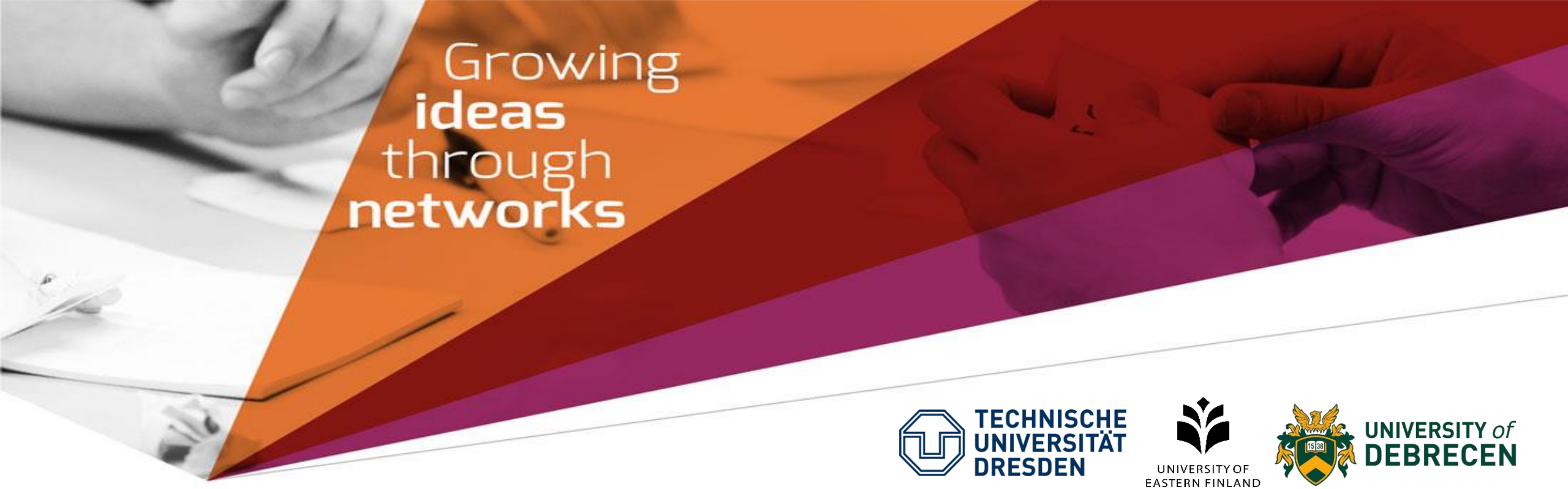


TECHNISCHE UNIVERSITÄT DRESDEN

UNIVERSITY OF EASTERN FINLAND

UNIVERSITY of DEBRECEN

Hydro-morphological mapping of river reaches using videos captured with UAS

Anette Eltner, David Mader, Hannes Sardemann, Jens Grundmann, Melanie Elias, Eliisa Lotsari, Franziska Wolff, Diana Spieler, Bálint Nagy, Noemi Szopos, László Bertalan

cost
EUROPEAN COOPERATION IN SCIENCE & TECHNOLOGY

Funded by the Horizon 2020 Framework Programme of the European Union

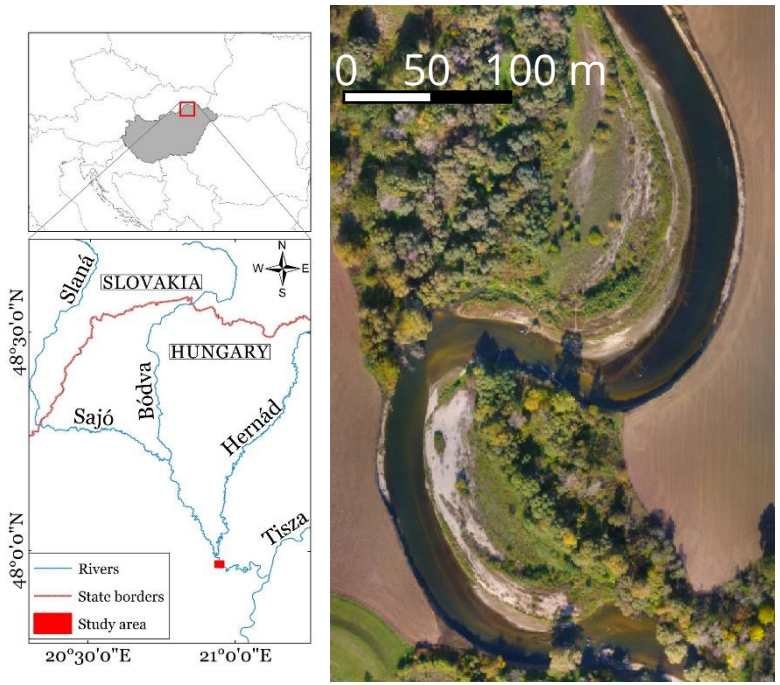
HARMONIOUS
uas for environmental monitoring

