Photogrammetry techniques to investigate river processes and vegetation management methods.

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river science

Introduction

Flow regulation and water abstraction

- ↓ reduces river dynamics,
  - ↑ increases vegetation encroachment,
    - and alters habitat

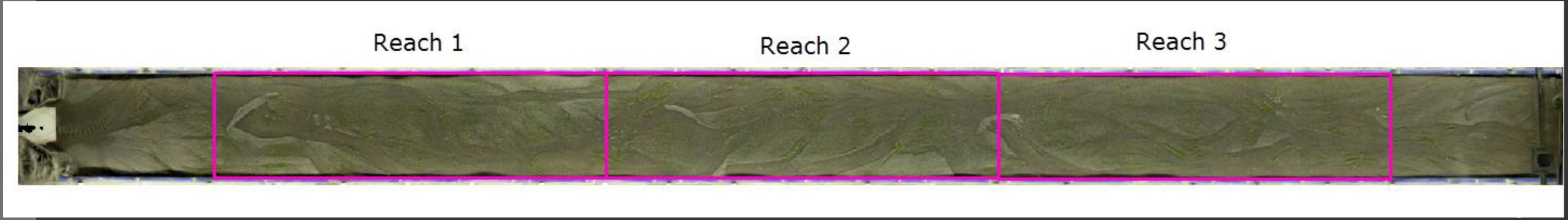
Flood events can

- reconnect floodplain dynamics,
  - regulate invasive vegetation,
    - and recreate habitat.

Experiments

- Quantify how rivers control vegetation through morphological process
  - Can this be manipulated?

- Experiments at University of Trento
  - Flume: 24 x 1.6 m
  - Braided river: 1% slope, sediment D_{50} 1 mm
  - Vegetation: Arugula (*Eruca sativa*) 1.1 cm tall.
  - Flow rates: low, medium, high

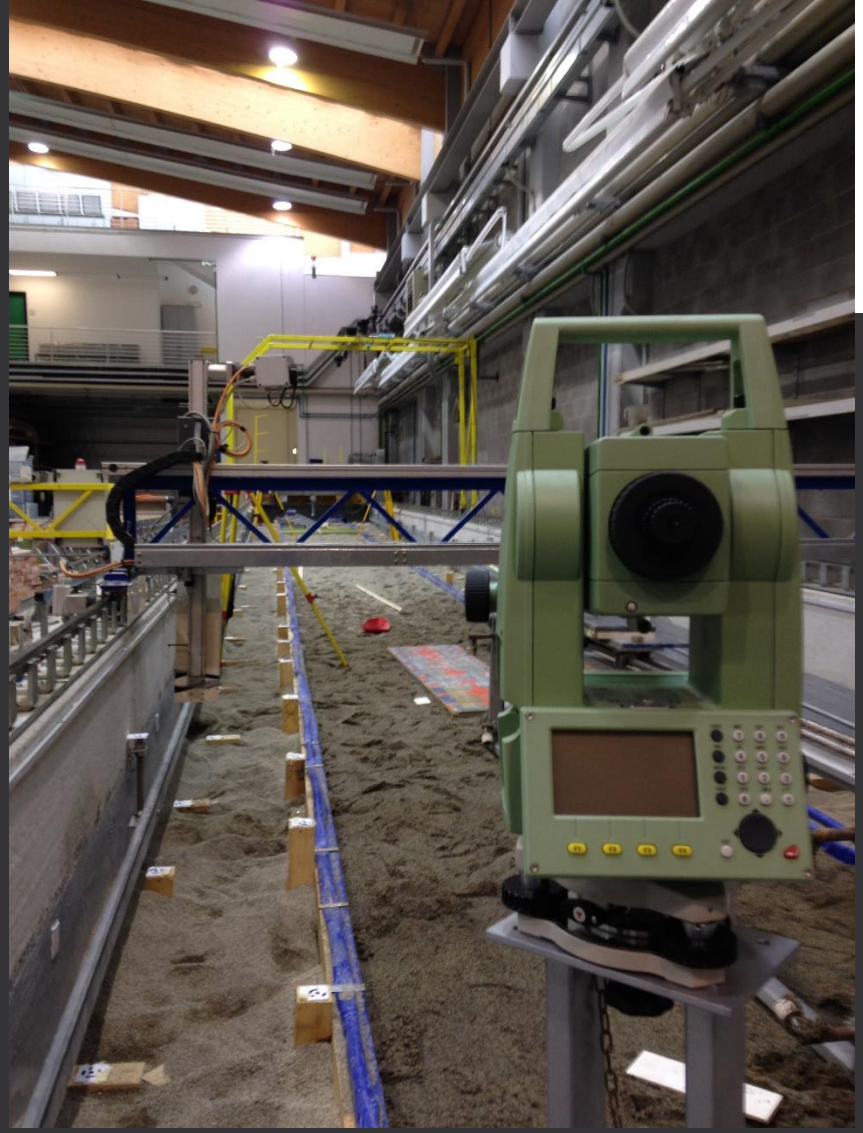


Challenges

- Quantify subtle morphologic changes (millimeter accuracy and resolution)
- Bed elevation – bathymetry
- Fast data acquisition (highly mobile bed)
- Repeat surveys, low cost

