Particle Mobility over flood and annual timescales in mountain streams of the Luquillo Critical Zone Observatory

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Bedload transport at the flood and annual scale

**Flood scale**

- Sediment particles remain mobile for the duration of time it takes to find a stable resting place. [Lajeunesse et al., 2010]

- Initiation of motion occurs when the impulse exceeds a critical value. [Diplas et al., 2008]

- Transport rate is dependant on a host of factors.

**Annual scale**

- Measurements from several floods may not characterize the system at the annual or longer timescales.
Field sites located in the Mameyes river drainage basin in the Luquillo Mts. PR.

- Field site located 3.5 km downstream of USGS stream gage.
- Field sites at USFS stream gages.

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DEM 30m

- USGS stream gage
- Field sites
- Field site located 3.5 km downstream of USGS stream gage.
- Field sites at USFS stream gages.

Stage (m)

Time from placement (days)
Passive Radio Frequency ID (RFID) Tracer particles (study methods)

- Tracking of tracers done after individual floods, several floods, and on an annual scale.
- Each tracer has a Unique ID allowing calculation of which tracers moved, distance of movement, and which tracers were immobile.

Grain size distributions

Similar D50

Photograph by Justin Singh
Tracer movement & Critical Shields stress

Range of critical Shields stresses explored (.03 - .12). Average value of .043 determined from tracers.

3 relevant units of time

Real time – total elapsed time since tracer deployment.

Transport time – total time tracers spent above the threshold for incipient motion.

Shields time – cumulative excess Shields stress.

\[ t_{Shields} = \int (\tau_* - \tau_{*cr}) \, dt \]
Single flood scale

• Most probable flight lengths for populations 1, 2, 3 are 3.5, 5, and 7 meters respectively.
• Predicted characteristic flight length \(\approx 10\) m. (Lajeunesse et al., 2010)
Calculating a bedload transport flux from tracer particles

Fraction of bed area covered by tracers

\[ A_T = \frac{N\pi ab}{wl} \]

Tracer flux

\[ Q_T = \frac{n\pi abX_l}{dt} \]

Cobble Bedload flux

\[ Q_s = \frac{n\pi abX_l N\pi ab}{dt \cdot wl} \]

Coarse Bed load for 5\textsuperscript{th} tracking

\[ Q_s \text{ real time} = 9.51 \times 10^{-7} \text{ m}^3/\text{min} (0.0025 \text{ kg/min}) \]
\[ Q_s \text{ transport time} = 3.104 \times 10^{-4} \text{ m}^3/\text{min} (0.823 \text{ kg/min}) \]
References
