



EPS-01

Exploring gravel bar roughness
as a proxy for flood intermittency in a
natural channel



IMPACT

- Rivers shape topography over time
 - Erosion affects agriculture, drinking water, and shapes habitats
- Predicting erosion
 - Difficult because the arrangement of sediment grains is complex

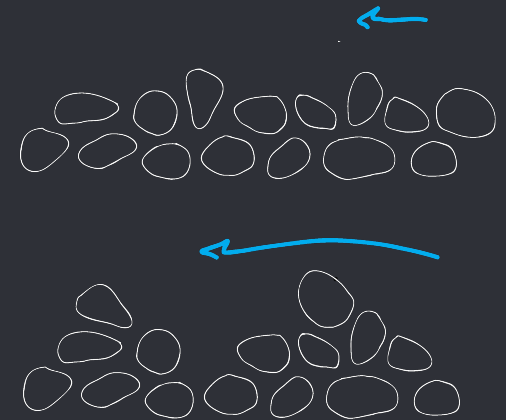
BACKGROUND

Interplay between grain protrusion and sediment entrainment in an experimental flume

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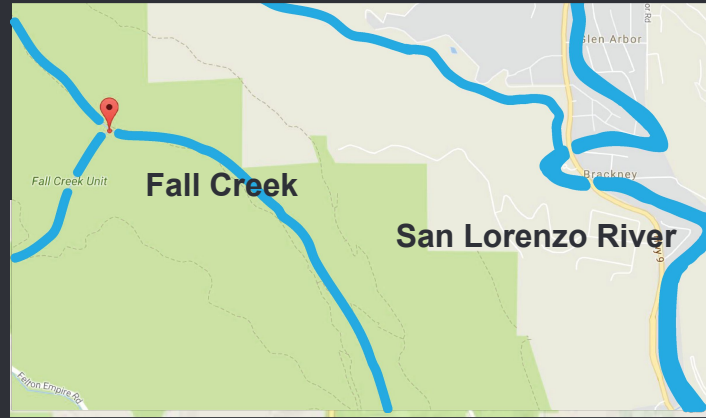
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- Lower flow = smoother bed
 - less erosion
- High flow = rougher bed
 - more erosion

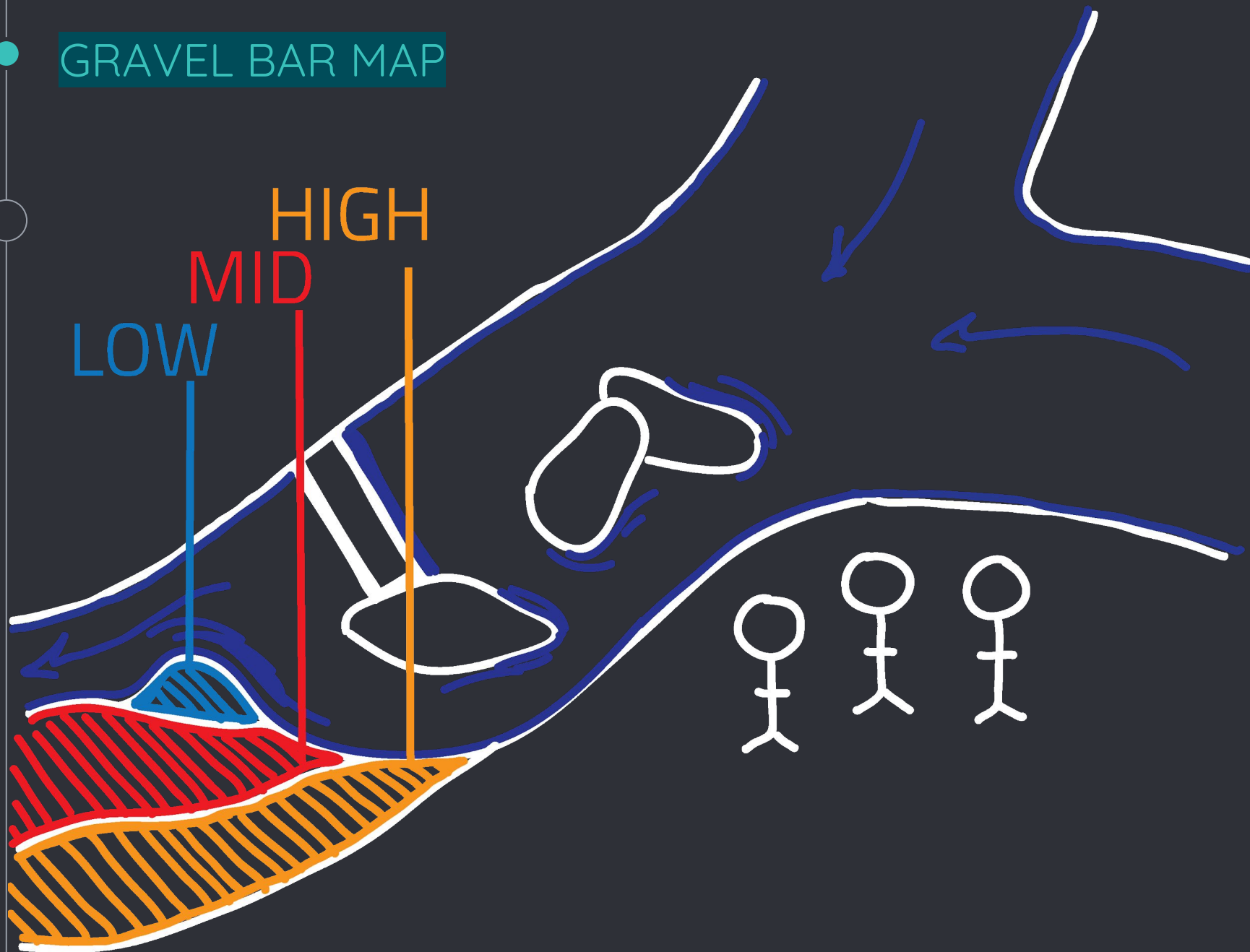
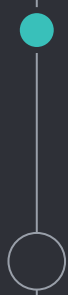


Is this true in a natural river?