Advances in Environmental Monitoring with UAS, Debrecen, Hungary (30th March 2022)

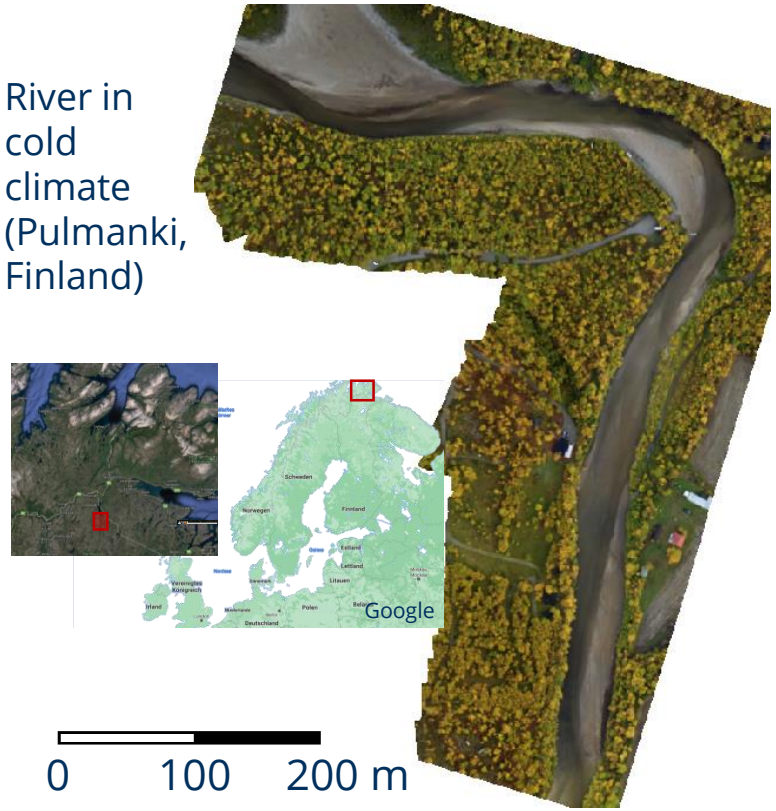
Two study sites

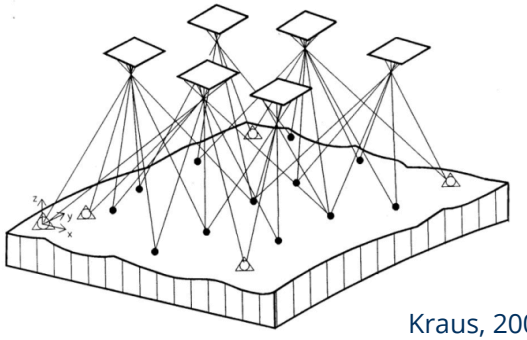
- To illustrate approaches of topographic and bathymetric survey and flow velocity and discharge measurement at river reach scale

River in continental climate (Sajo, Hungary)



River in cold climate (Pulmanki, Finland)

