

# Airborne and UAV-borne Laser Bathymetry applied on a mountain river reach

Theresa Himmelsbach<sup>1</sup>, Jan Rhomberg-Kauert<sup>2</sup>, Gottfried Mandlbauer<sup>2</sup>, Wolfgang Dobler<sup>1</sup>, Bernhard Gems<sup>1</sup>, Markus Aufleger<sup>1</sup>

<sup>1</sup> Unit of Hydraulic Engineering, Faculty of Engineering Sciences, University Innsbruck, Austria

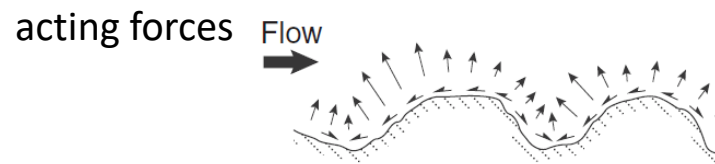
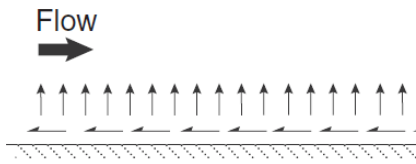
<sup>2</sup> Department of Geodesy and Geoinformation, TU Vienna, Austria

**3D underwater mapping from above and below**

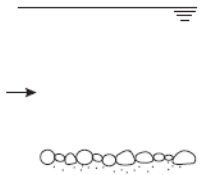
3<sup>rd</sup> International Workshop  
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# What distinguishes mountain rivers from other river types?

