

CLINIC: Landlab's NetworkSedimentTransporter

As we get settled:

1. Introduce yourself to your neighbor! Why are you here, why are you NST-curious?
2. Have Landlab experience? *Chat with people around you, identify a peer mentor in your neighborhood*
3. Make sure you can access explore.openearthscape.org



NSF grants [GLD 2138504](#) and [CSSI 2104055](#)

Landlab's NetworkSedimentTransporter:

A Lagrangian model for riverbed material transport dynamics

CSDMS May 2025

NSF grants [GLD 2138504](#) and
[CSSI 2104055](#)





Gameplan

(~20 min) **lecture Intro to the NST**

(~40 min) **notebook 1: a simple flume configuration**

break

(~30 min) **notebook 2: reading in a shapefile**

*Interrupt me
with questions!*

(~15 min) **discussion**



NSF grants GLD 2138504 and CSSI 2104055



Intros

Allison Pfeiffer
Associate Professor
WWU Geology

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PhD Candidate
VT Bio Sys Eng



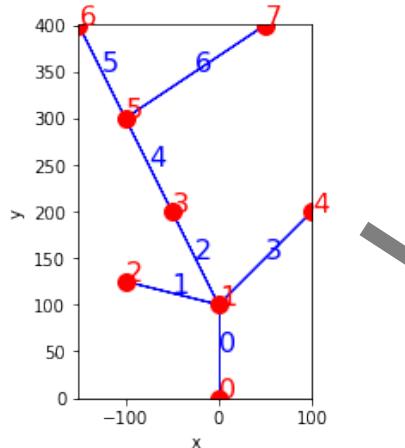
The NetworkSedimentTransporter

- Simple 1D morphodynamics.
- Network: not just a long profile
- Langrangian: tracking individual ‘parcels’ of sediment
- Wilcock & Crowe transport equations: gravel & sand

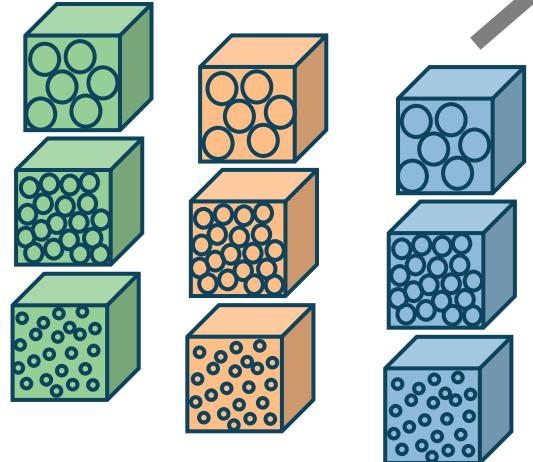
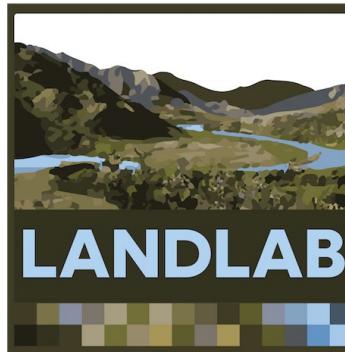
👍 **Good for:** evolving bed grain size, exploring pulse transport, *tracing* transport of sand/gravel

✗ **Not good for:** long profile topographic evolution (i.e. major incision), long timescale (i.e. millennia)

Lagrangian model for bed sediment transport

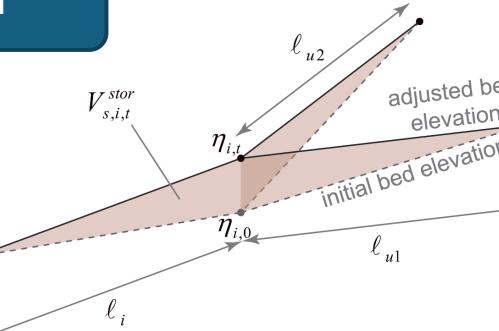


The grid



“Parcels” of sediment

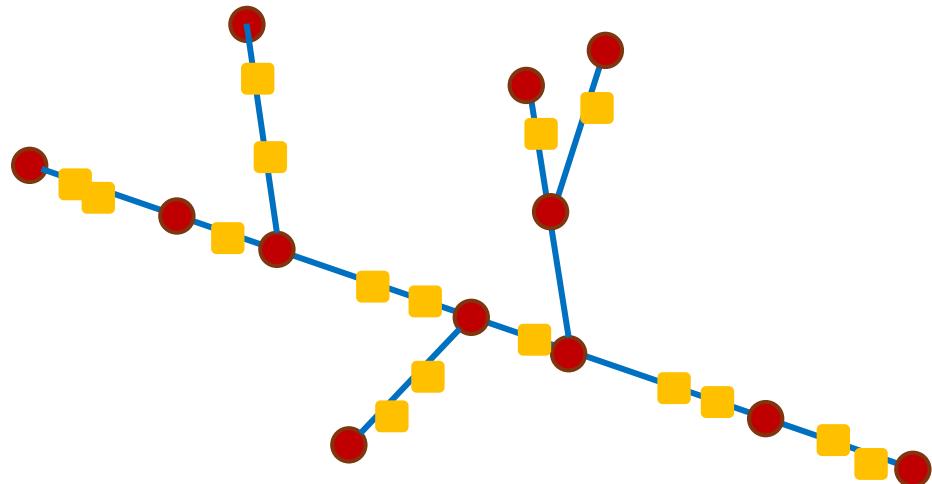
Network Sediment Transporter



NetworkSedimentTransporter: A Landlab component for bed material transport through river networks

The NST grid and parcels

Grid: elevation, slope, flow depth, channel width



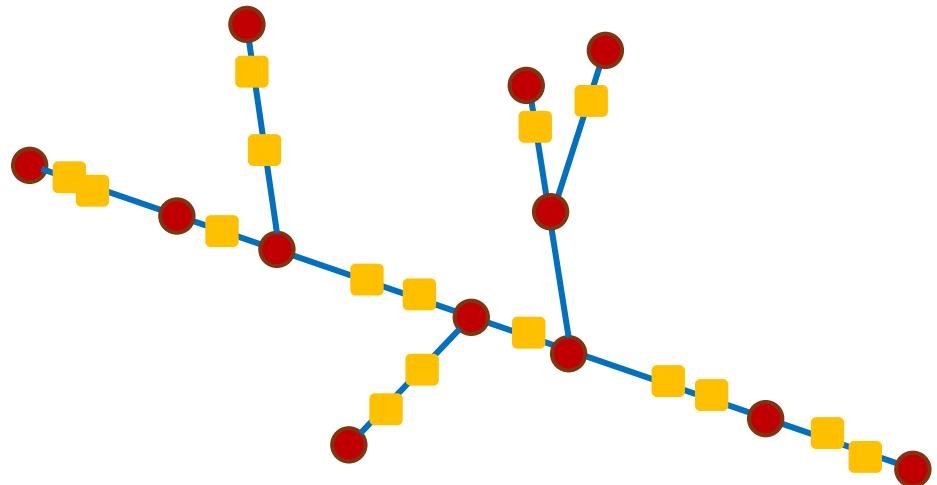
Parcels: current link, location on link, time arrival in link