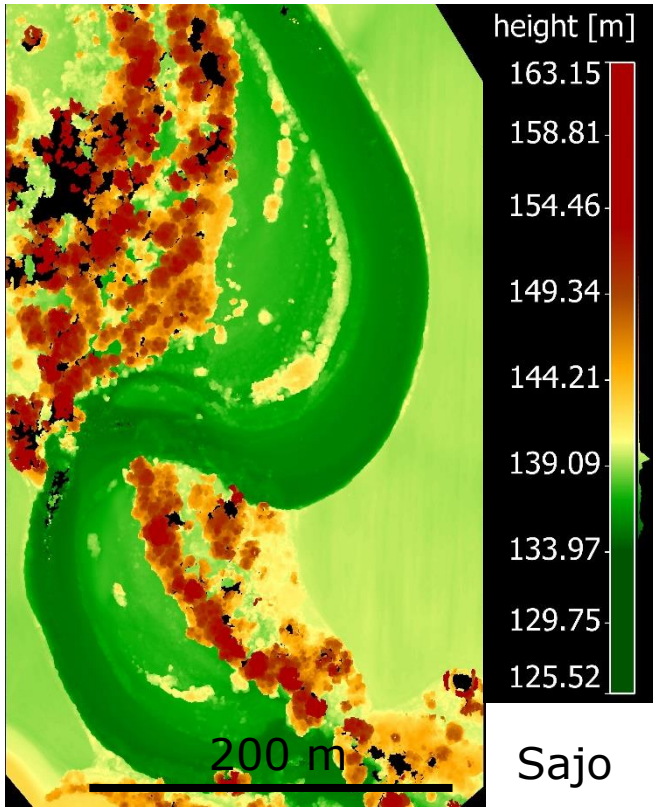




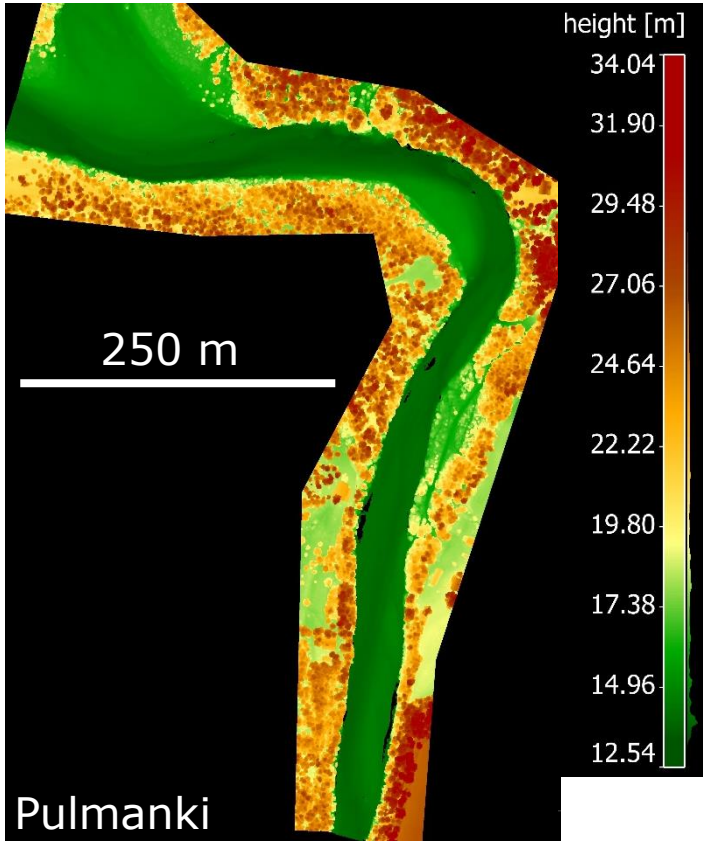
Kraus, 2007

Topographic mapping

- Using UAV photogrammetry to reconstruct the earth surface above and below the water surface