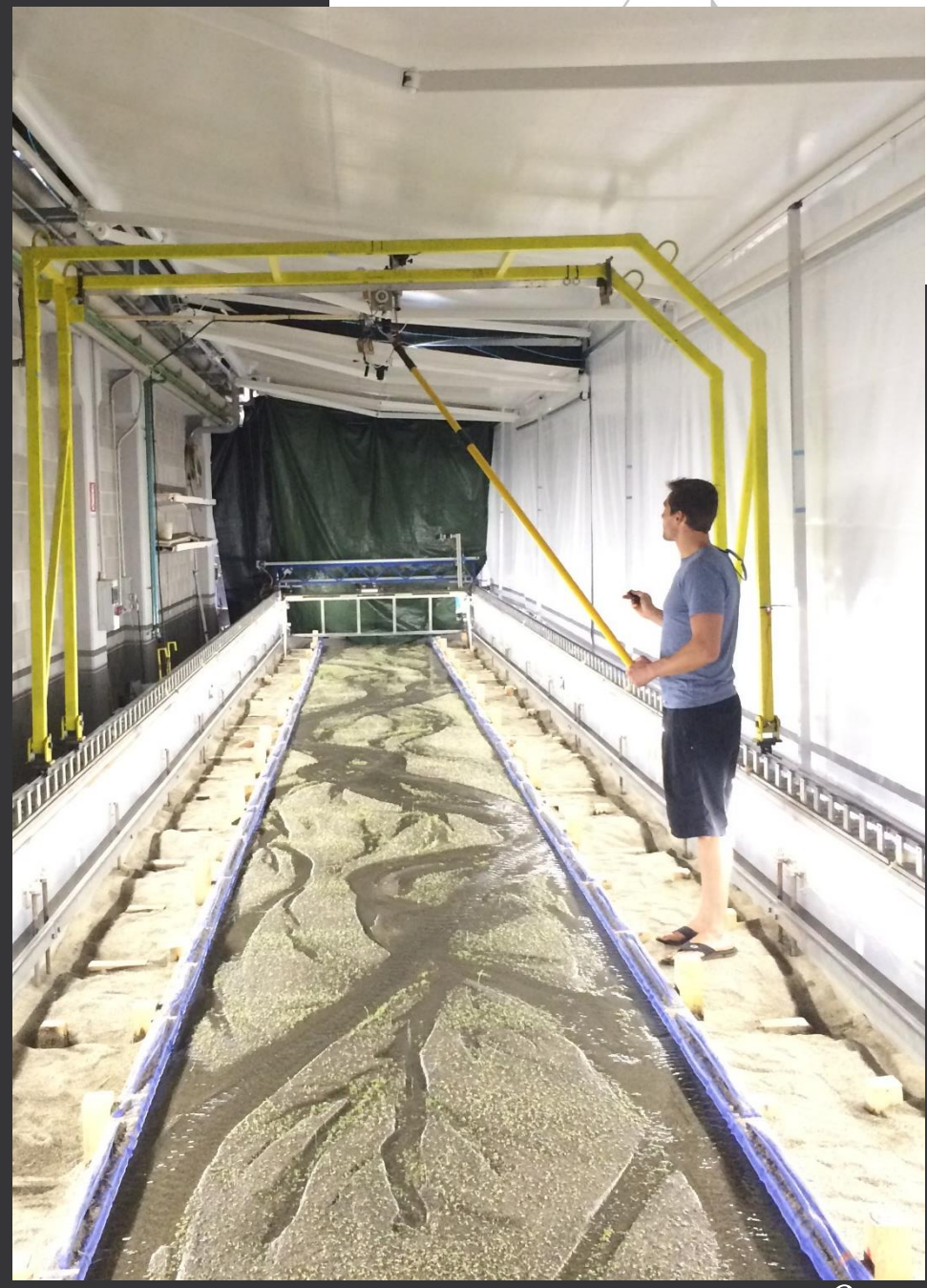
Methods

- Photogrammetry - **Structure-from-Motion (SfM)**
  - Millimeter accuracy
    - Total station & redundant survey
  - Bed elevation – bathymetry
    - Refraction correction



Methods

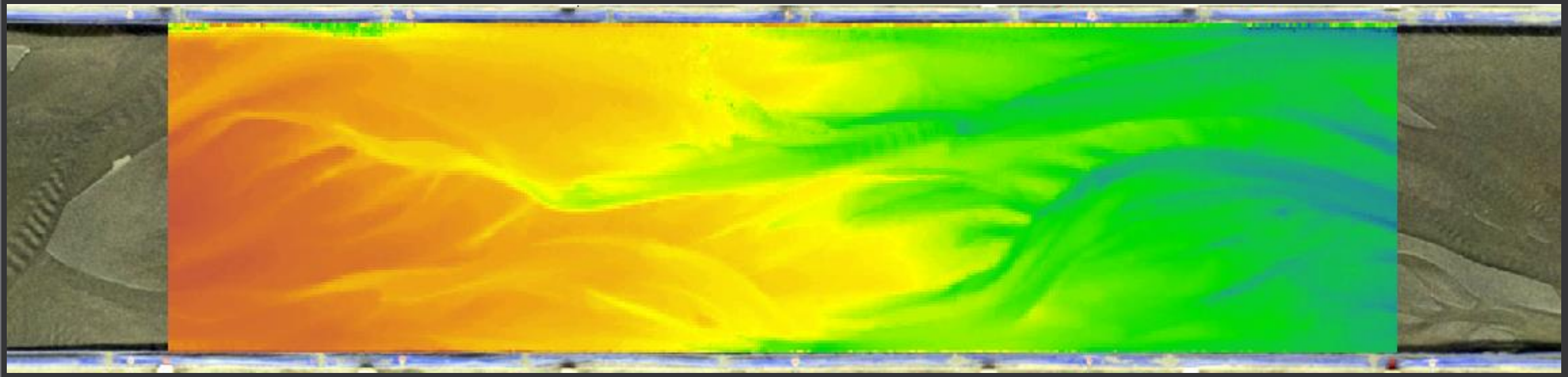
- Photogrammetry - **Structure-from-Motion (SfM)**
  - Fast data acquisition (highly mobile bed)
    - Coded targets & Track system
  - Repeat surveys, low cost
    - Yes!