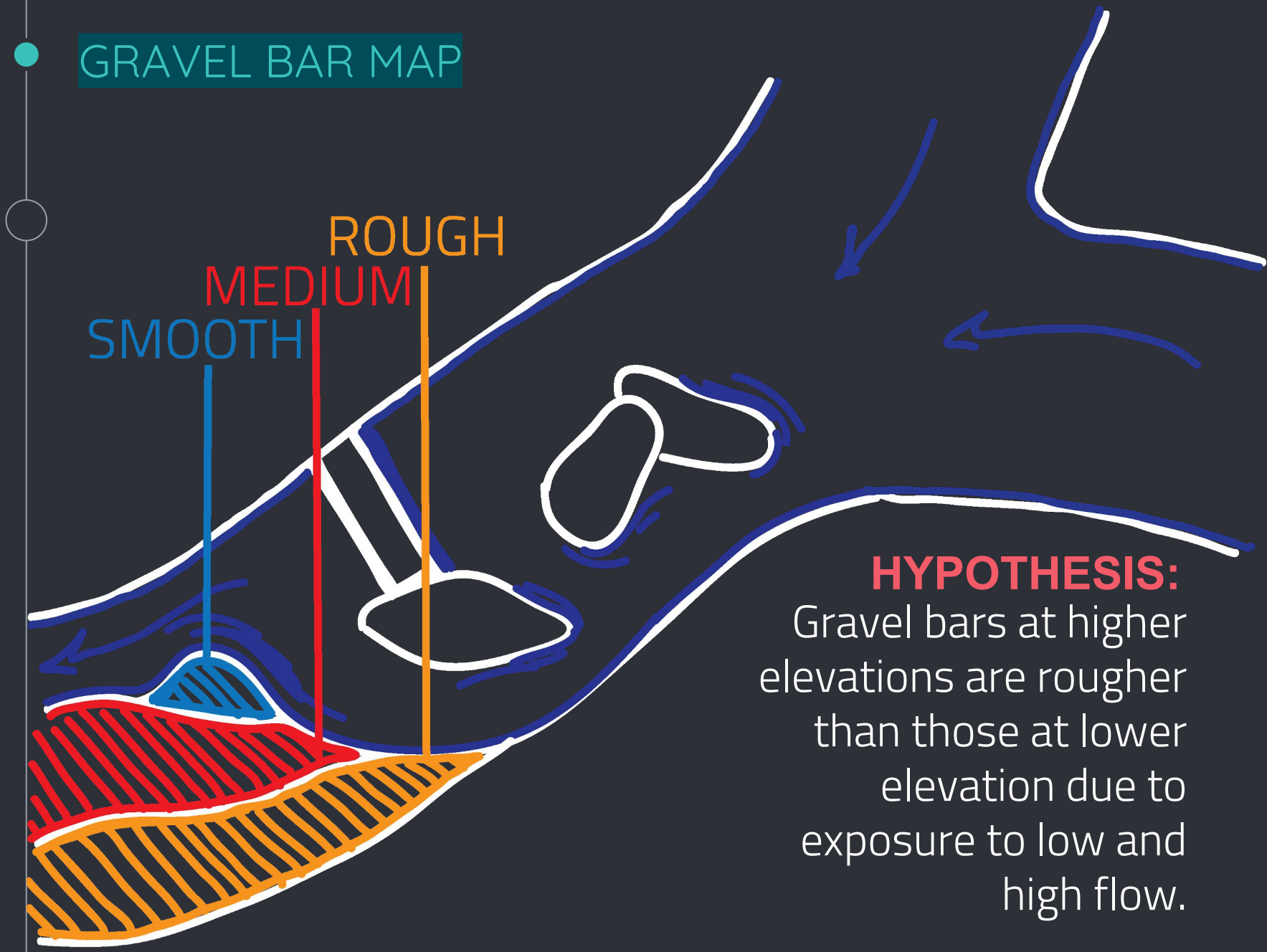
FIELD SITE



GRAVEL BAR MAP



GRAVEL BAR MAP

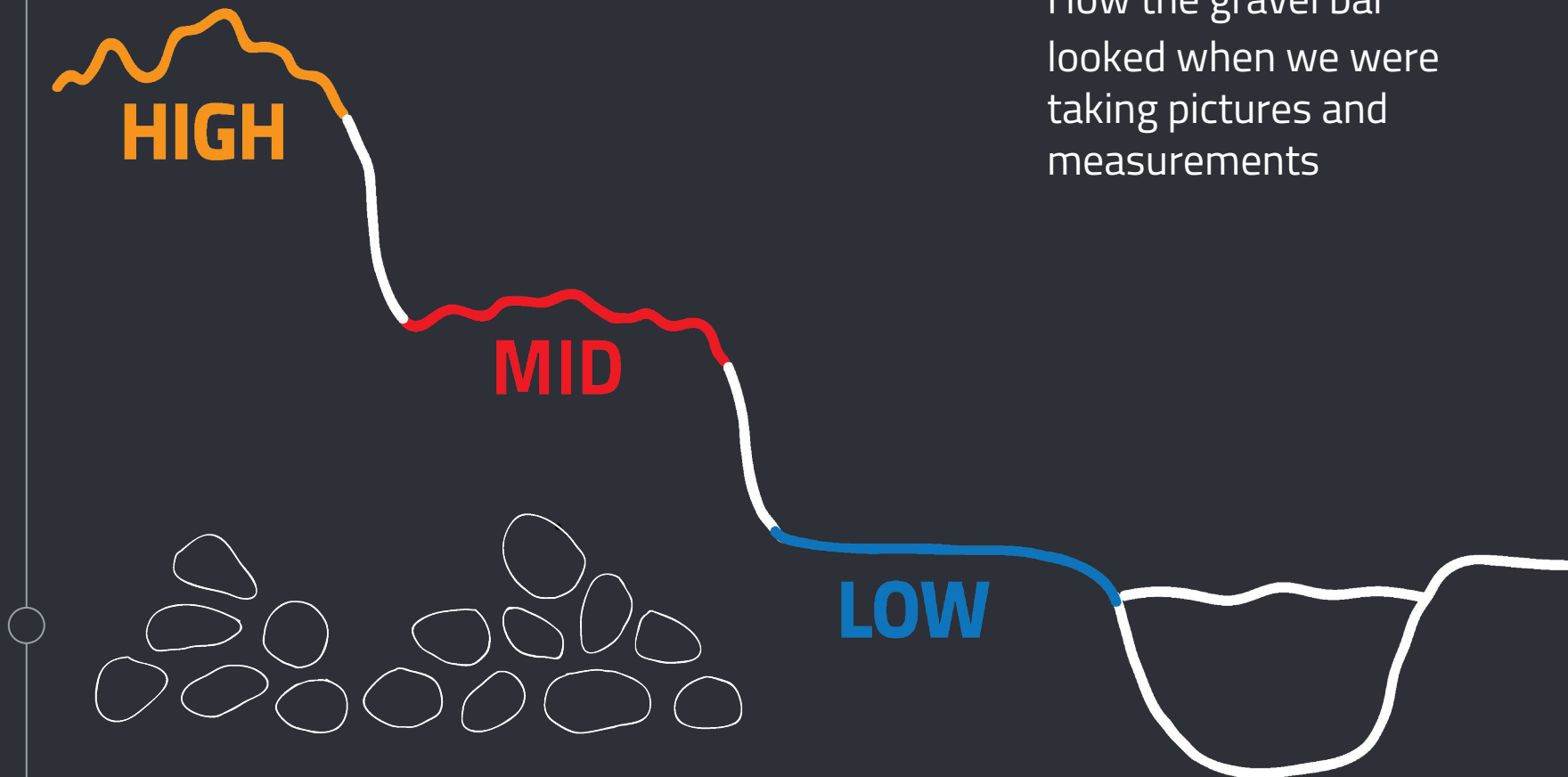


HYPOTHESIS:

Gravel bars at higher elevations are rougher than those at lower elevation due to exposure to low and high flow.