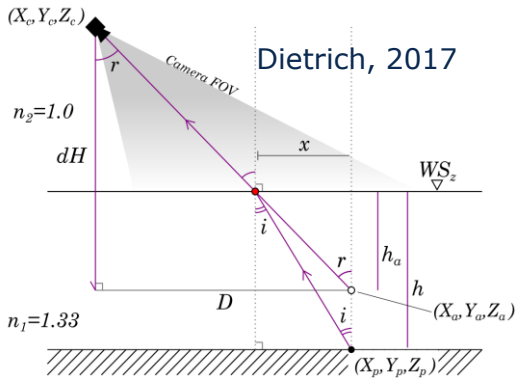


Sajo



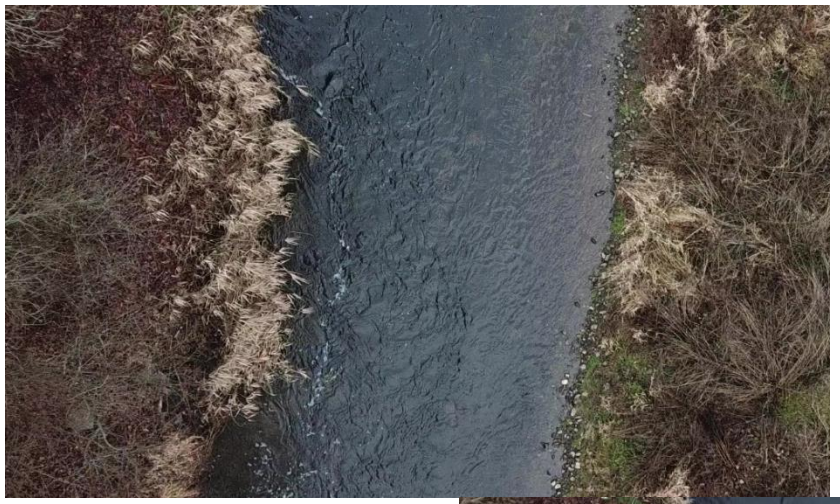
River bathymetry

- Underwater region error during reconstruction due to refraction impact
  - Needs correction
- Improving visibility of river bed at more turbulent locations
  - Stacking co-registered images
  - Calculation of median image