Methods

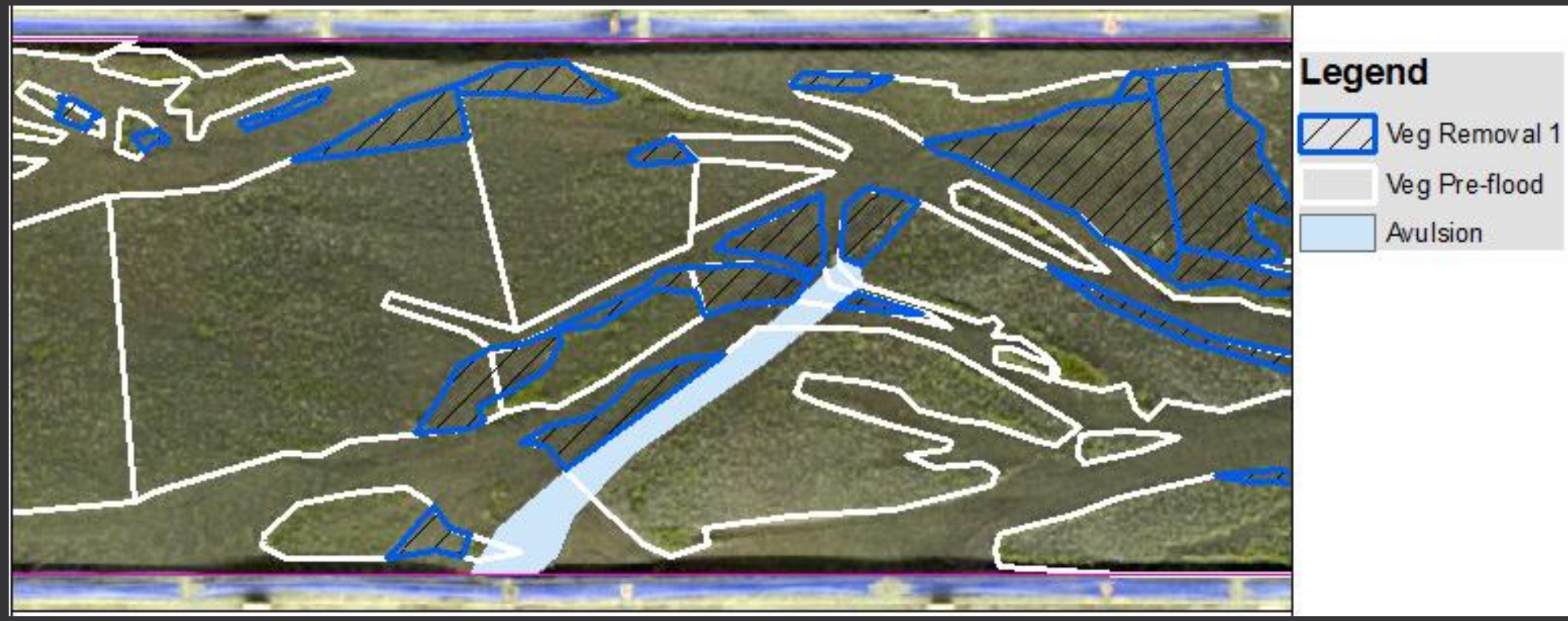
- Quantify vegetation and morphology changes
  - Produced DEMs: z errors 2 mm
  - Orthoimagery: 0.5 mm resolution

Javernick L, Brasington J, Caruso B. 2014. Modelling the topography of shallow braided rivers using structure-from-motion photogrammetry. Geomorphology213(0):166–182.DOI:10.1016/j.geomorph.2014.01.006



