How does abrasion affect channel response to a coarse sediment pulse?

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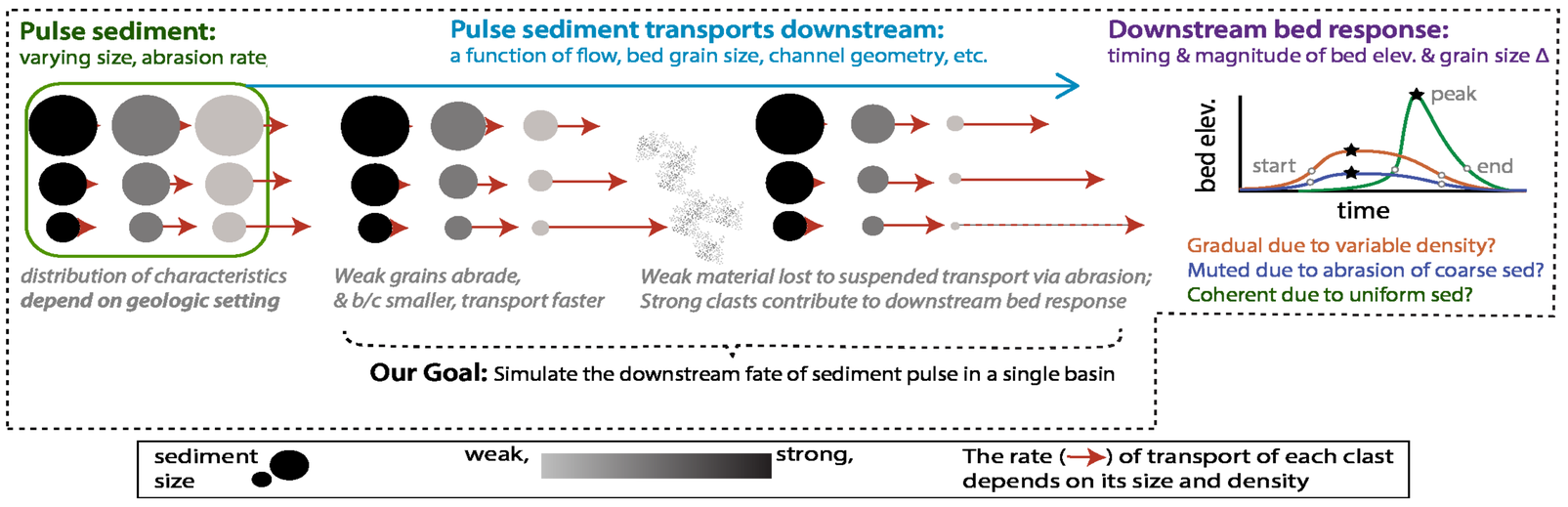
(Background)

In volcanic landscapes, large sediment pulse from the volcanoes are deposited in channels and affect channel morphology and bed texture. Here, we use a simple morphodynamic model to explore the extent to which bed material abrasion controls the downstream fate of sediment pulses in terms of transit time and the magnitude of response in channel bed elevation and grain size change.

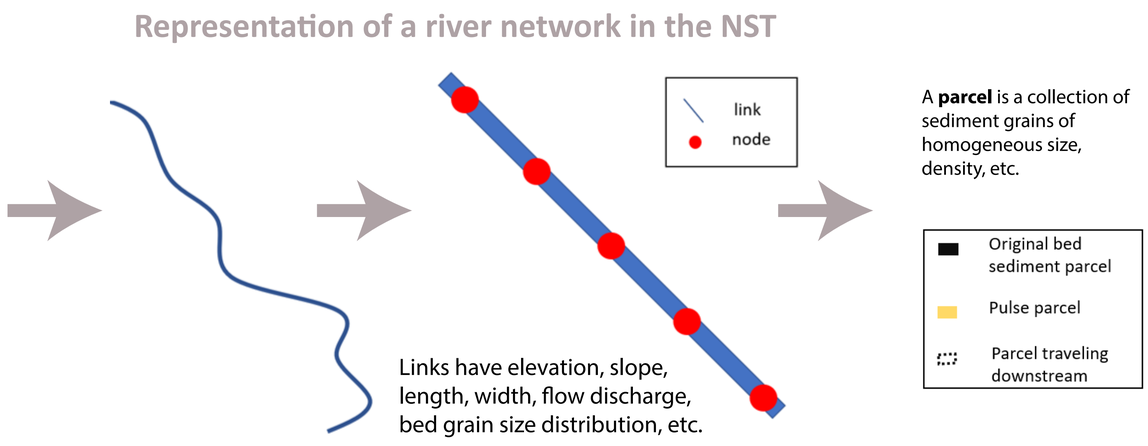
Overarching hypothesis:
In volcanic landscapes, abrasion is an important control on the morphodynamics of sediment pulses from large mass wasting deposits of heterogeneous sedimentary characteristics.