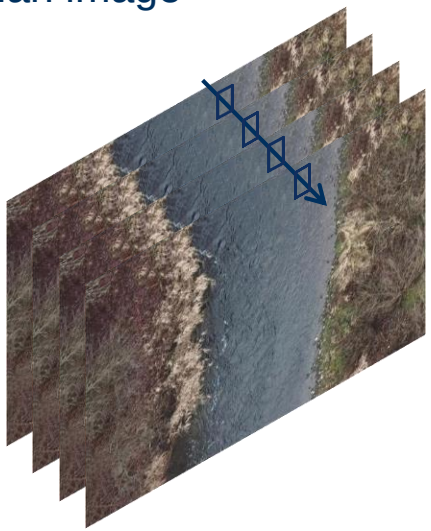


Dietrich, 2017

$$n_1 \sin i = n_2 sin\, r$$



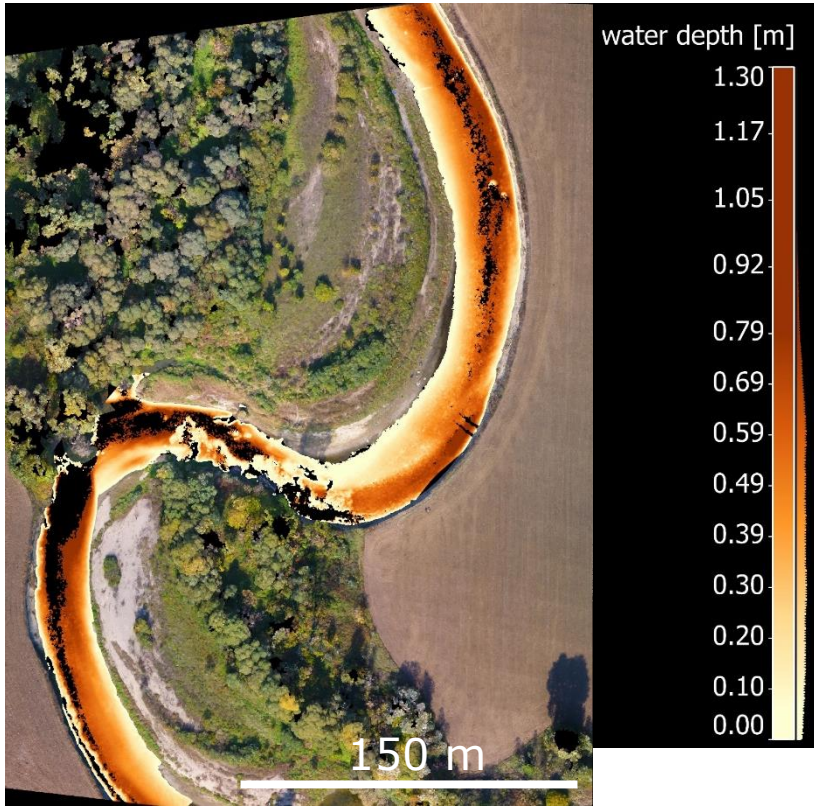
Original image



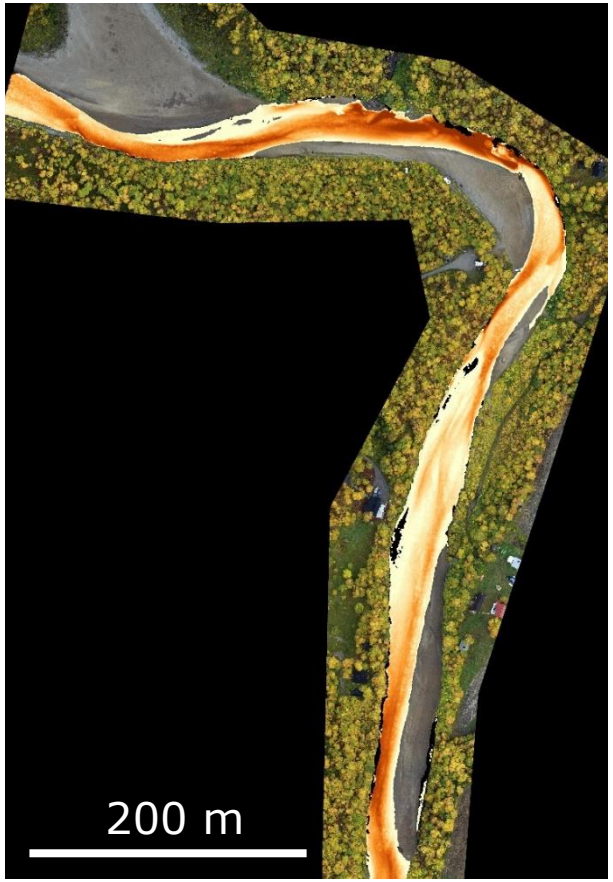
Filtered image

River bathymetry

Sajo