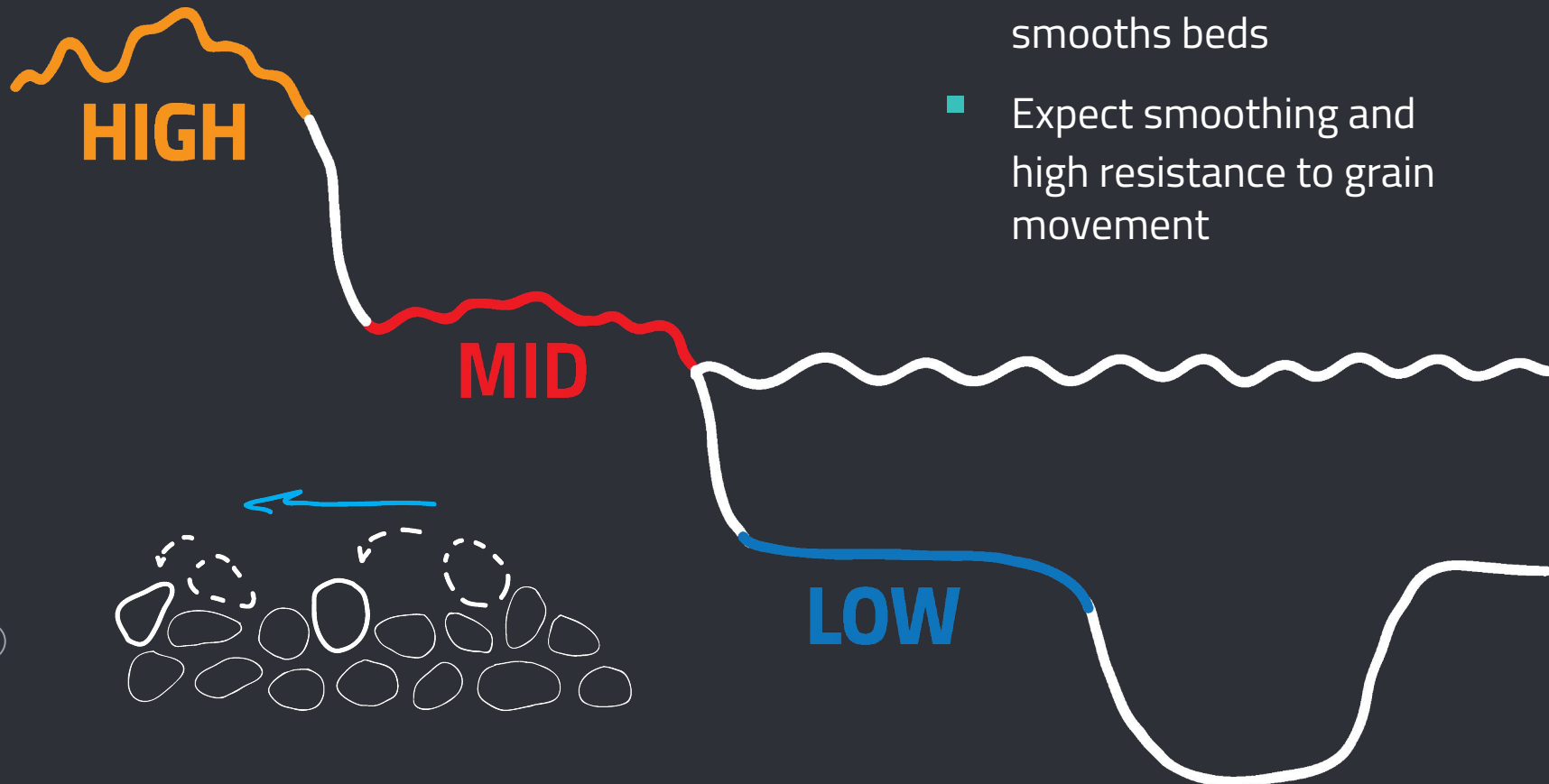
Fall Creek - Base Flow

- Low flow
- No movement
- How the gravel bar looked when we were taking pictures and measurements