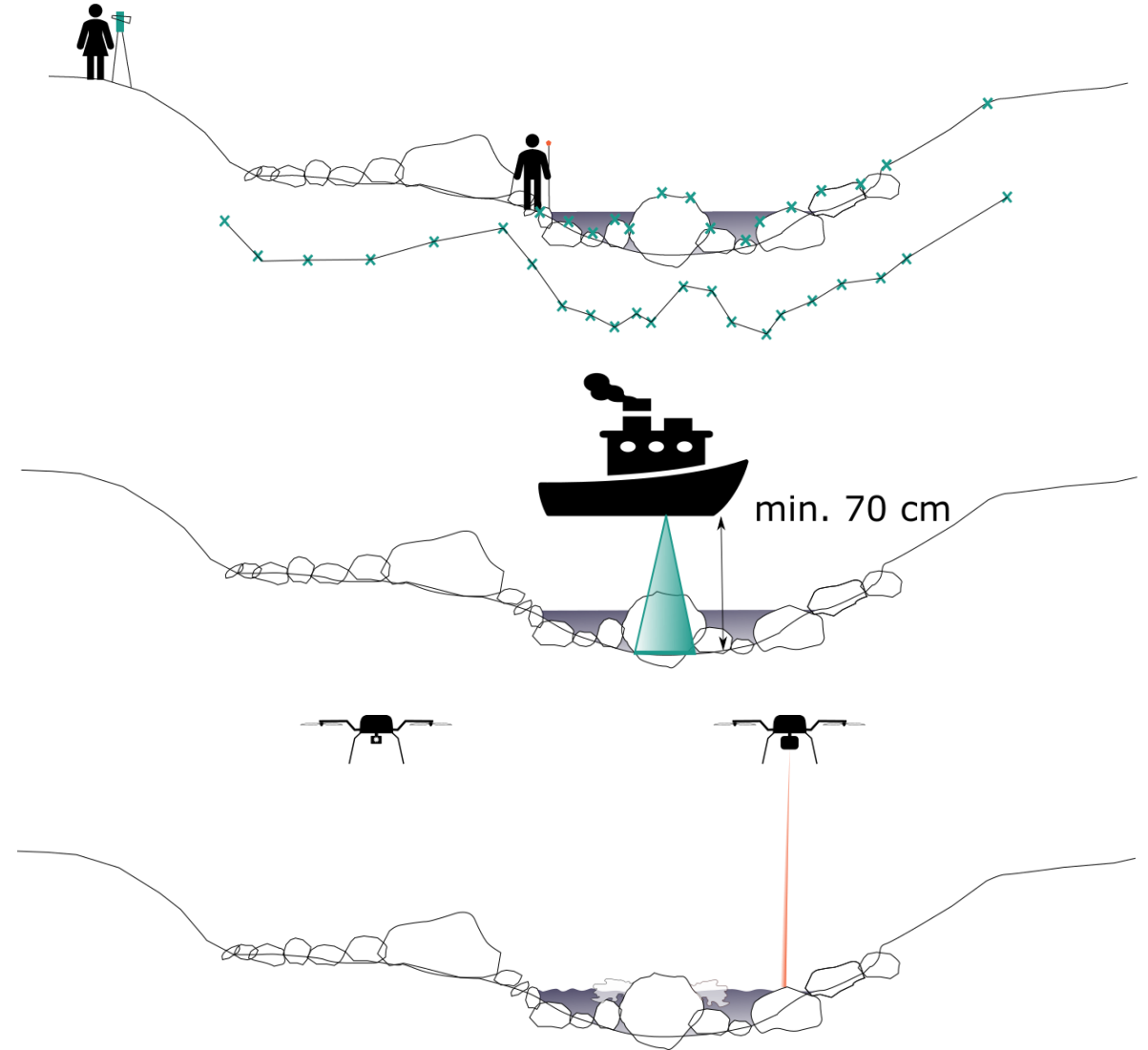


flow depth



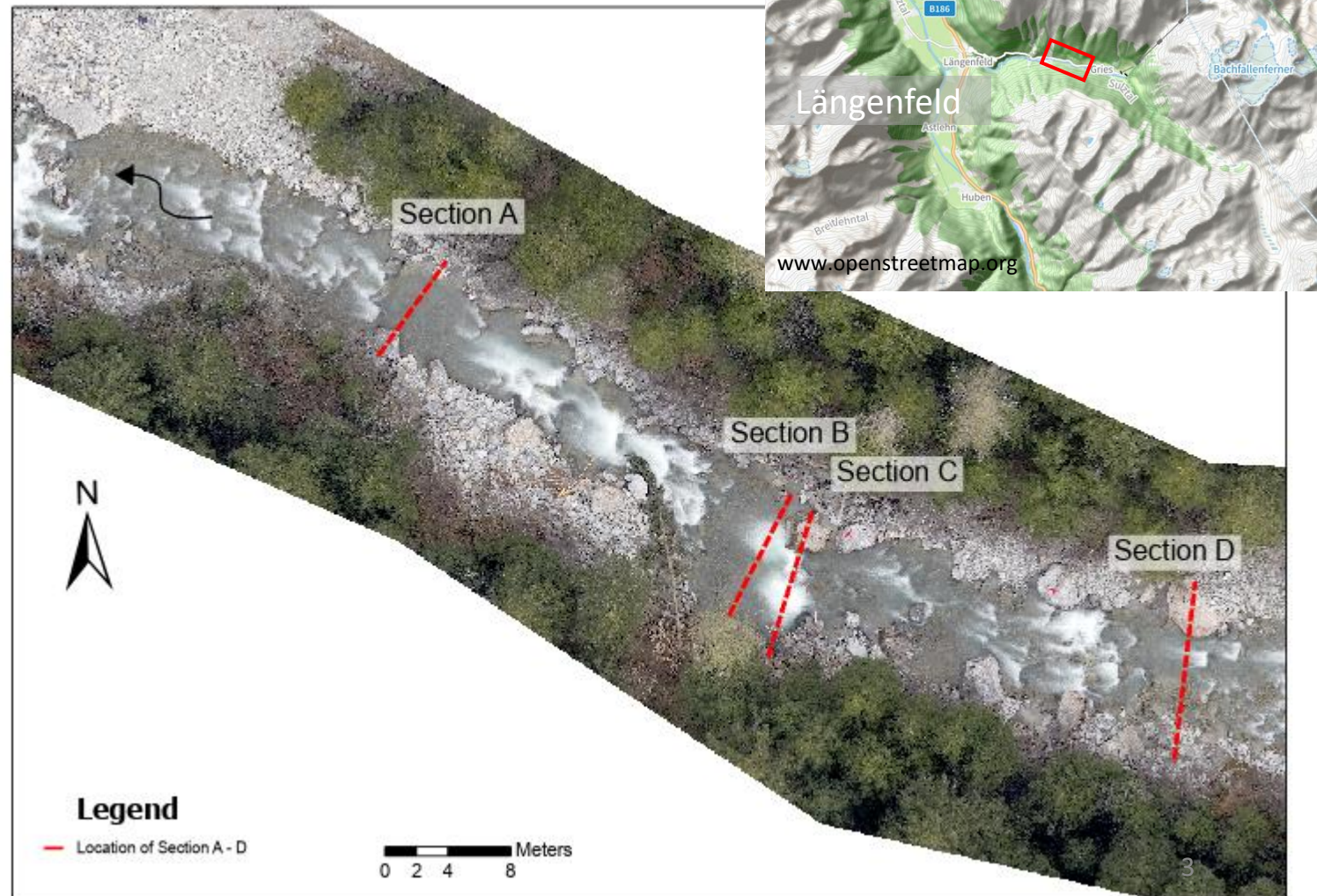
Hydraulically smooth flow

Hydraulically rough flow



# Mountain river Fischbach

- Oetztal Valley, Tyrol, Austria
- Altitude: 1500 m
- River slope: 8 %
- Grain size:  $D_m = 110$  mm,
- Immobile boulders
- Morphology: step-pool systems
- Nivo-glacial flow regime, glacier fed
- Annual mean discharge:  $MQ = 3.5$  m<sup>3</sup>/s
- Discharge winter month:  $Q = 0.5$  m<sup>3</sup>/s
- Length study section: 90 m

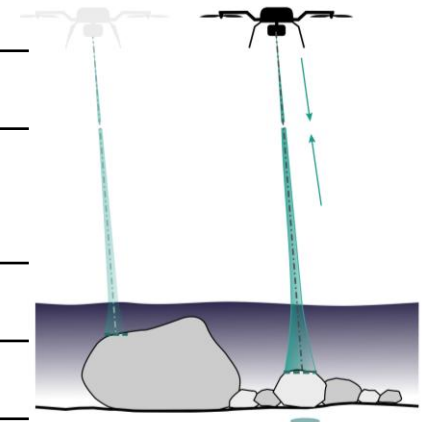
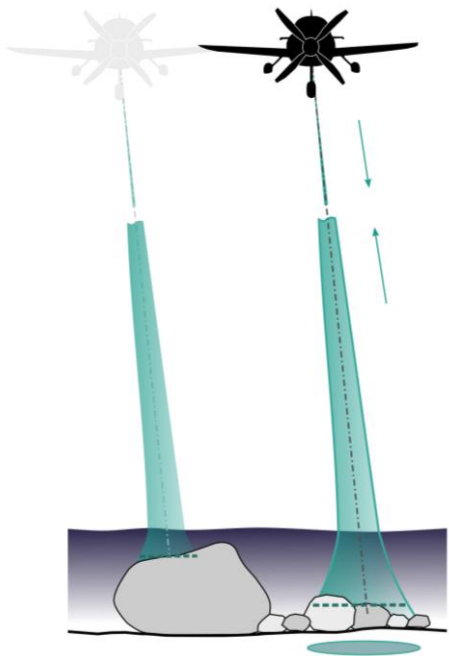