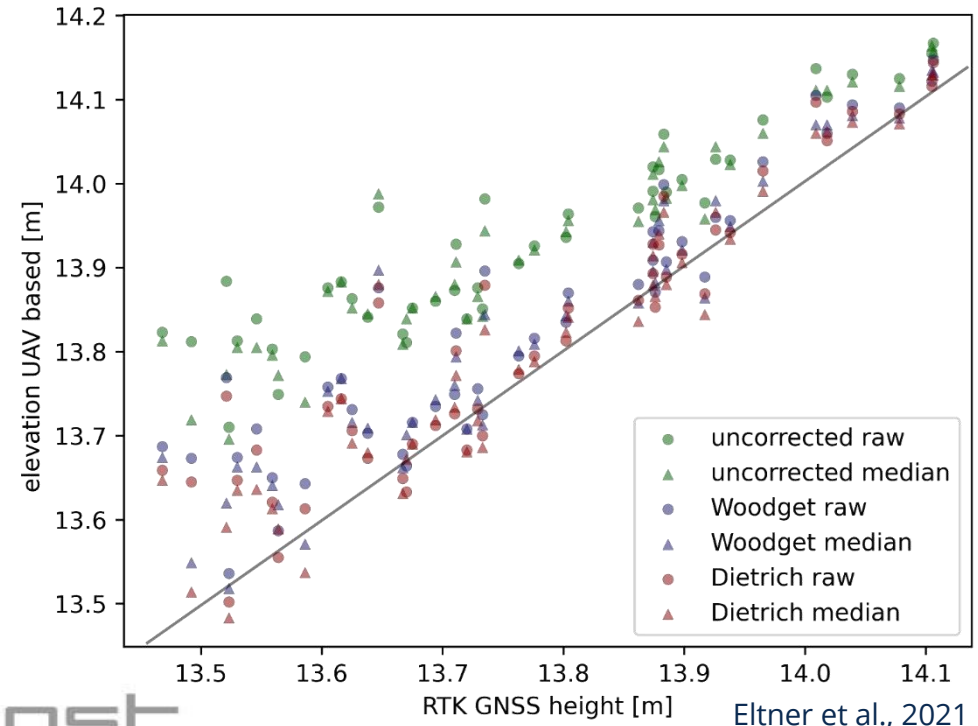


Pulmanki



River bathymetry

- Comparing water depth to RTK GNSS point measurements at Pulmanki



Eltner et al., 2021

Pulmanki

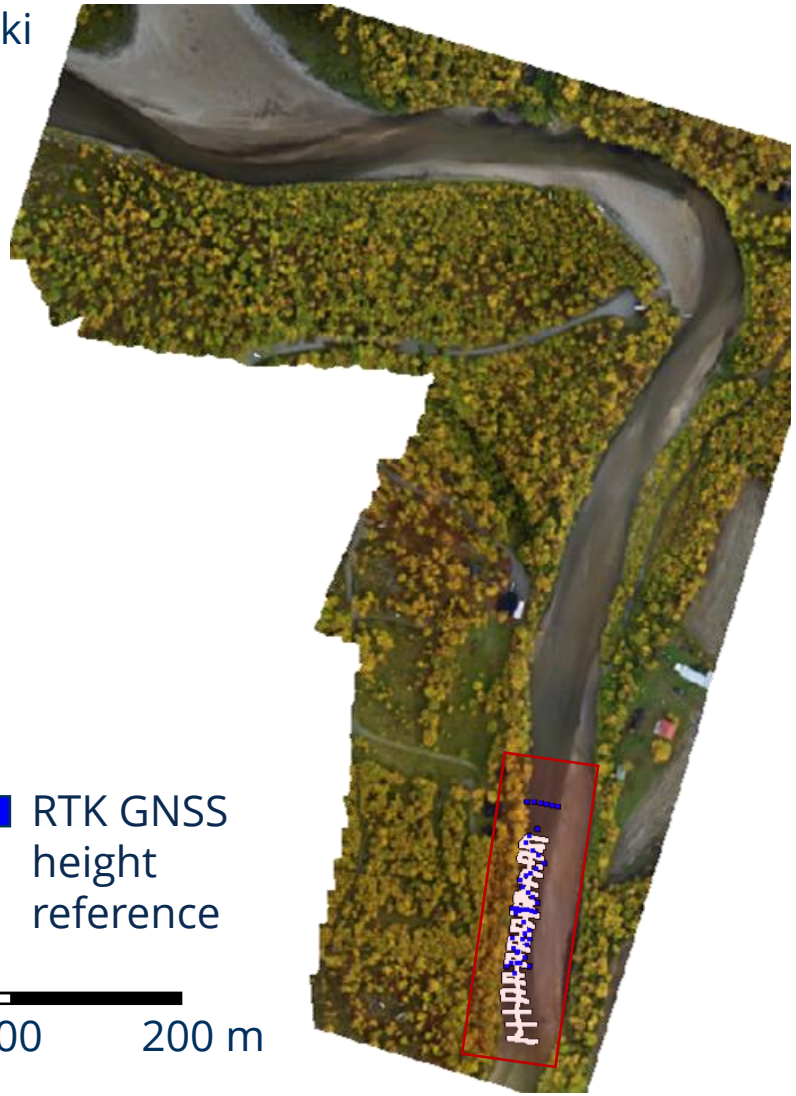
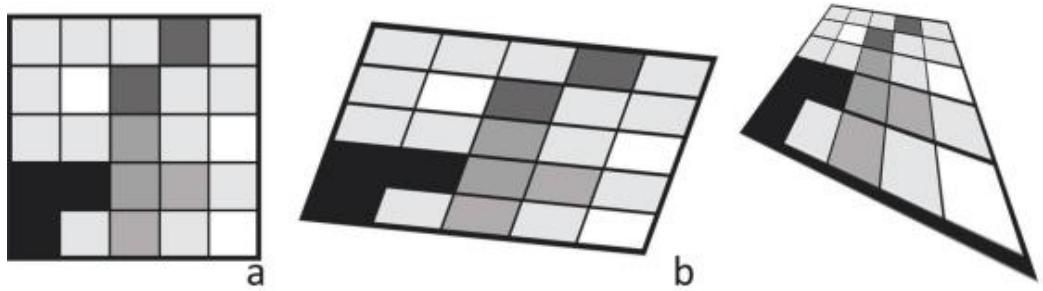