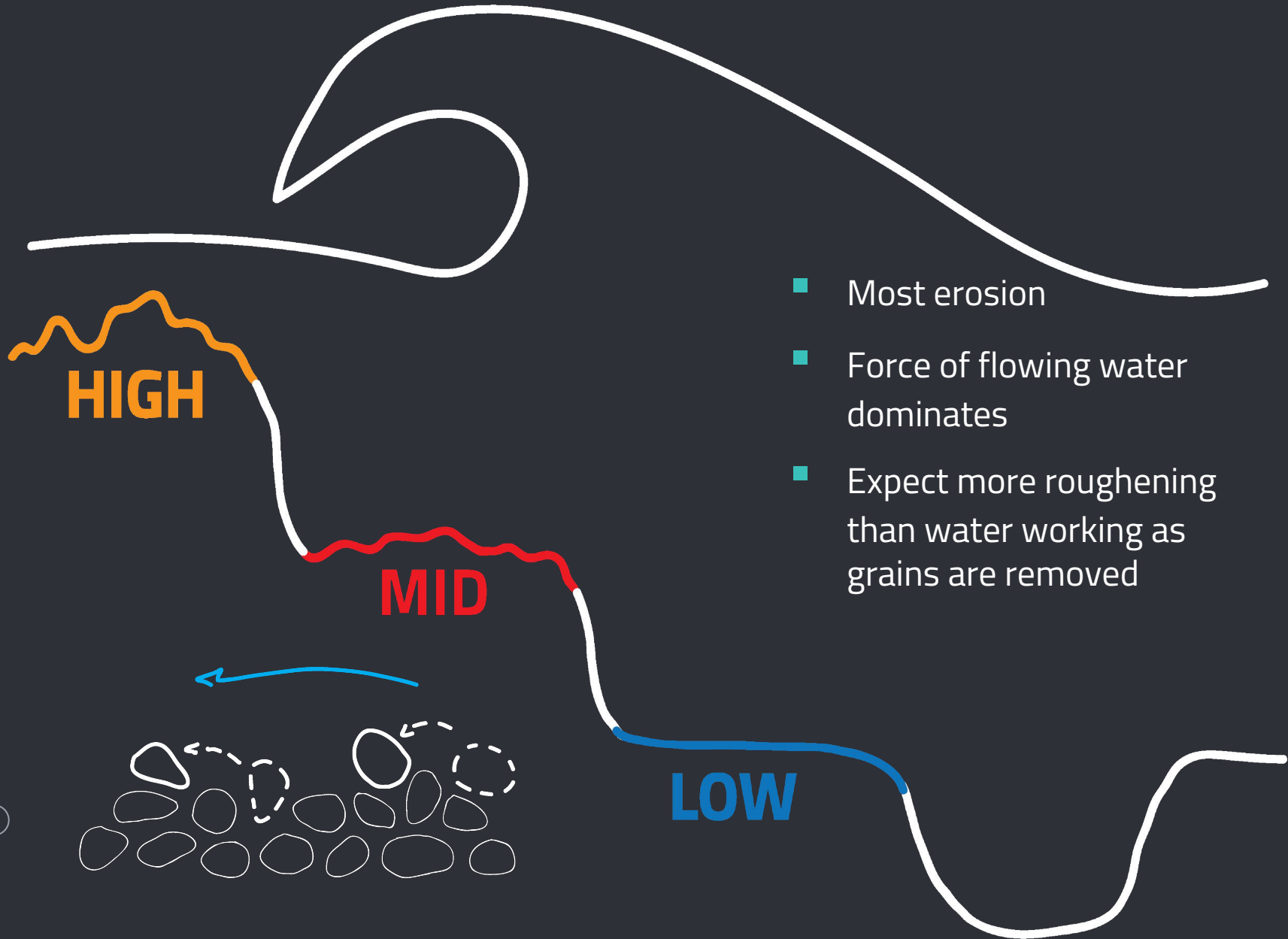


Fall Creek - Small Floods

- Force of gravity dominates
- Intermittent transport smooths beds
- Expect smoothing and high resistance to grain movement