volume, grain size, abrasion rate, density,
+user assigned characteristics

As parcels transport, parcel and grid attributes **evolve**

The NST grid and parcels

Grid: elevation, slope, flow depth, channel width



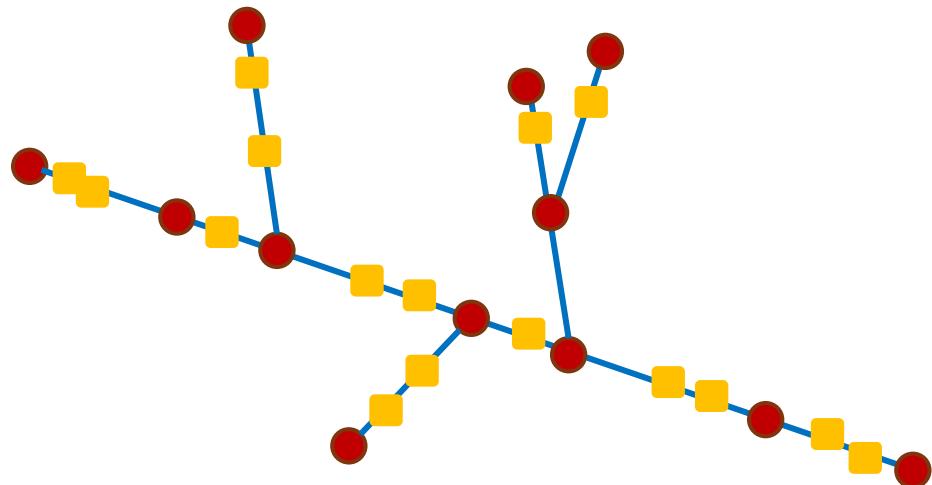
Parcels: current link, location on link,
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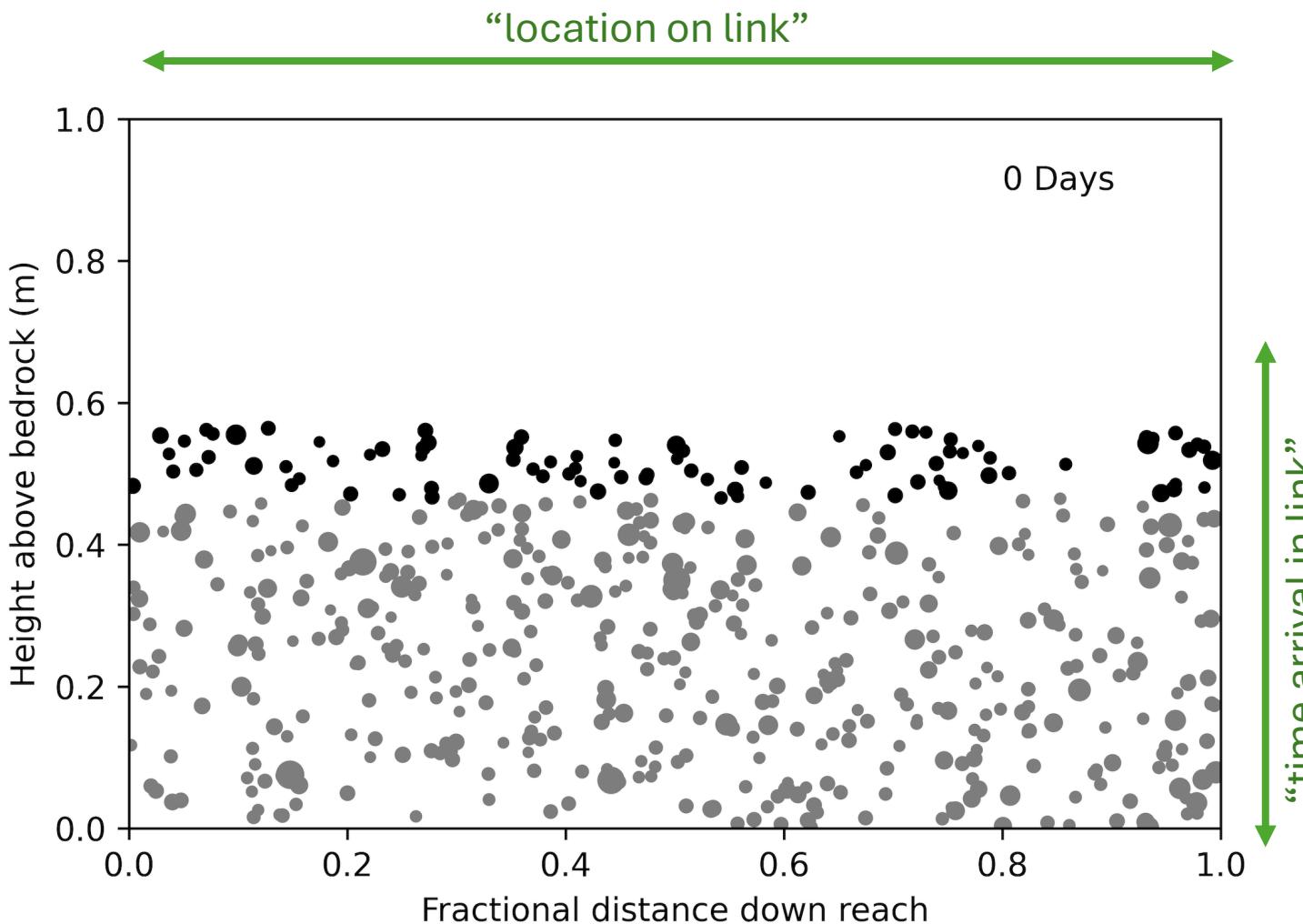


Parcels: current link, location on link,
time arrival in link

volume, grain size, abrasion rate, density,
+user assigned characteristics

As parcels transport, parcel and grid attributes **evolve** (or can evolve)

Tracking parcels on a link



Active parcels
Storage parcels

Dot size reflects
parcel grain size

Each dot represents a
parcel.