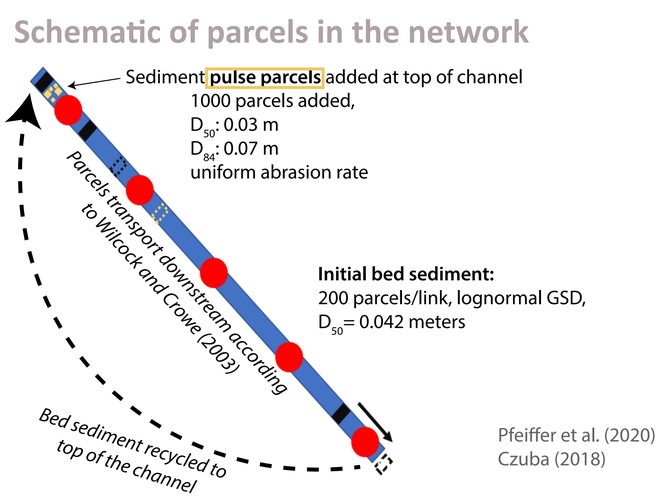


(Methods) Lagrangian 1-D morphodynamic sediment transport modeling

The **Network Sediment Transporter** (NST) is a Lagrangian 1-D morphodynamic modeling component of **Landlab** that **tracks bed sediment moving and interacting on a river network**. The NST represents channel reaches as links on the network model grid. Links are separated by nodes. Sediment is tracked as discrete parcels, collections of sediment with uniform size and characteristics. Parcels are transported according to Wilcock and Crowe (2003) transport equations. We run the model for 1000 timesteps (1 timestep = 7 days), inputting a pulse of 5000 m^3 with parcels that have a slightly smaller median grain size and narrower grain size distribution than the bed. We track elevation and grain size change and compare the results of model results with and without abrasion.