# Applied Sensors

## Airborne Laser Bathymetry (ALB)

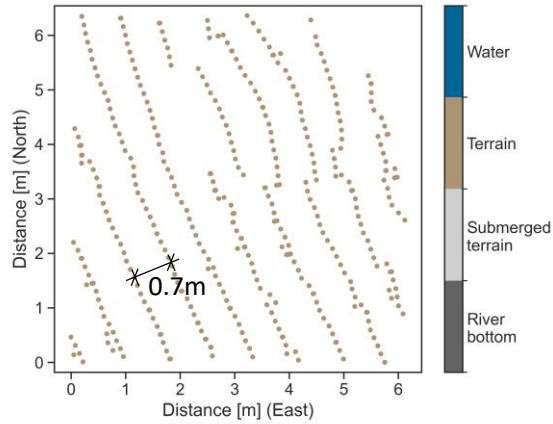
## UAV-borne Laser Bathymetry (ULB)

Sensors	<i>RIEGL VQ-880-G</i>	<i>RIEGL VQ-840-GL</i>
Pulse repetition rate [kHz]	550	200
Pulse duration [ns]	1.5	1.5
Beam divergence [mrad]	0.7	2.0
<b>Case study</b>	<b>February 2024</b>	<b>April 2024</b>
Operating altitude [m AGL]	510 ± 15	102 ± 14
Resulting footprint diameter [m]	0.4	0.2
Platform speed [m/s]	61	5
Resulting point density (filtered) [points/m <sup>2</sup> ]	9	211
Discharge [m <sup>3</sup> /s]	0.5	1.4
Refraction correction	No	Yes
Georeferencing	Tyrolean DTM	Tyrolean DTM