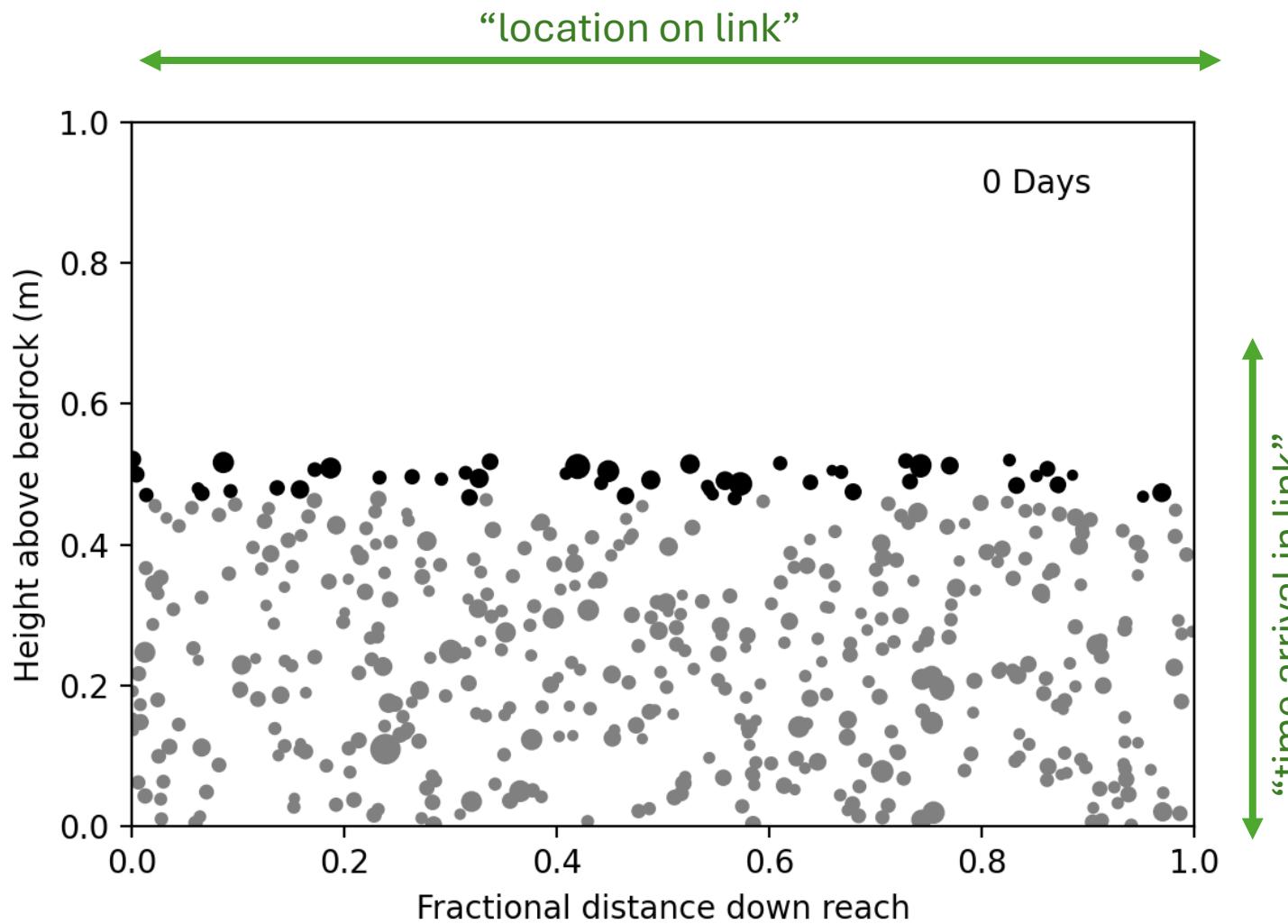
Vertical stacking:

- First in, last out
- Active layer = top 10 cm

For example:

Parcels.dataset[“**location_in_link**

Tracking parcels on a link



Active parcels
Storage parcels
Pulse parcels

Dot size reflects
parcel grain size

Each dot represents a
parcel.

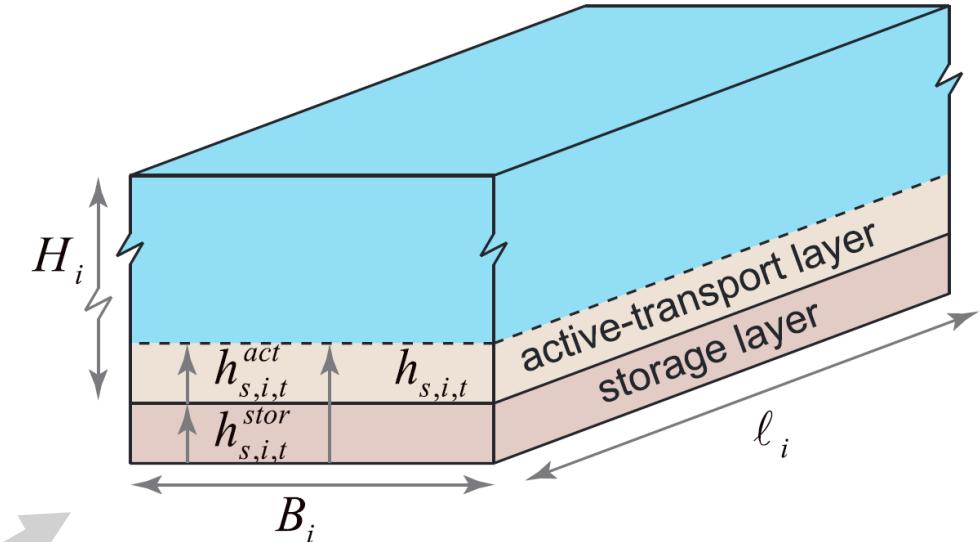
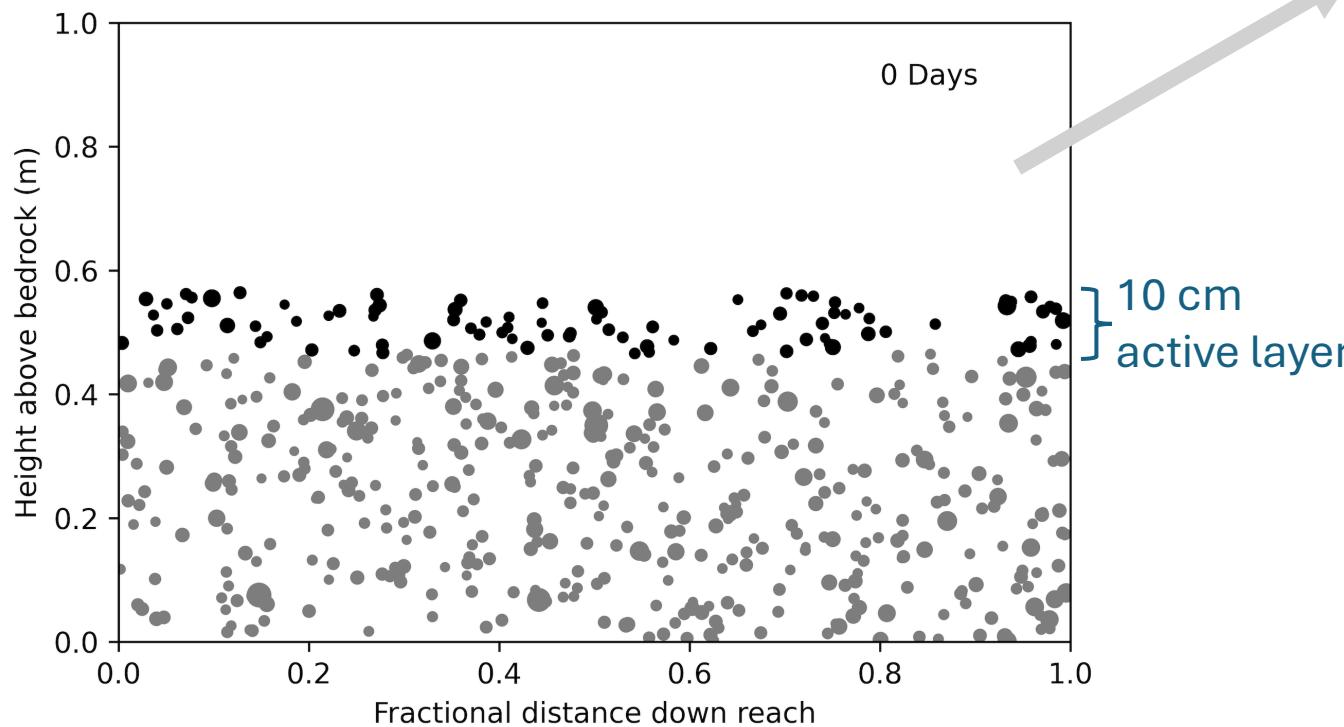
Vertical stacking:

- First in, last out
- Active layer = top 10 cm

syntax:

Transport and storage

Parcels are partitioned into active and storage layers, downstream transport distance calculated via Wilcock and Crowe (2003) eqns.



Active layer – here, 10 cm (other options available)

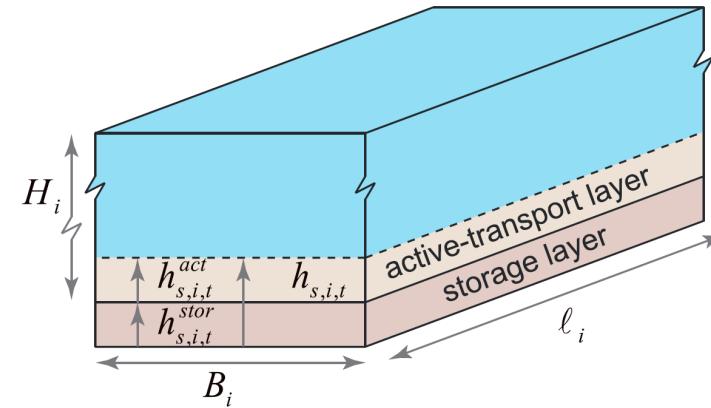
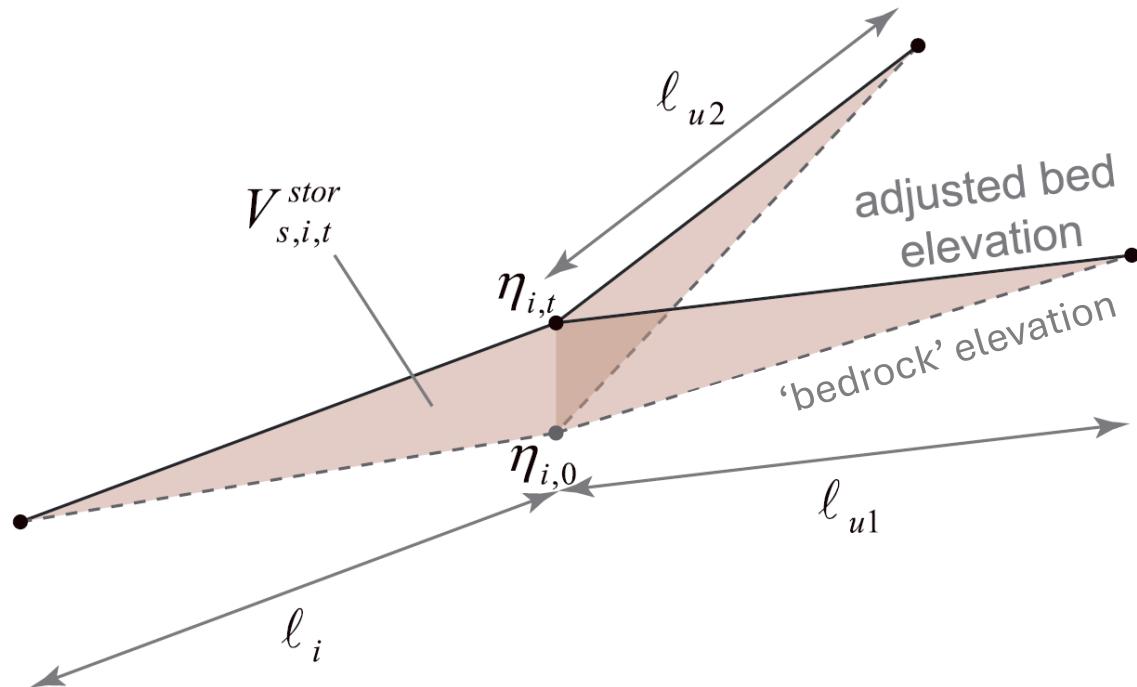
Wilcock and Crowe (2003)

- Hiding function to account for GSD interactions.
- Critical Shields stress = $f(\text{sand content})$