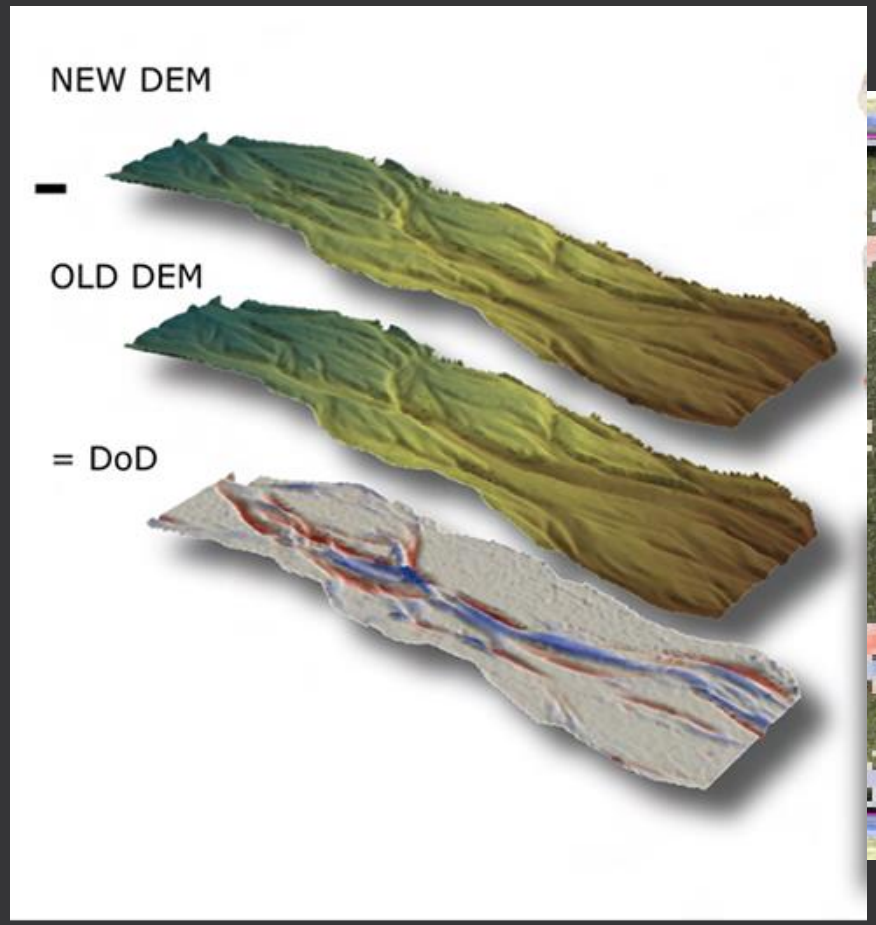
Methods

- Mapping vegetation removal
  - Manually mapped



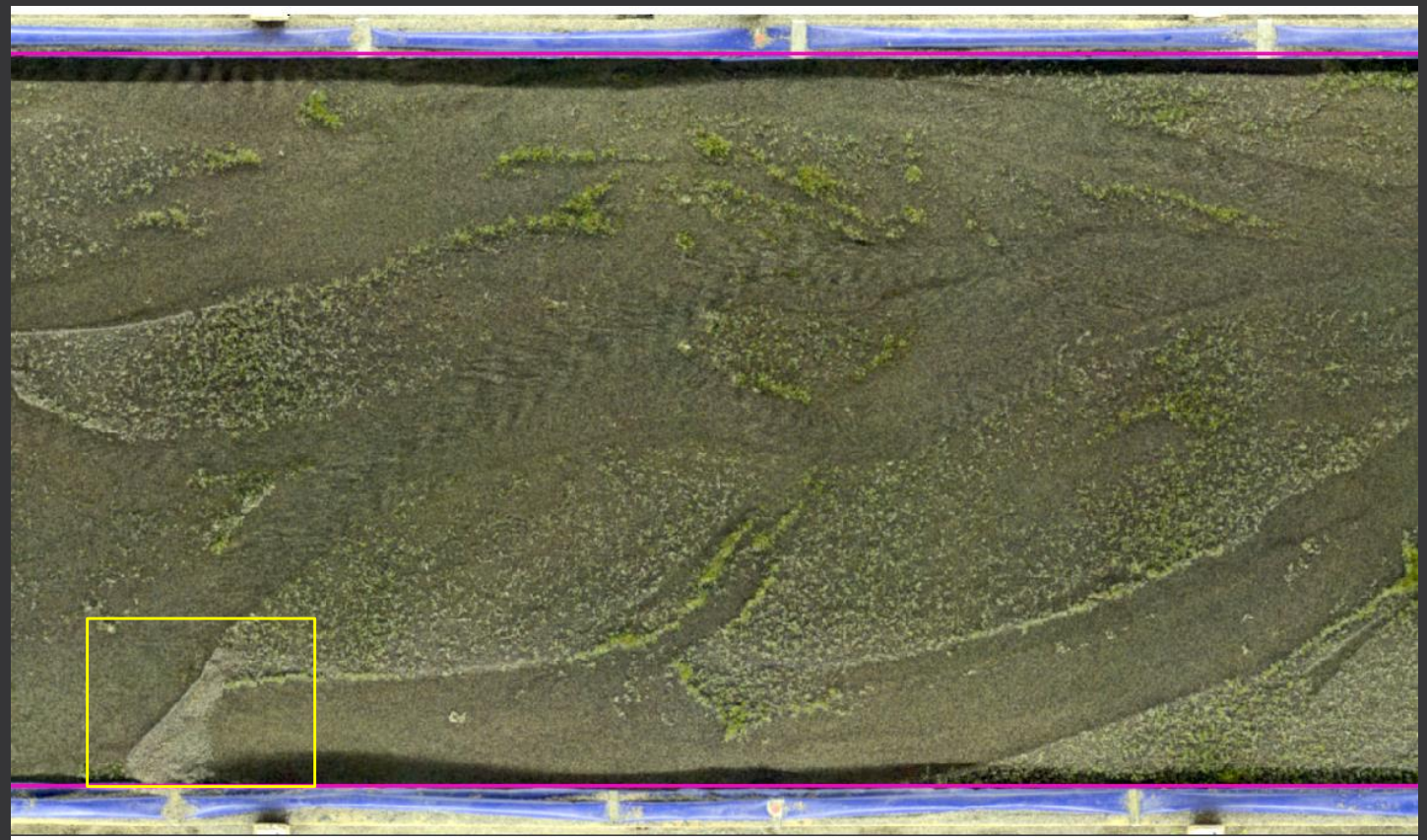
Methods

- Morphological changes
  - Geomorphic Change Detection Toolset (version 6.1.14)



Methods

- Channel manipulation
  - Subtle and single channels



Methods

- Channel manipulation
    - Aggressive and multiple channels

Methods

- **Manipulation classification (natural and manipulated):**
  - **A:** Major adjustments: main channel shift
  - **B:** Minor adjustments: anabranch shift or redistribution
  - **C:** No adjustments