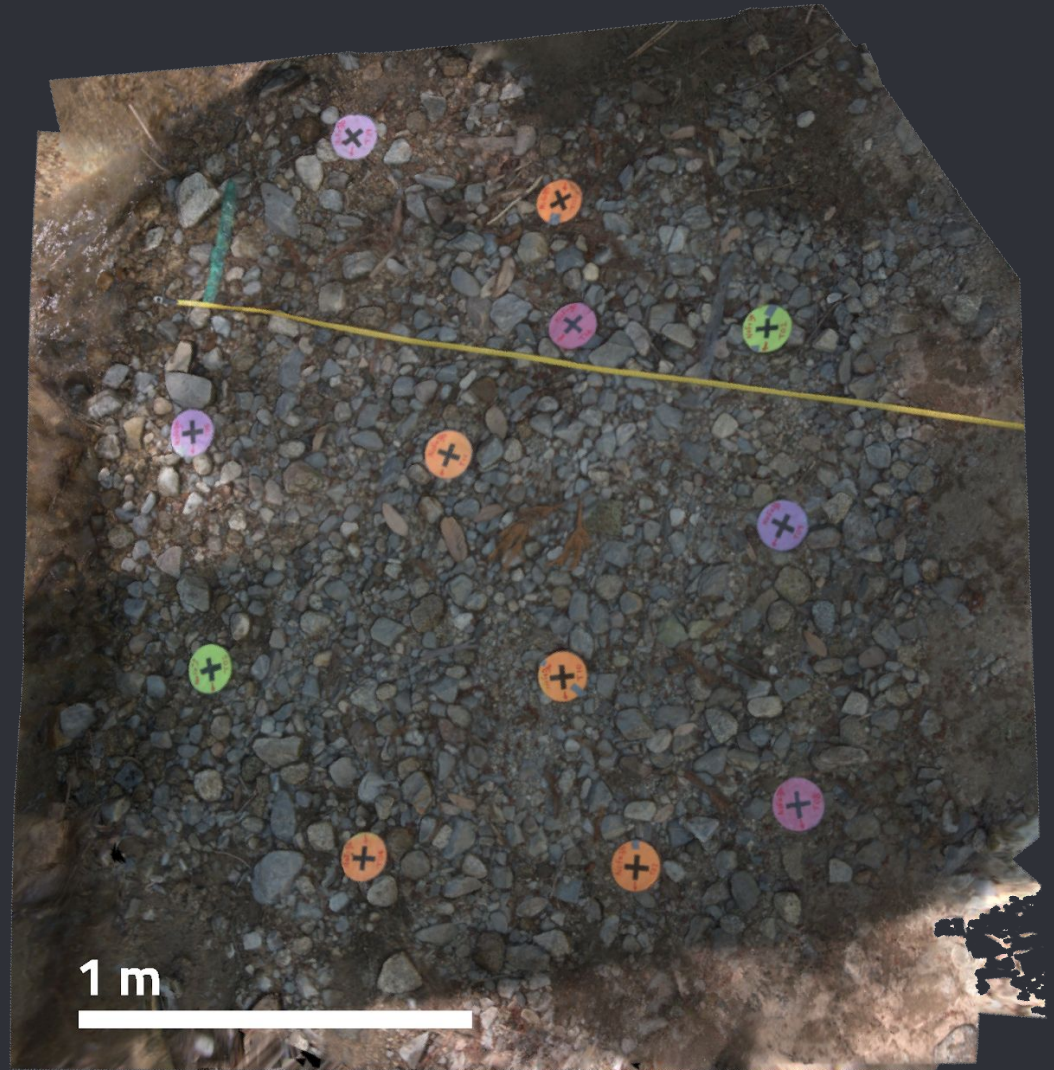
Fall Creek - Large Floods



SETUP FOR MEASURING ROUGHNESS

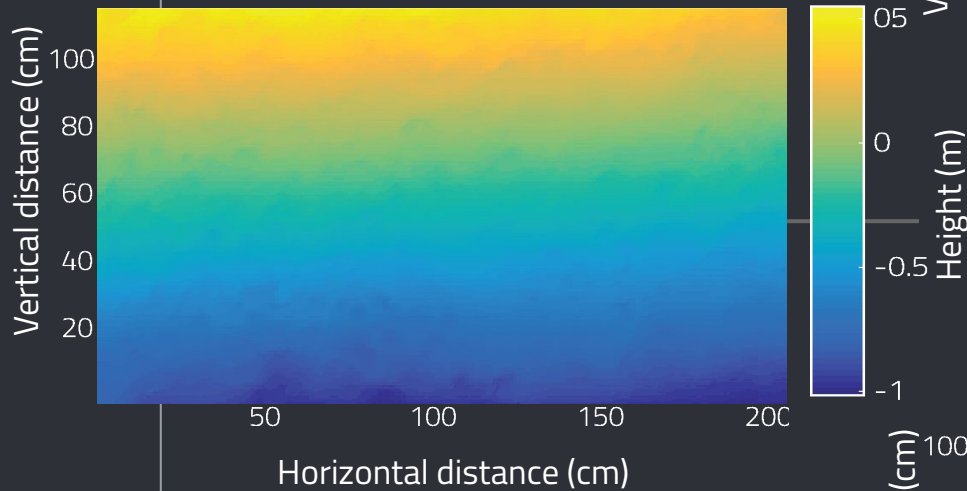
Structure from Motion

- Powerful software that uses digital photos to generate high resolution 3D model
- Use SFM to make precise measurements of gravel bar topography on grain-scale
- Also used photos from field to measure grain size