Virtual velocity

How grid characteristics evolve

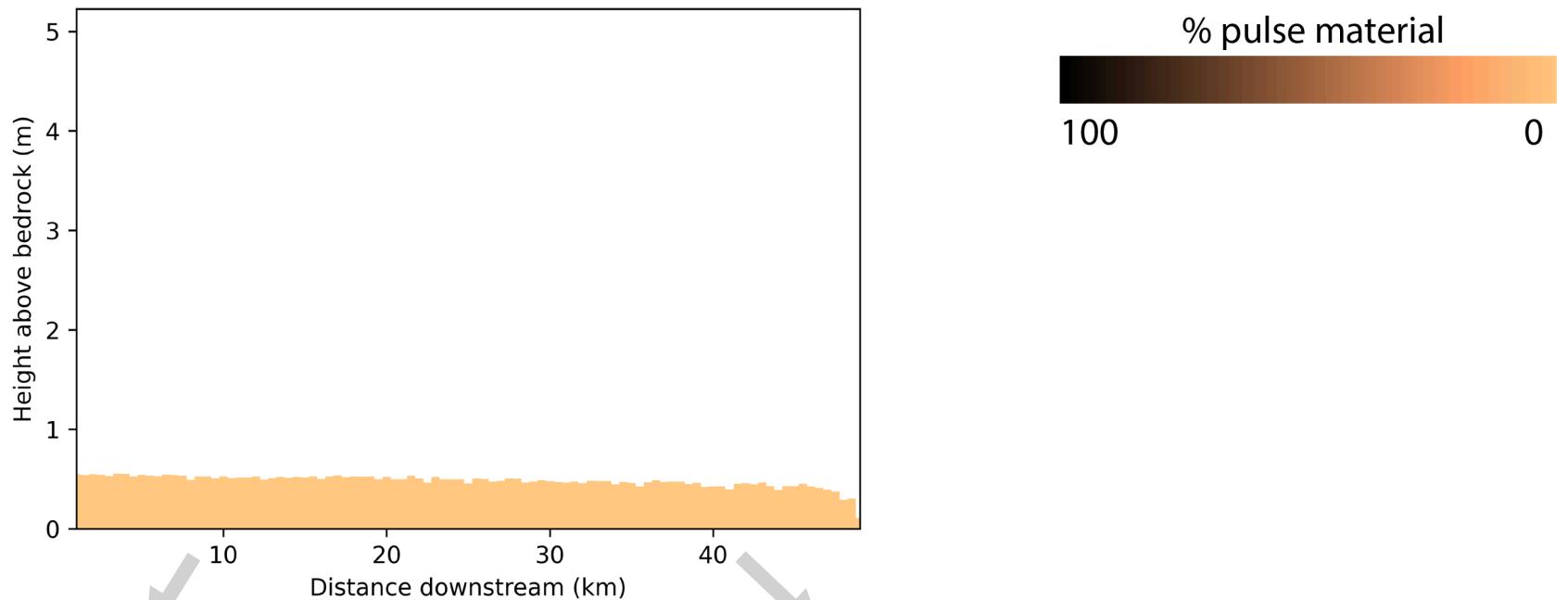
grid node topographic elevations evolve as a function of the volume of storage layer parcels on the downstream link, distributed among adjacent links.



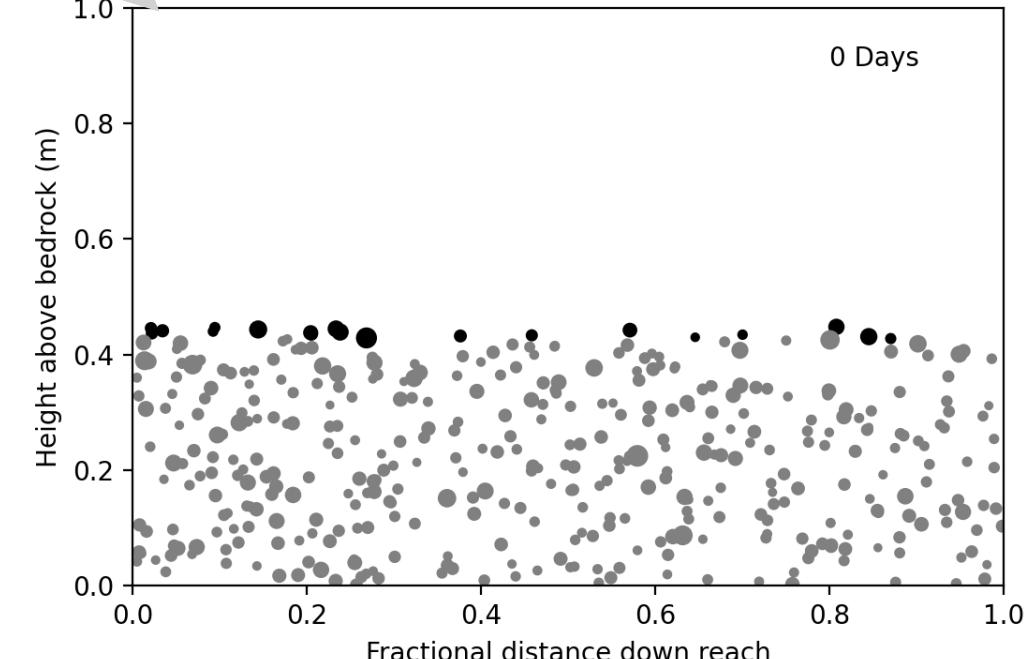
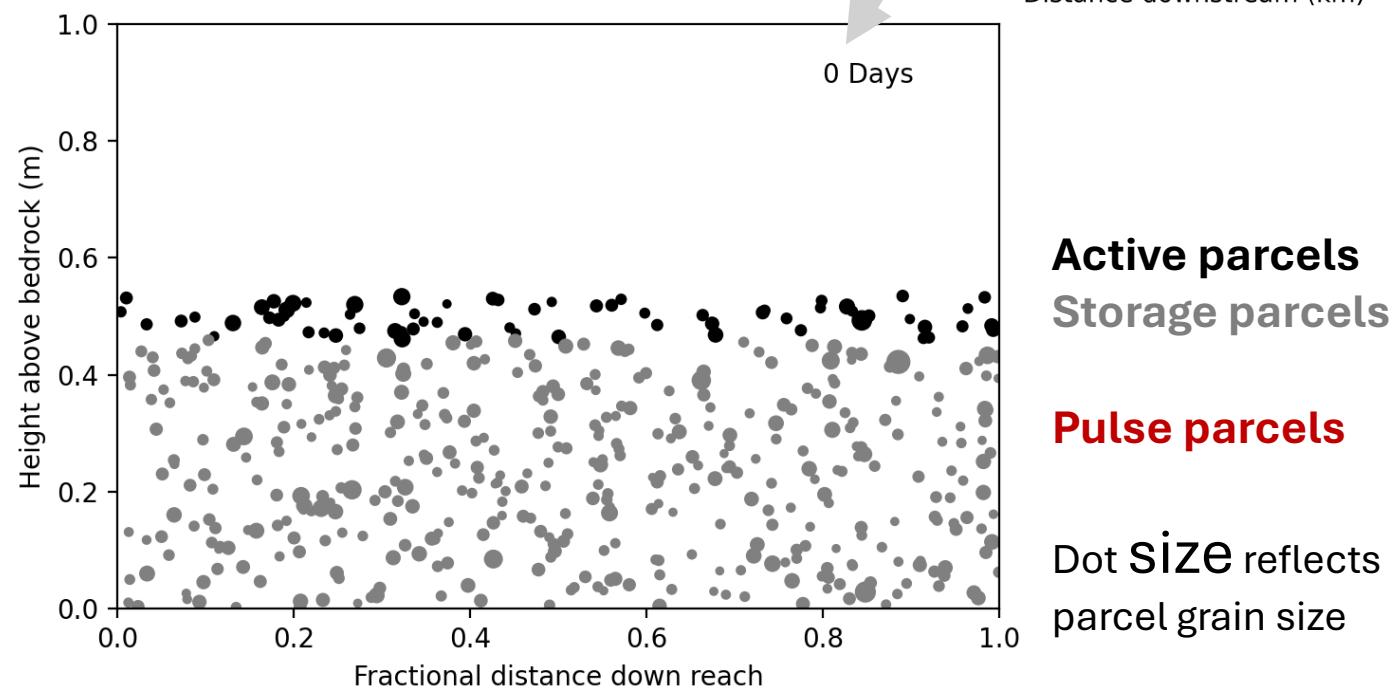
For example:

```
grid.at_link["channel_slope"]  
grid.at_node["topographic_elevation"]
```