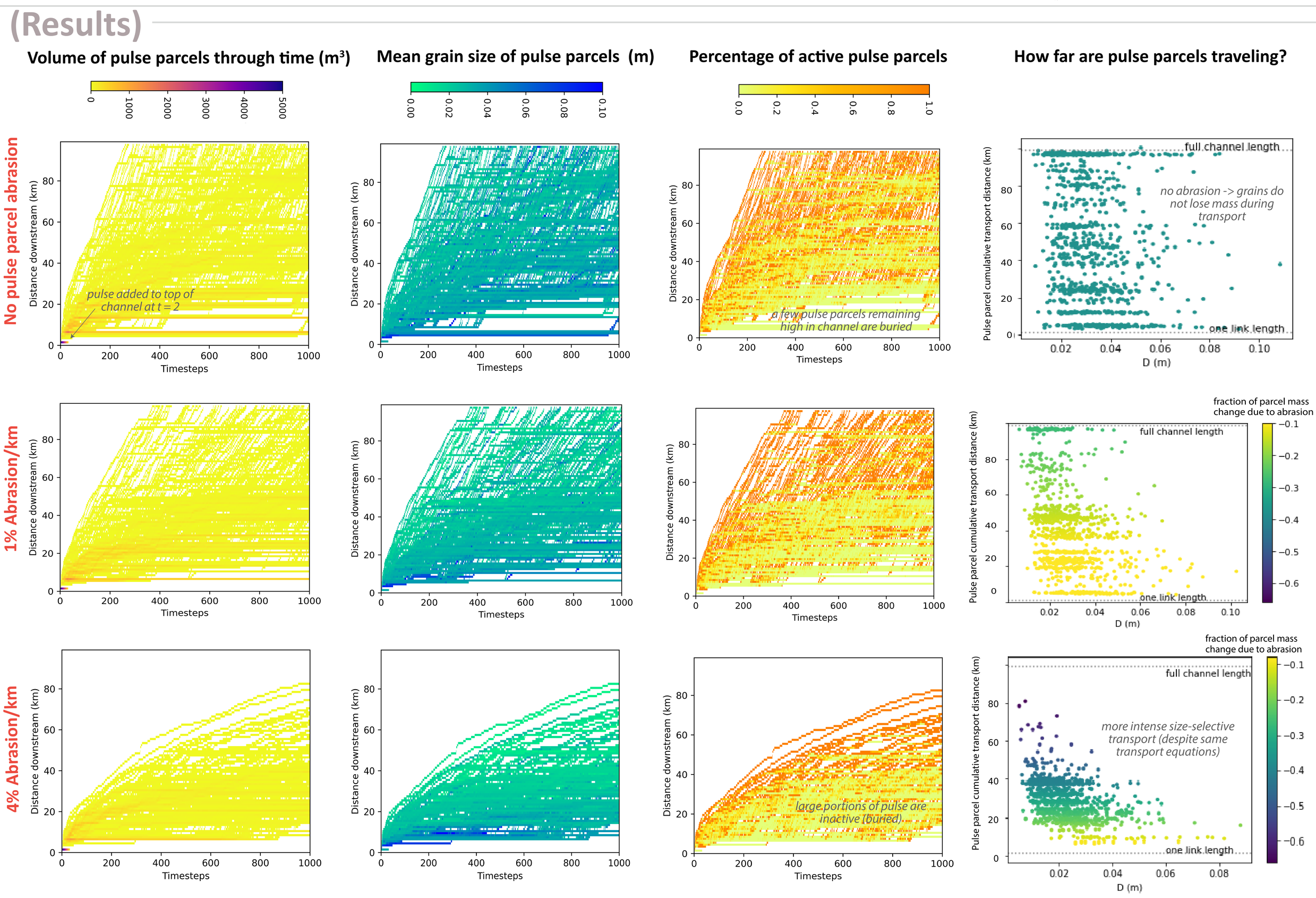
Model Inputs:
- Channel morphology: topographic and bed elevation, slope, length, area & width
- Hydrologic: flow depth
- Bed Sediment Attributes: grain size distribution & parcel volume





Pfeiffer et al. (2020)
Czuba (2018)

(Results)



(Conclusions)

Returning to our hypothesis:

- YES, abrasion (at a rate regularly seen in volcanic sediments) impacts the downstream effects of sediment pulses, but not in the way we expected

- Higher abrasion rates lead modeled pulses to concentrate, rather than disperse.

- Lots of exploration still to do! Do these results persist with different active layer thickness? Different pulse GSD?

(Next) Model Improvements

Future improvements to this work will include:

1. Apply this **toy model to a specific river** with more realistic conditions.
2. **Zeroing the model** (running to steady state bed conditions) before adding pulse.
3. Running the model on CSDMS High Performance Computing Cluster (**HPCC**).
4. Incorporate **variable density and variable abrasion** rate within a pulse.

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References: Czuba, J.A., 2018, A Lagrangian framework for exploring complexities of mixed-size sediment transport in gravel-bedded river networks: Geomorphology, v. 321, p. 146–152.; Pfeiffer, A., Barnhart, K., Czuba, J., and Hutton, E., 2020, NetworkSedimentTransporter: A Landlab component for bed material transport through river networks: Journal of Open-Source Software, v. 5, p. 2341, doi:10.21105/joss.02341.