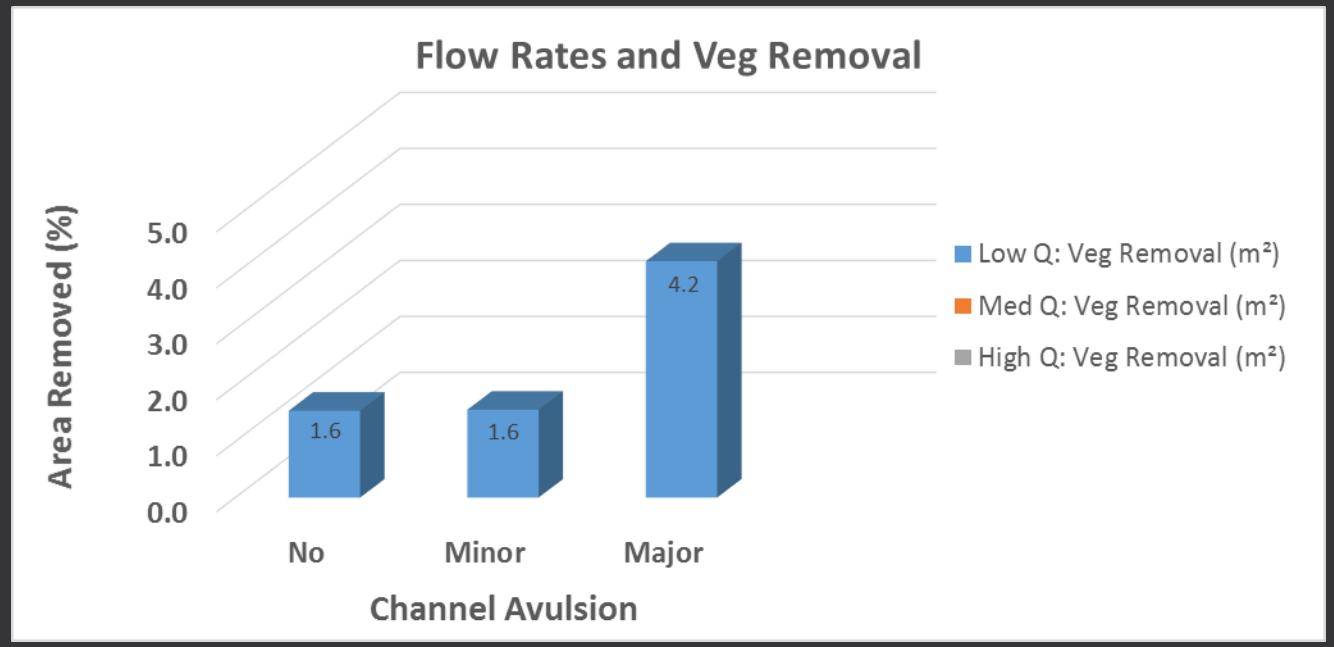
Results

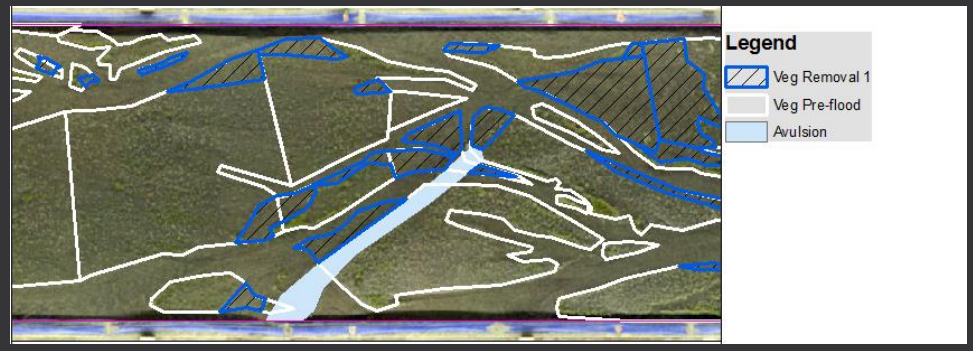
- Number of experiments
  - Sample size: 135 (45 each Q)
    - No manipulation: 64
    - Minor manipulation: 50
    - Major manipulation: 21

Results/Discussion

Vegetation removal

- Low Q:
  - Major is significantly greater.

