	9.48 ± 0.2	0.58	64	5.1	5.6	0.59 ± 0.1	1.0 ± 0.2	5.9	6.9	6.4	0.0094	3.17	1.22	1.20	0.45
12	16.77 ± 0.17	0.58	64	5.1	5.6	0.59 ± 0.1	1.0 ± 0.2	5.4	6.9	6.2	0.017	3.17	1.16	1.20	0.45
12	26.77 ± 0.23	0.58	64	5.1	5.6	0.59 ± 0.1	1.0 ± 0.2	0.5	4.5	2.5	0.027	3.17	0.31	1.20	0.45
12	34.23 ± 0.03	0.58	64	5.1	5.6	0.59 ± 0.1	1.0 ± 0.2	0.5	4.5	2.5	0.034	3.17	0.31	1.20	0.45
13	0 ± 0	0.42	65.5	5.1	5.6	0.48 ± 0.1	0.9 ± 0.2	0.5	4.5	2.5	0	3.21	0.39	1.52	0.48

[a] For all experiments, upstream flume width was 9.6 cm, and upstream water surface slope was approximately 0.007. Water velocity at waterfall brink (u_{brink}) was calculated from conservation of mass based on water discharge (Q_w), channel width, and flow depth at brink (h_{brink}), mean ± standard deviation reported. Maximum, minimum, and average plunge-pool depth ($h_{pool} = z_{lip} - z_{sed}$) measured at equilibrium reflect topographic variability across pool floor. H_{drop} - waterfall drop height, r_{pool} - plunge-pool radius, D - sediment grain size, Q_{sc_pool} - plunge-pool sediment-transport capacity, τ_{*pool}/τ_{*c} - transport stage on plunge-pool floor, L_d - turbulent diffusion length scale, δ - radius of jet-descending region, z_{lip} - elevation of the plunge-pool downstream lip, z_{mixed} - elevation of the top of the well-mixed layer of sediment near the plunge-pool floor, z_{sed} - elevation of the top of the sediment deposited on the pool floor.