Image co-registration

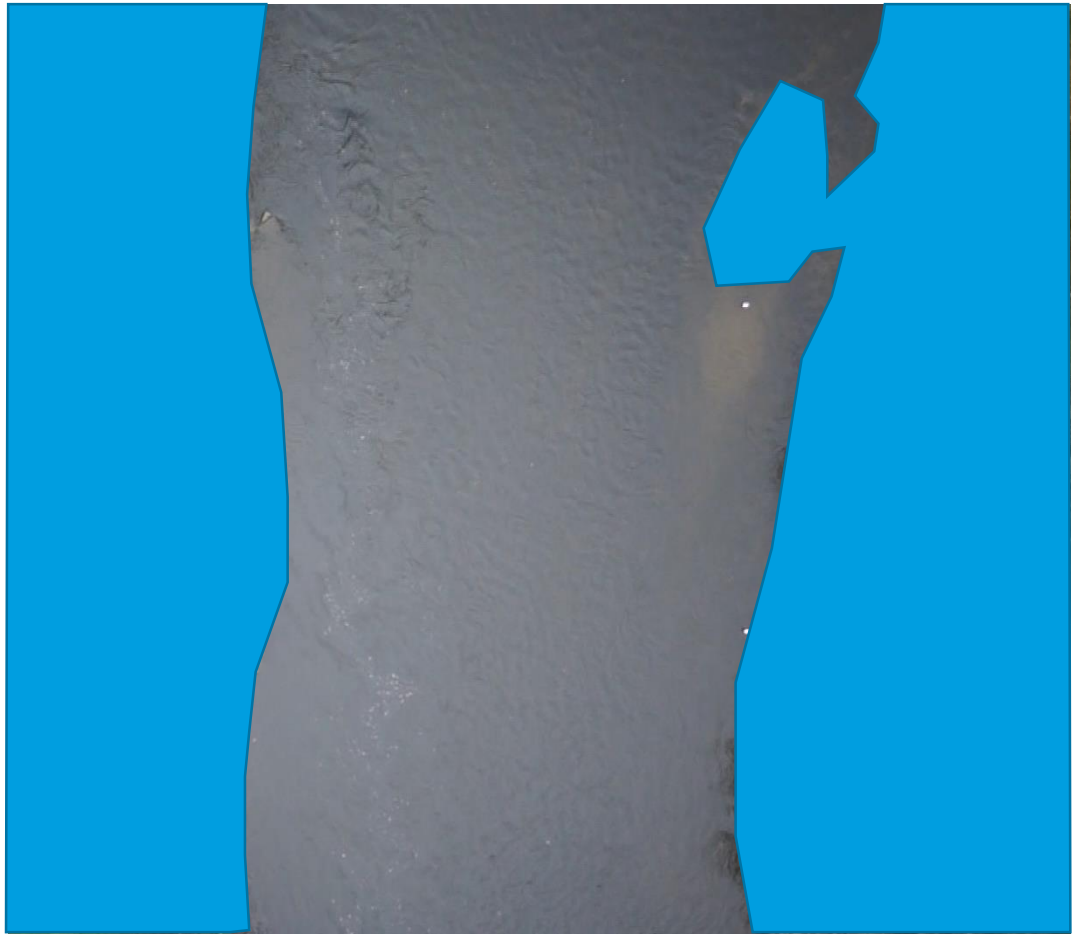
- PTV workflow
- Frame preparation → co-registration of frames (same approach as for median images)



Eltner et al., 2022

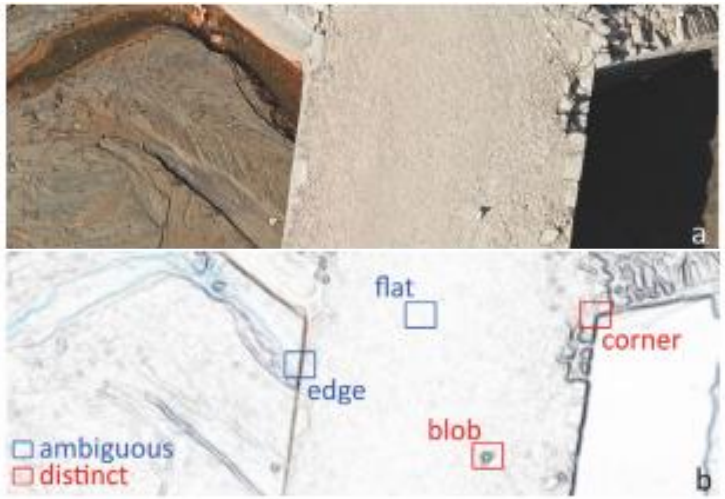
Masking region of interest

- PTV workflow
- Frame preparation → co-registration of frames (same approach as for median images)
- Mask water area



