Using remote sensing techniques to extract bathymetry from gravel bed streams in a mountain drainage basin

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Bathymetry data: why is it important?

- Basic descriptor of channel morphology
- Adjusts in response to fluctuations and disturbances
- Controls location of channel units

Woodget et al., 2014; Dietrich, 2015
Current surveying techniques

• Lower spatial resolution

• New applications demand higher resolution data
  • Geomorphic change detection
  • Physical habitat modeling
  • 2D hydraulic modeling
  • Sediment budgeting
  • Restoration monitoring

Woodget et al., 2014; Dietrich, 2015
Remote sensing & bathymetry data

- **Structure-from-Motion (SfM)**
- **Equipment**
  - Camera
  - GPS
Salmon River, Oregon
Field Work: Photo acquisition

• DJI Phantom Pro III
  • 12 megapixel
  • 3-axis gimbal

• Camera angle off-nadir
  (James and Robson, 2014)
Field Work: RTK-GPS

- 30 Ground control points placed, 24 used in processing
- Cross sections (175 in channel points)
Results

SfM processing

- 0.4 cm orthophoto
- 1.5 cm DEM (digital elevation model)
Diagram of light refraction in water

\[ h_a = n \times h_p \]
where ‘n’ is a refraction coefficient

\[ 1.34 = 1.34 \times 1 \]

Diagram developed from Woodget et al., 2014
Water surface

Edge-of-water elevations

- GPS cross section data
- Extracted from DEM

1.5 cm DEM
Corrected Bathymetry

Elevation

- 337.4 m
- 333.2 m
Comparison of Channel Bathymetry along Cross Section A

Elevation (m) vs. Distance (m) for RTK-GPS and Corrected, Predicted Water Surface levels.
Actual vs. Corrected Water Depths

$R^2$

0.76 - glide
0.48 - riffle
0.56 - pool
Limitations and Considerations

• White water or turbid water

• Depth limit

• Light and shadow

• What is the appropriate refraction coefficient?

• Number of validation points necessary?
Time and Cost comparison

• 500 meter reach
• Field work: ~ 2 – 3 days
• Post processing: ~5 – 7 days

• Might take longer, but results include:
  • High resolution orthophoto and DEM
  • Spatially continuous data set
Summary

• Remote sensing techniques have great potential to extract bathymetry
• SfM can produce accurate bathymetry data sets in shallow, clear streams
• Develop guidelines for application
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