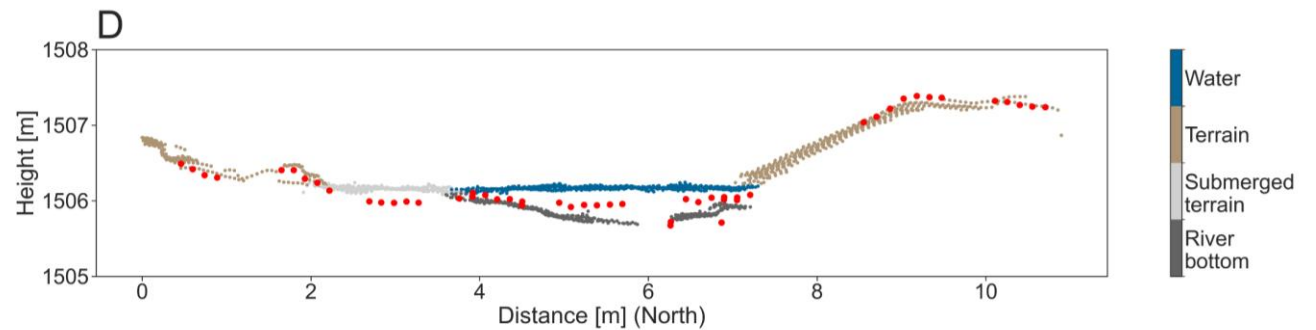
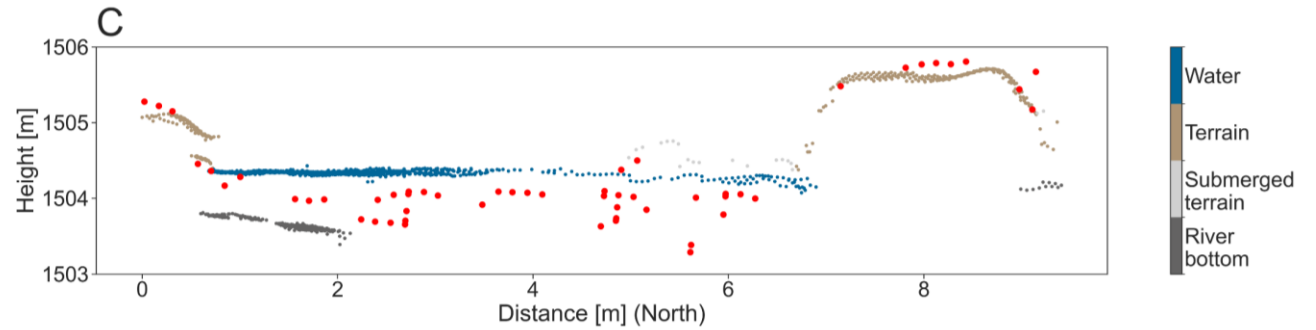
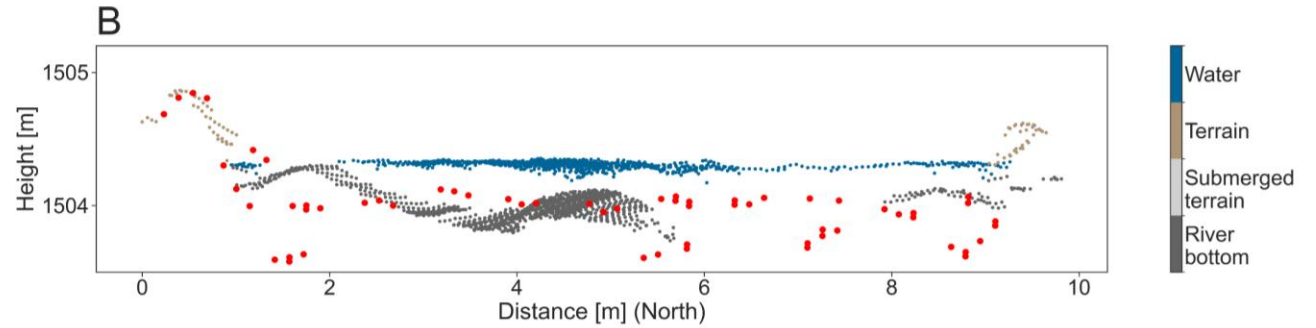
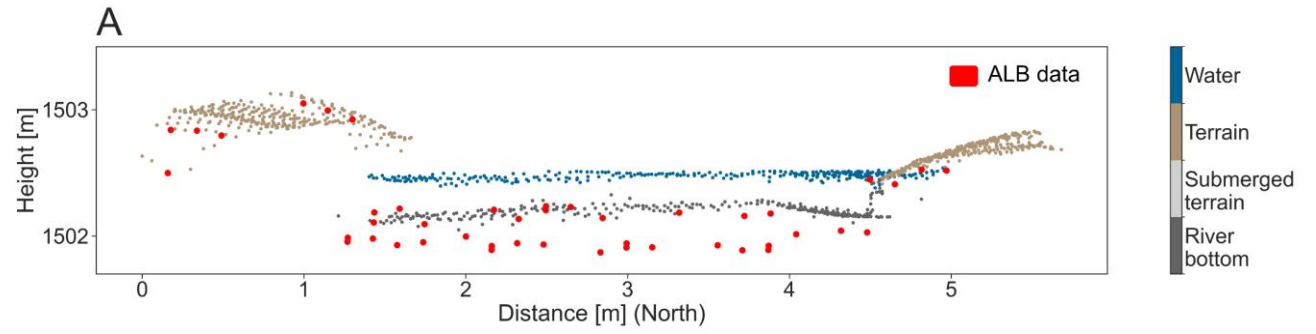
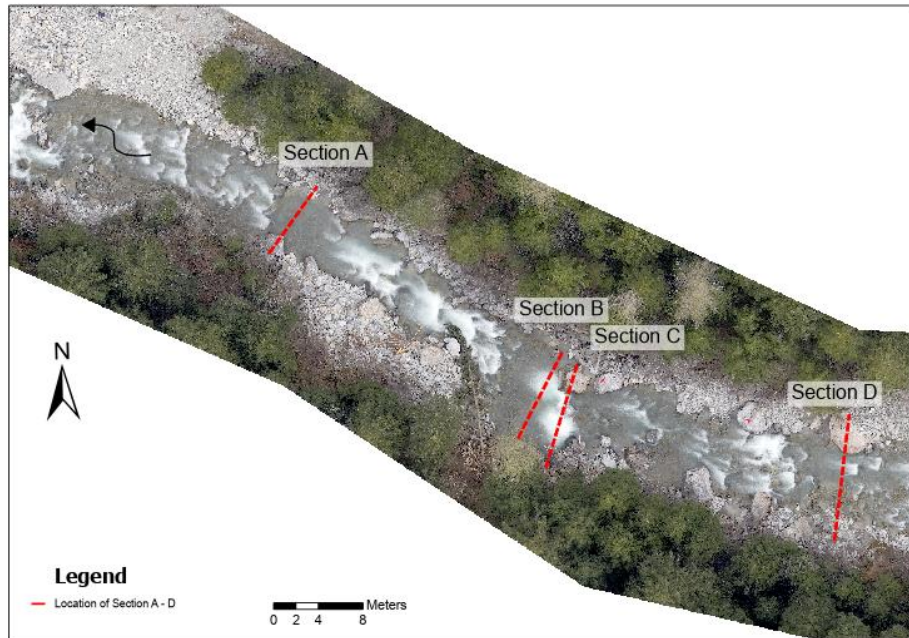
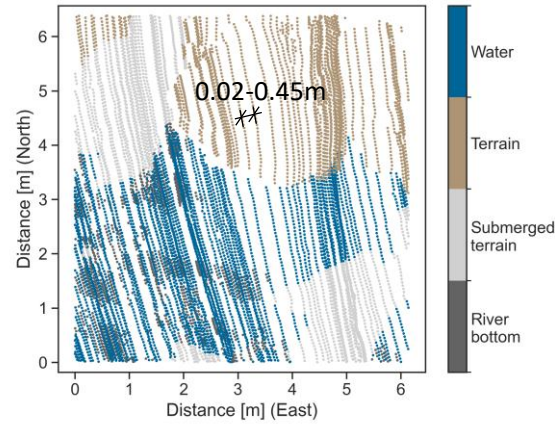


# ALB vs. ULB data

A - ALB data



B - ULB data



# Findings

- Using sensors with small beam divergence and high pulse repetition rates, the operating altitude and the speed of the platform are decisive factors for the detection of underwater objects.
- An UAV-operated sensor is more suitable for capturing submerged mountain river topography due to a smaller footprint diameter and smaller point-to-point spacing, but is less effective for surveying longer river reaches.
- Laser Bathymetry was unable to deliver bathymetry data points in whitewater rapid sections.

# Take home messages

- Hydraulic and bed load research on mountain river is limited due to a lack of spatially comprehensive bathymetry data.
- UAV-operated laser bathymetry is able to reproduce the heterogeneity of mountain river beds.
- Challenges remain for whitewater rapids, for very shallow flows and turbulent water surfaces, and could be subject to future studies.

Contact:

**Theresa Himmelsbach MSc**

Universität Innsbruck  
Unit of Hydraulic Engineering – Institute for Infrastructure  
Faculty of Engineering Science

Phone +43 512 507-62207

E-Mail [theresa.himmelsbach@uibk.ac.at](mailto:theresa.himmelsbach@uibk.ac.at)