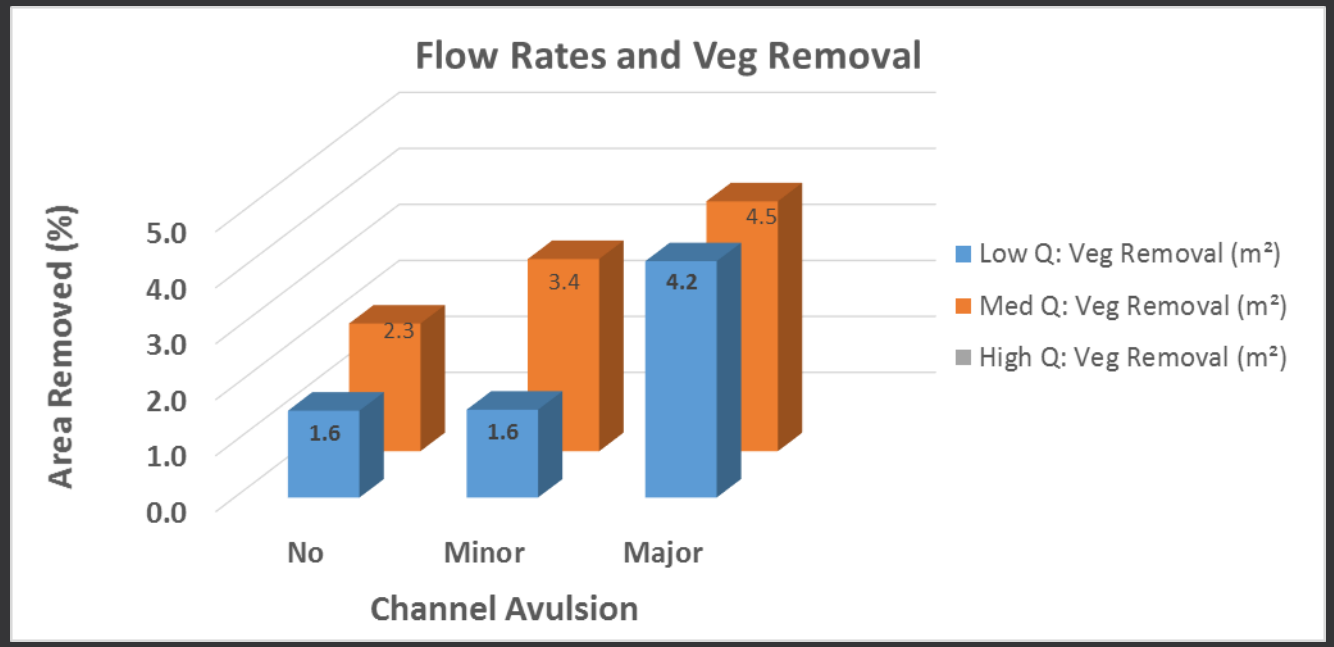


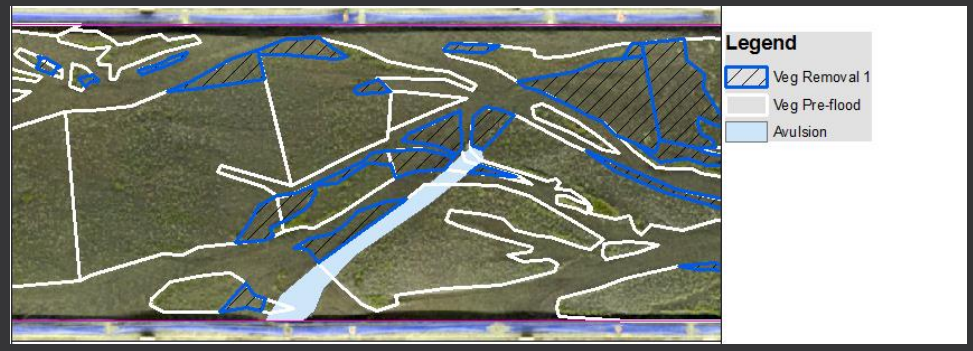


Results/Discussion

Vegetation removal

- Low Q:
  - Major is significantly greater.
- Medium Q:
  - Steady increase

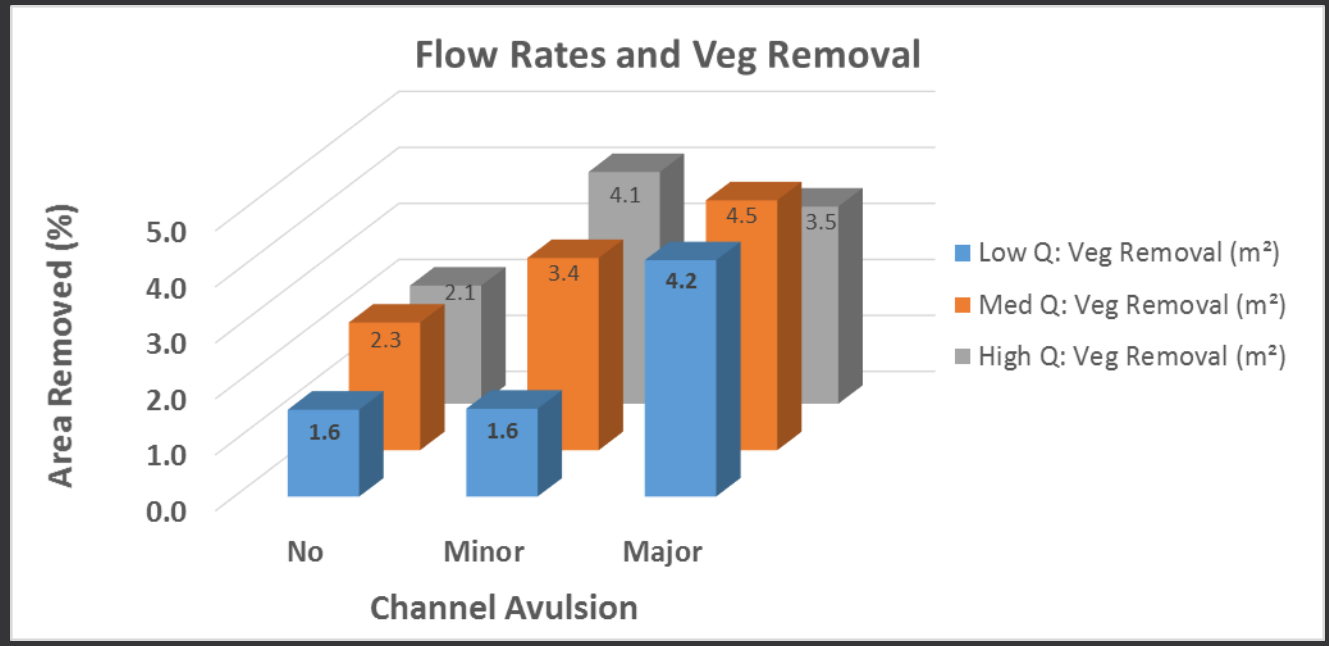


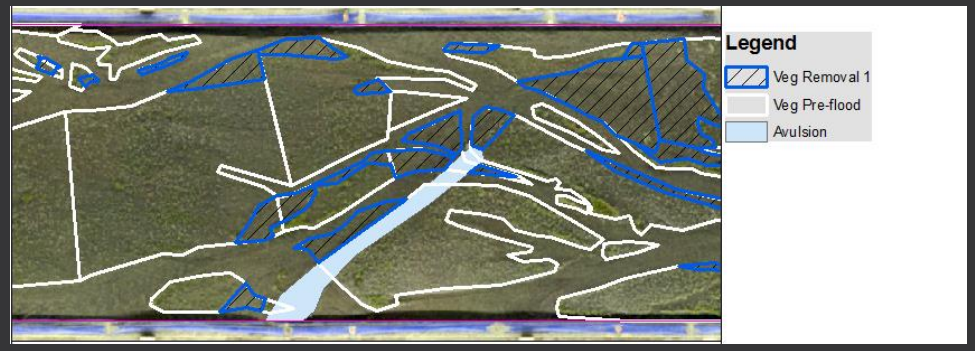


Results/Discussion