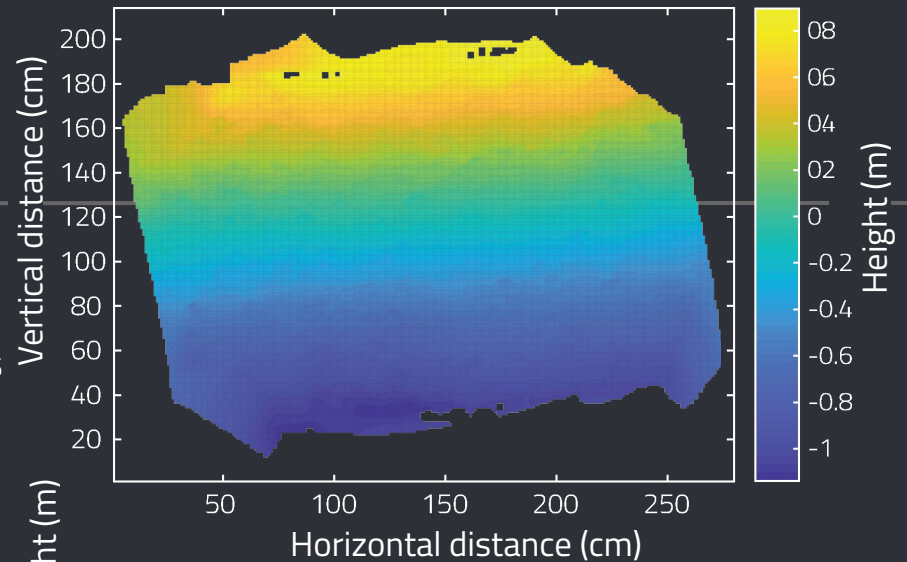


INITIAL ANALYSIS

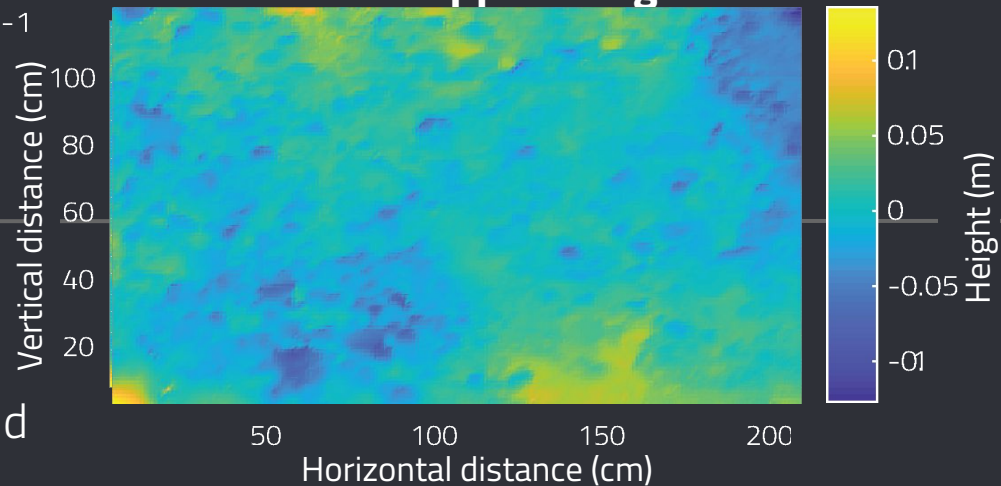
Cropped Height Grid



Height Grid



Detrended Cropped Height Grid

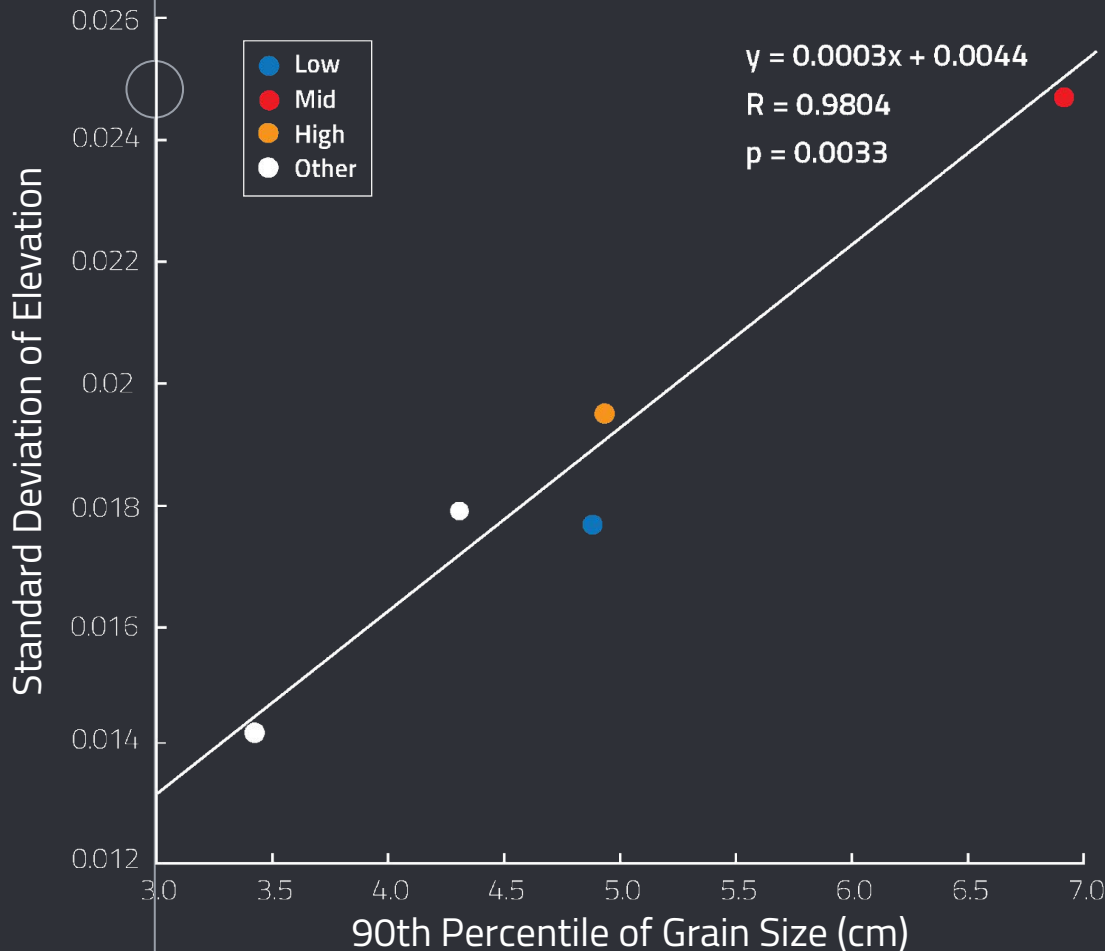


Plotting in MATLAB

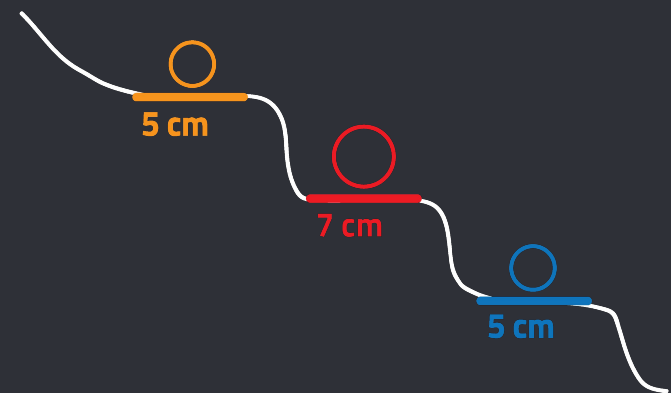