Pulse transport at the channel scale:

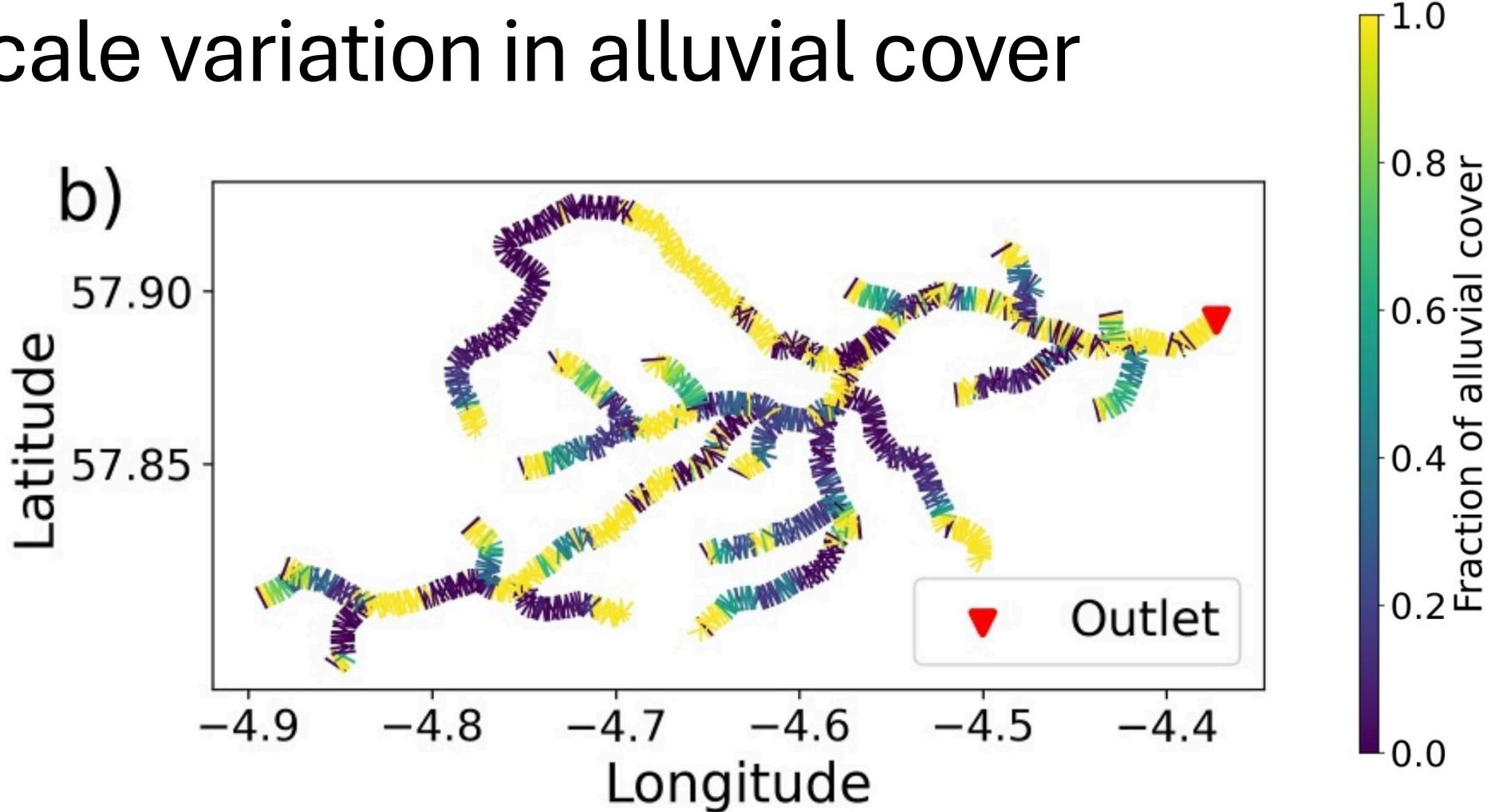


Parcel transport at the link scale:



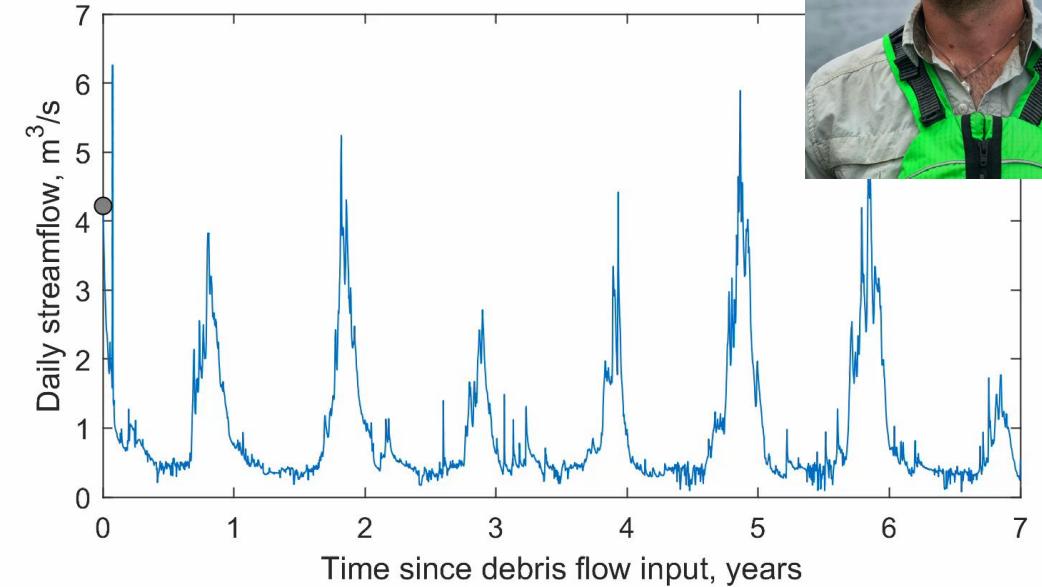
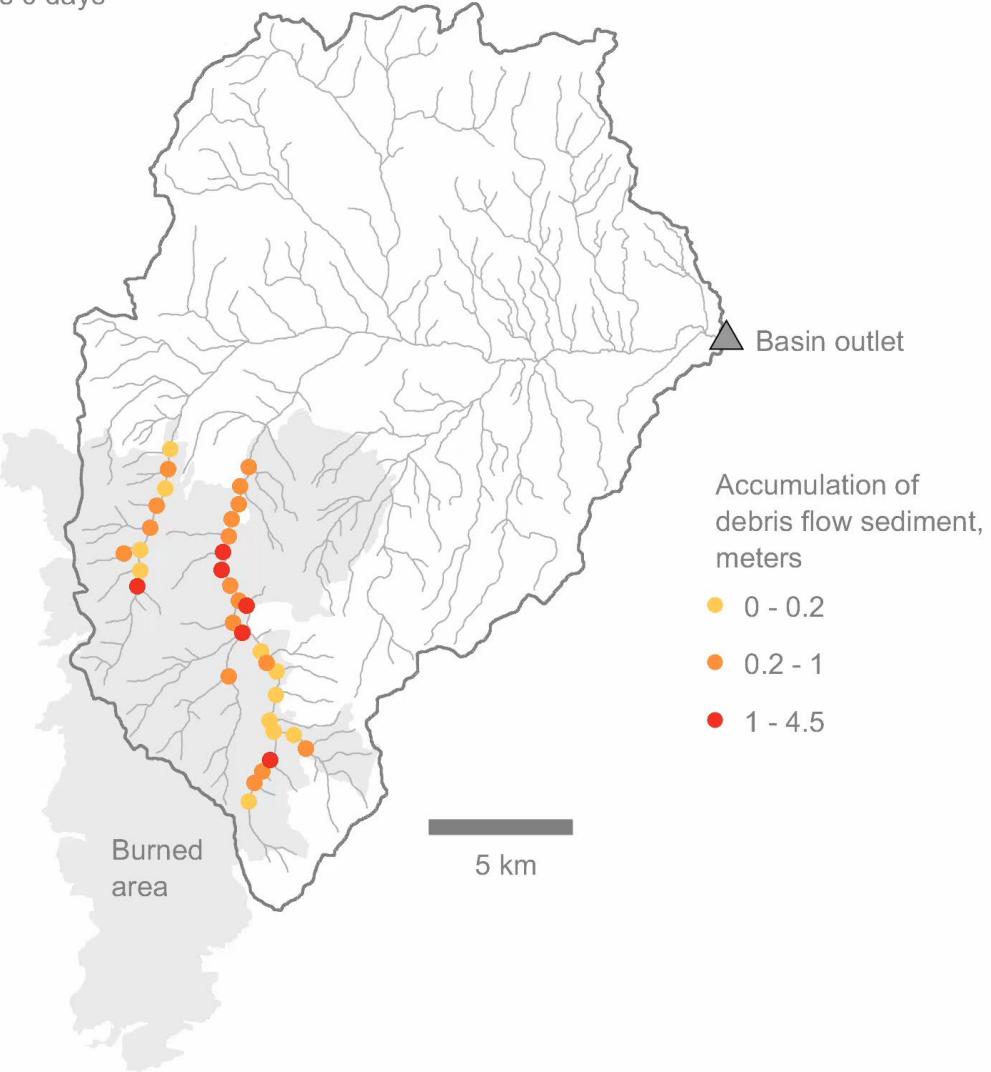
NST examples:

Network scale variation in alluvial cover

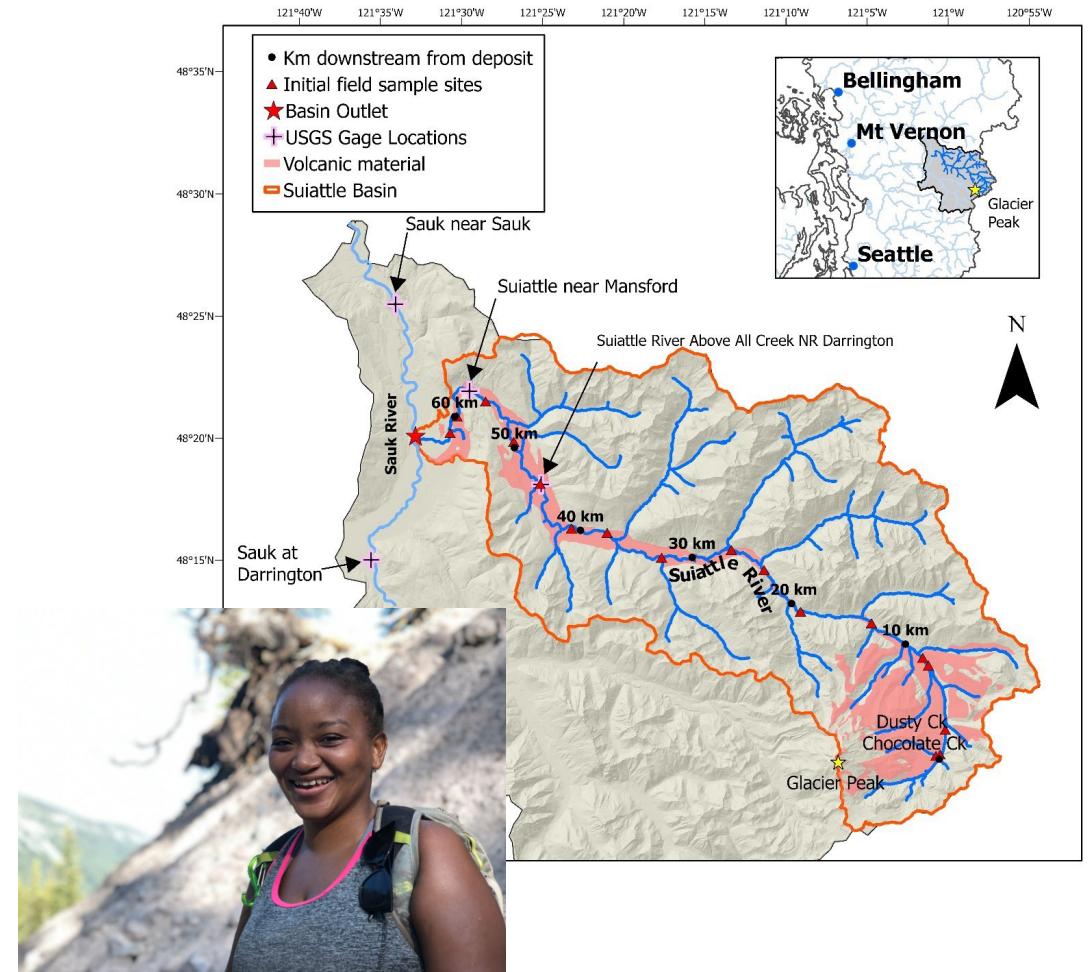
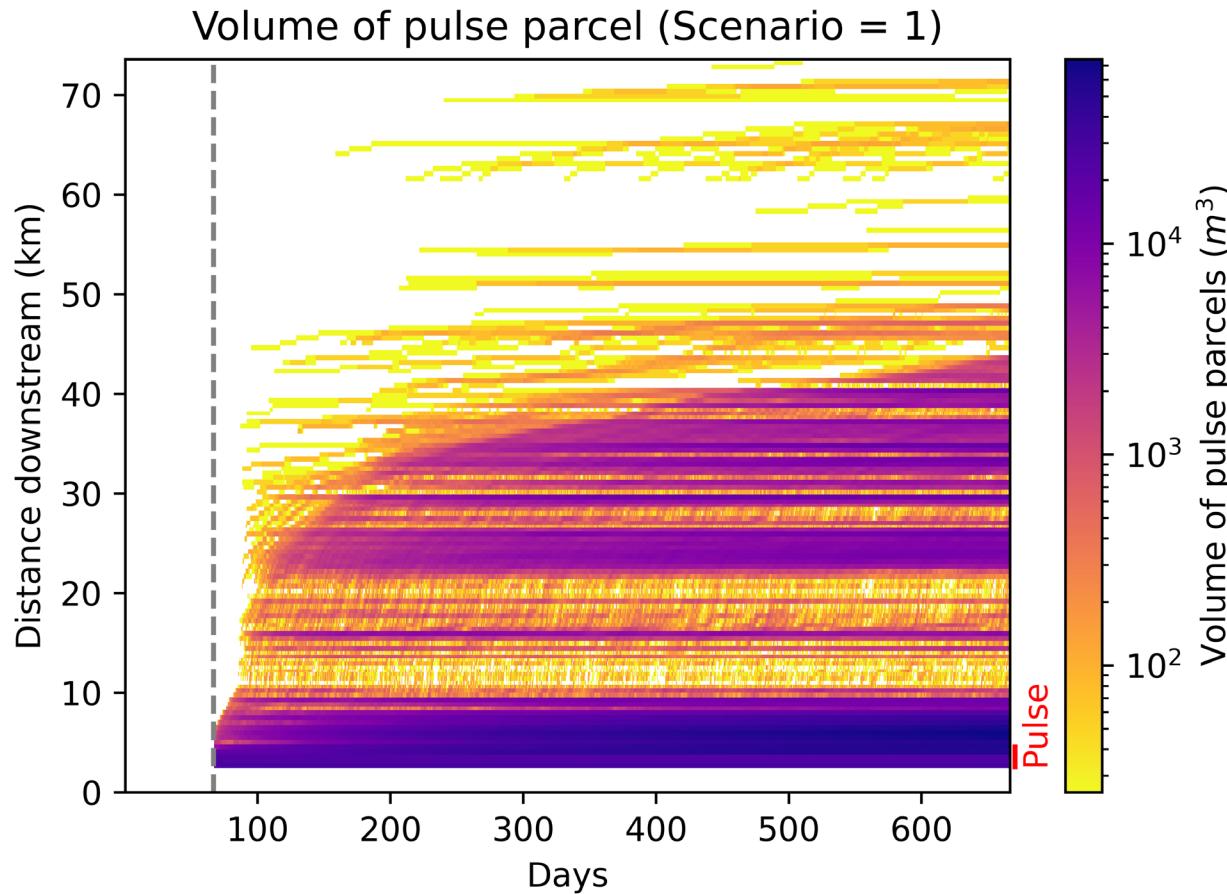


NST examples: Fluvial reworking of post-wildfire debris flow sediment

Time since debris flow input
0 years 0 days



NST examples: The role of bed material abrasion in pulse transport



Ashanie Long-Reid
MS thesis coming later this month!

To the notebooks! bit.ly/3ZewE5i

NST-Clinic-CSDMS-2025

Resources for the Landlab NetworkSedimentTransporter Clinic at CSDMS in May 2025, hosted by Allison Pfeiffer, with contributions from Jon Czuba and Fatemeh Shacheri

The notebooks can be run locally if user installs Anaconda and the [landlab](#) library on their computer.

Click this button: [Run on EarthscapeHub](#) to open the lessons directly on the EarthscapeHub *explore* instance, which is a service provided by the [OpenEarthscape](#) project.

Note: The EarthscapeHub *explore* instance is password-protected. Please contact the [CSDMS help desk](#) about obtaining a login, or visit [this](#) CSDMS wiki page for more information.

For more information about the NetworkSedimentTransporter, see the [Pfeiffer et al. \(2020\)](#). These notebooks would be well supplemented by the many [Landlab tutorials associated with the NetworkSedimentTransporter](#).

Development of the Landlab NetworkSedimentTransporter has been supported by NSF grants [GLD 2138504](#) and [CSSI 2104055](#).



We'll start with **NST_FlumeExample.ipynb**

Break after notebook 1

Notes of caution for setup

Numerical stability (Courant number...?)

- Signs of instability:
 - Alternating links of aggradation/incision
 - Parcels move multiple links downstream in a single timestep
- Solutions:
 - Decrease timestep
 - Increase link length



What could you do with the NST?

What is on your wish list of improvements or additions to the NST?

discuss with person next to you