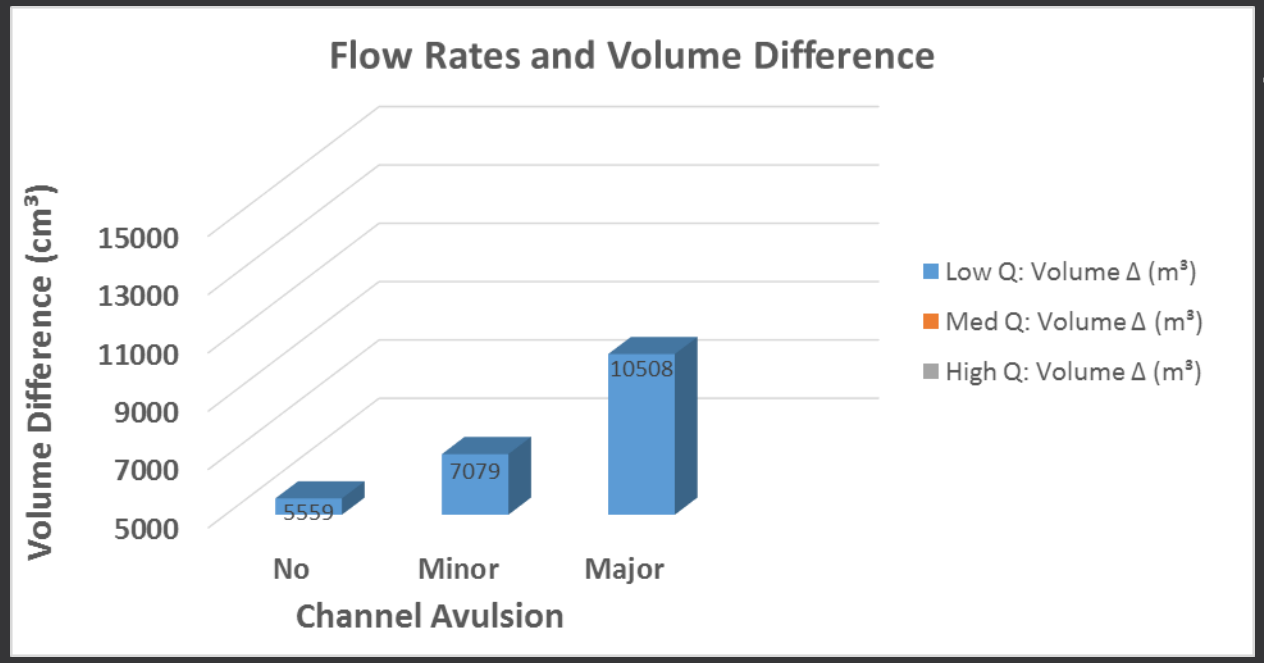
Vegetation removal

- Low Q:
  - Major is significantly greater.
- Medium Q:
  - Minor & Major Comparable
- High Q:
  - Minor & Major greater
  - Major dataset has small sample (3)
- All Datasets vegetation removal:
  - Low Q with major avulsion is greater than larger floods with and without avulsion