- Crop data
- Detrend by removing slope and intercepts

ROUGHNESS VARIES WITH GRAIN SIZE

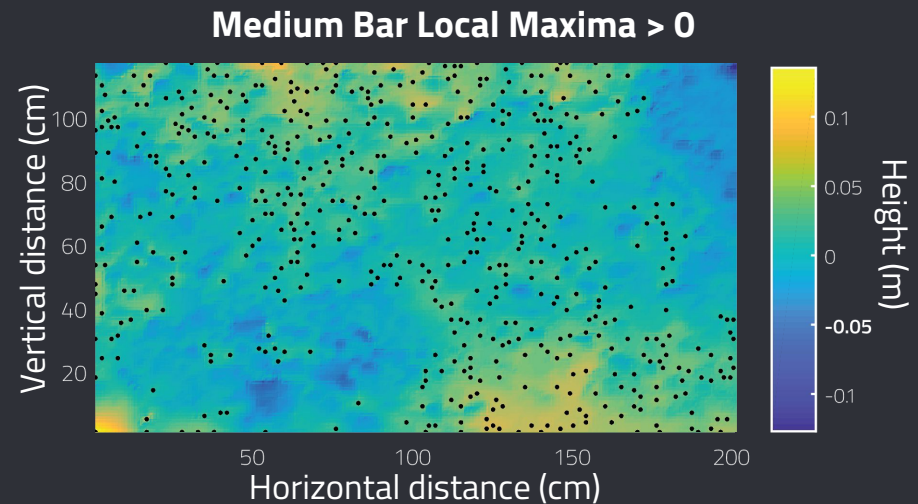
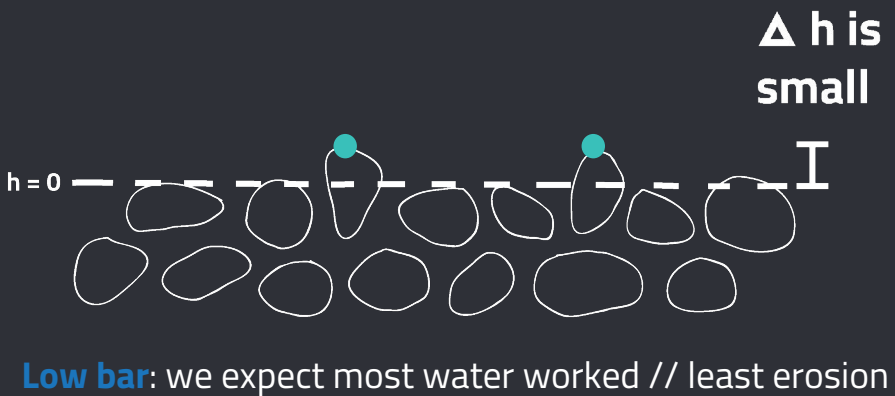
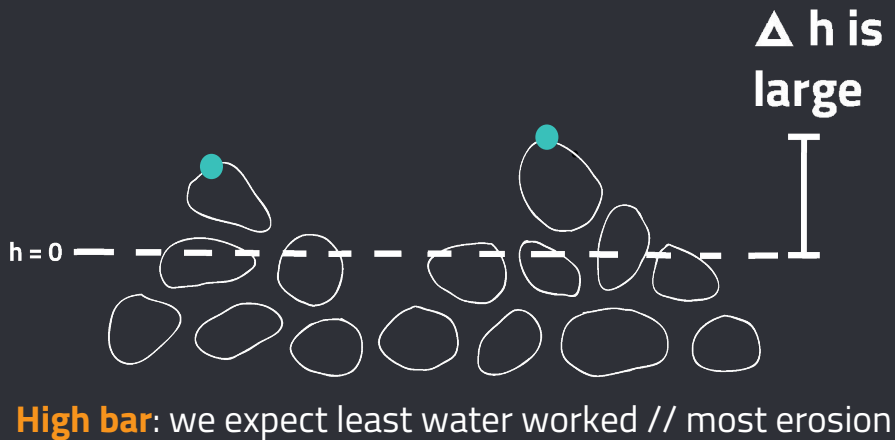
Standard Deviation of Elevation vs. D90