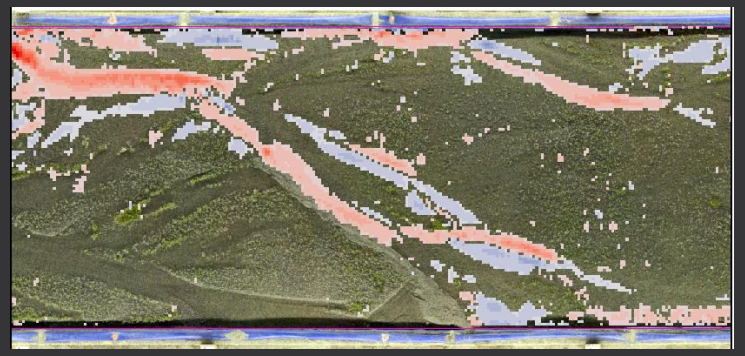


Results/Discussion

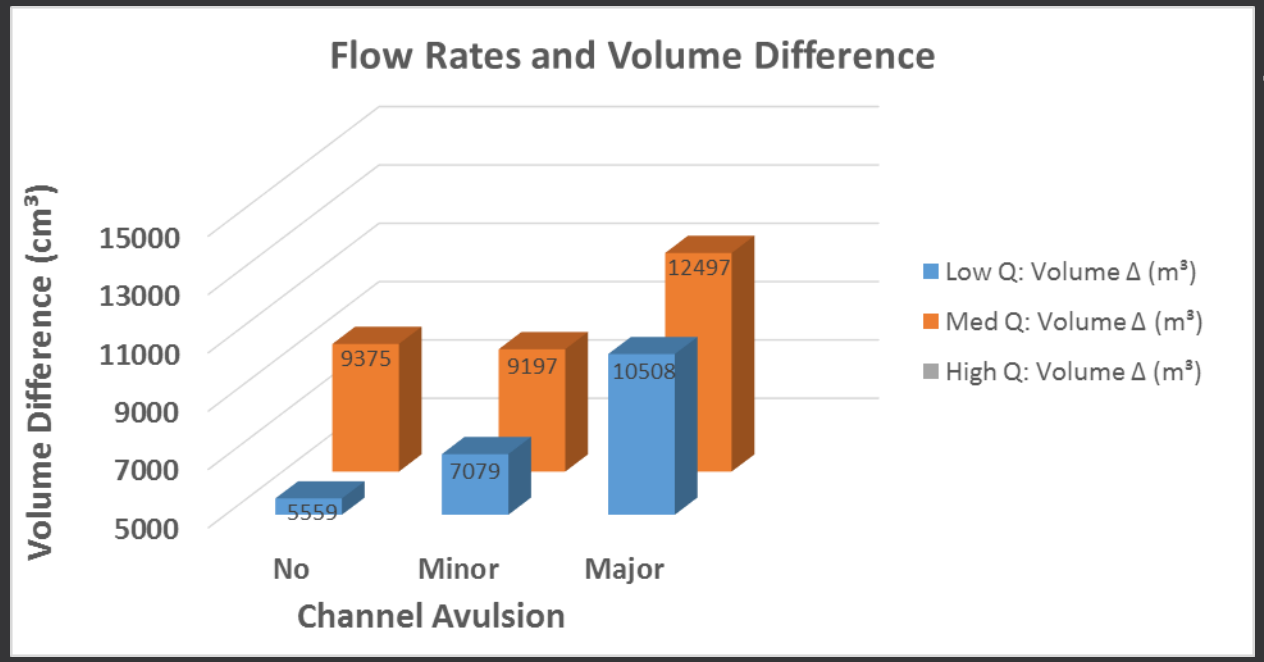


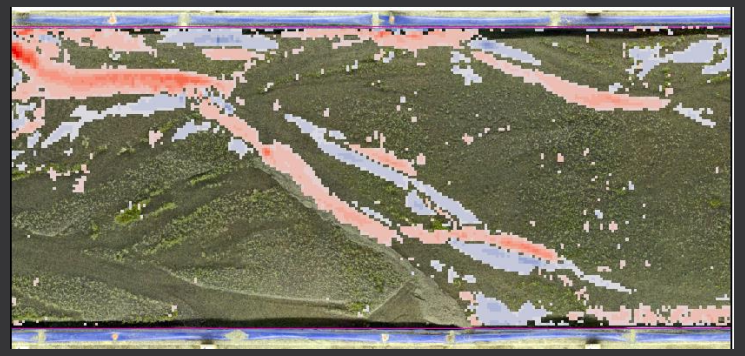
<u>Morp. Volume Changes</u>

- Low Q:
  - Steady increases in changes



Results/Discussion

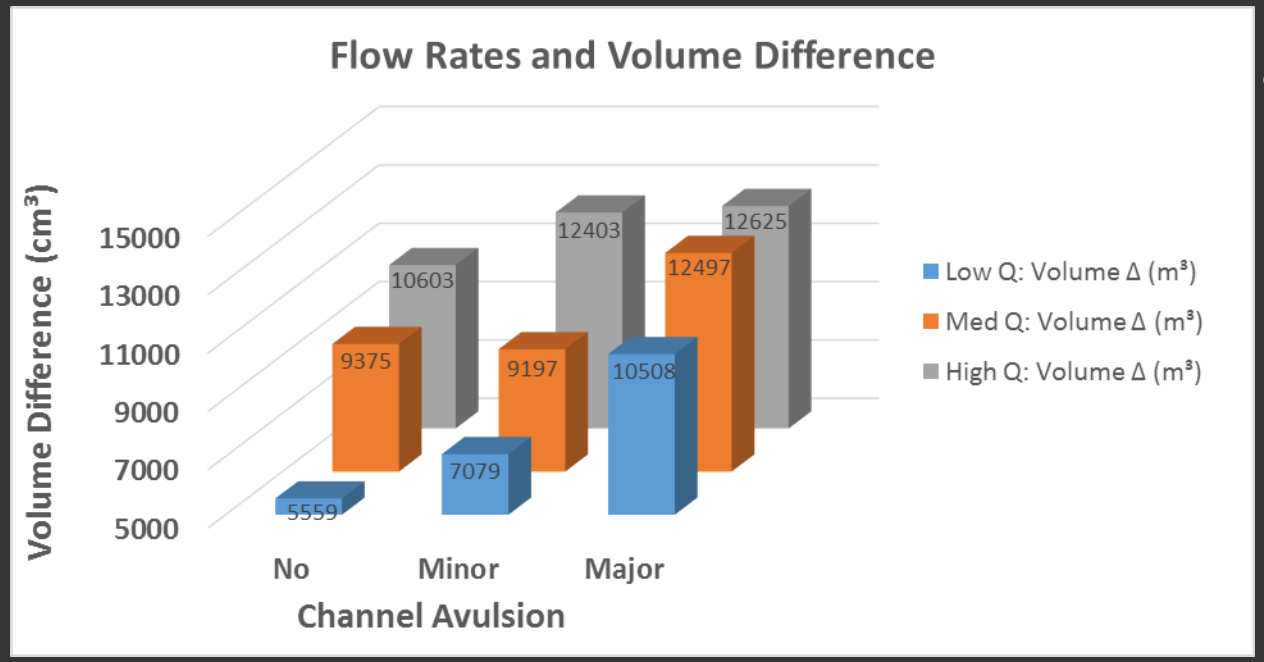


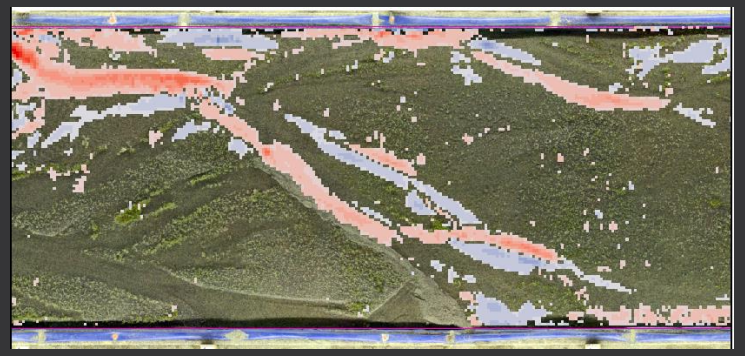


Morp. Volume Changes

- Low Q:
  - Steady increase in changes
- Med Q:
  - Major shows a significant increase

Results/Discussion





Morp. Volume Changes

- Low Q:
  - Steady increase in changes
- Med Q:
  - Major shows a significant increase
- High Q:
  - Minor and Major comparable
- All Datasets:
  - > Q = > volume difference
- Low Q, with major avulsion
  - Comparable to higher Q's without avulsion.

Conclusion

- **Remote sensing techniques**
  - SfM provided fast, accurate, and low-cost data.
    - Able to quantify and monitor vegetation and morphological changes

- **Vegetation management**
  - Vegetation dynamics are highly variable and depends on local morphological changes and bank erosion.
  - Small floods with manipulation had similar vegetation removal and morphologic changes as large floods without manipulation.

Questions?

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References:

Bertoldi, W. (2012). Life of a bifurcation in a gravel-bed braided river. *Earth Surface Processes and Landforms*, 37(12), 1327–1336. doi:10.1002/esp.3279

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Kleinhans, M.G., Ferguson, R.I., Lane, S.N., & Hardy, R.J. (2013). Splitting rivers at their seams: Bifurcations and avulsion. *Earth Surface Processes and Landforms*, 38(1), 47–61. doi:10.1002/esp.3268

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