- Grain size contributes to roughness
- Larger grain size = rougher bed
- Scale by grain size to isolate effects not due to grain size

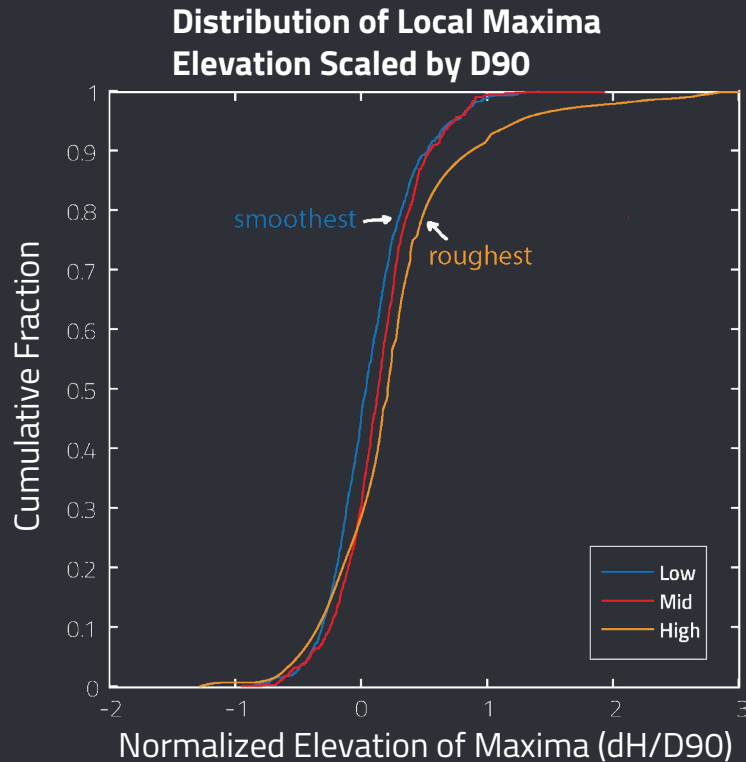


RESULTS: LOCAL MAXIMA



- More water working = fewer unstable grains = less erosion
- More water working = fewer high protruding, unstable grains (Masteller & Finnegan, 2017)

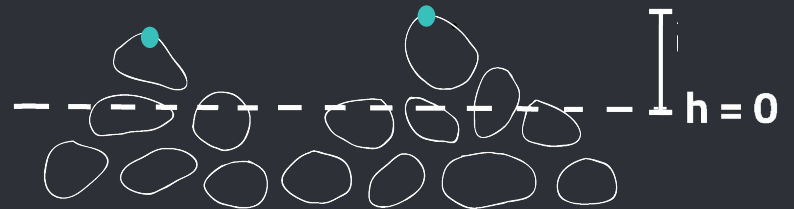
RESULTS: ROUGHNESS SCALES WITH BAR ELEVATION



- Narrow range = smoother



- Broader range = rougher



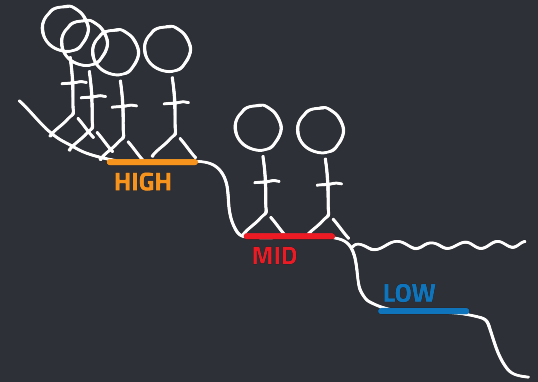
- Roughness increases with elevation from the river
- Biggest floods erode disproportionately because there are more unstable grains

CONCLUSION

- **Hypothesis:** gravel bars at higher elevations are rougher than bars at lower elevations
- **Results:** roughness varies with -
 - Grain size
 - Bar elevation
- **Impact:** Biggest floods do disproportionate amounts of erosion
 - increased water working increases river stability and resistance to erosion



FUTURE PLANS



- Field work at Fall Creek
 - Take measurements of actual stream flow and water elevation
 - Help us understand previous data
- Field work at other channel systems
 - Roughness results from water flow patterns
 - Determine if similar results can be seen in different rivers with different environmental conditions



THANKS
FOR
LISTENING!