Feature detection

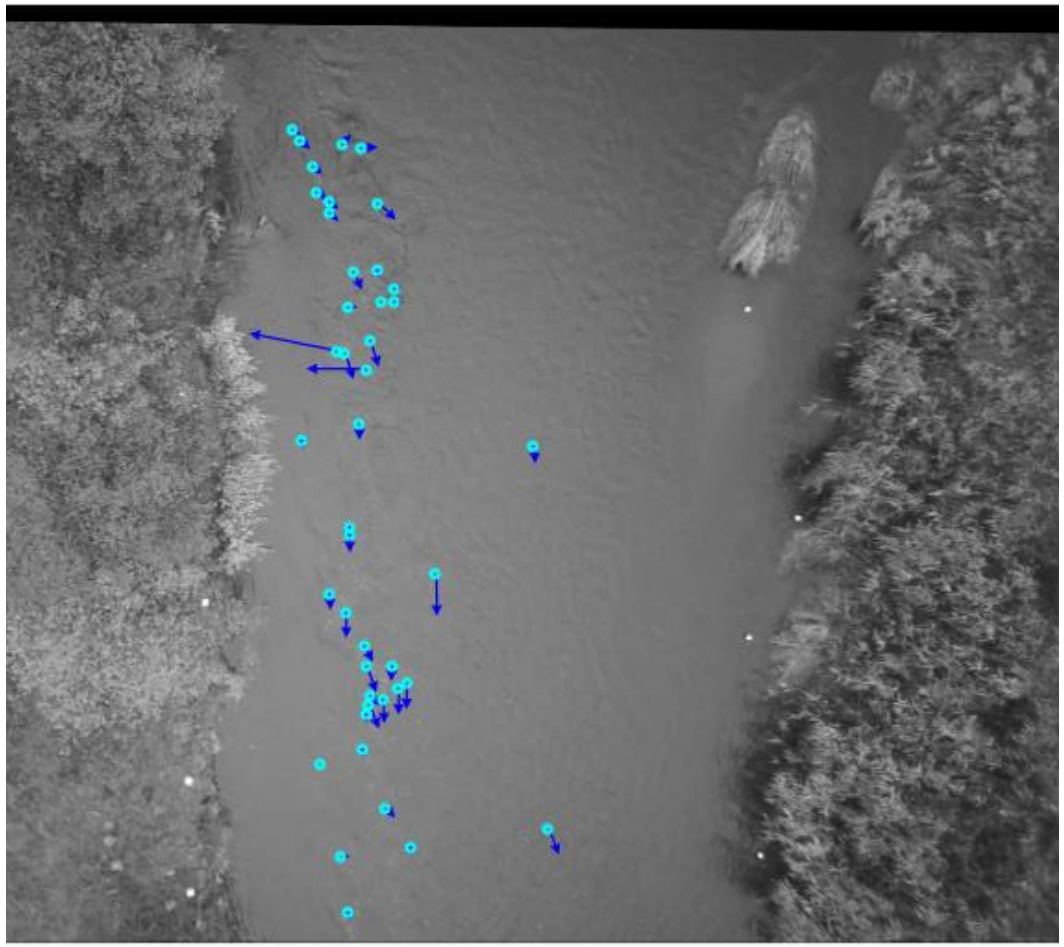
- PTV workflow
- Frame preparation → co-registration of frames (same approach as for median images)
- Mask water area
- Extract features for tracking



Eltner et al., 2022

Feature tracking

- PTV workflow
- Frame preparation → co-registration of frames (same approach as for median images)
- Mask water area
- Extract features for tracking
- Match features

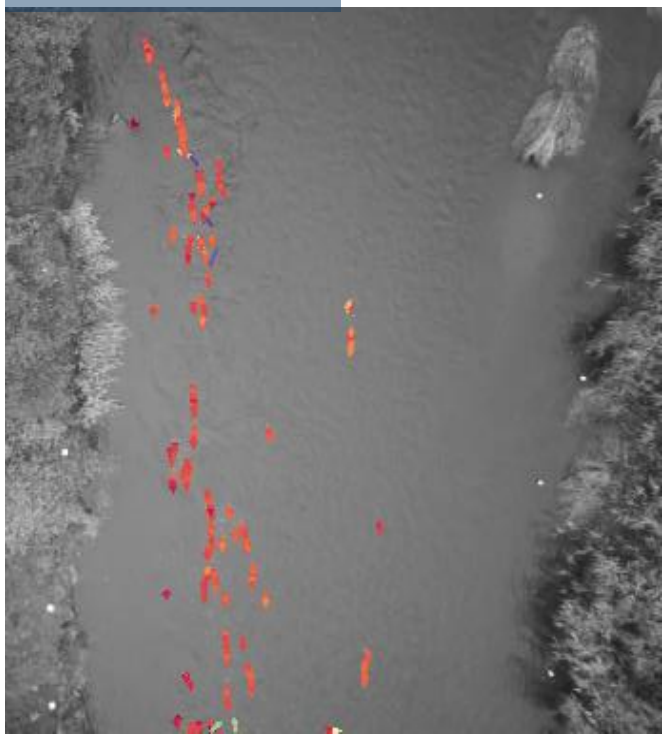


Filtering tracks

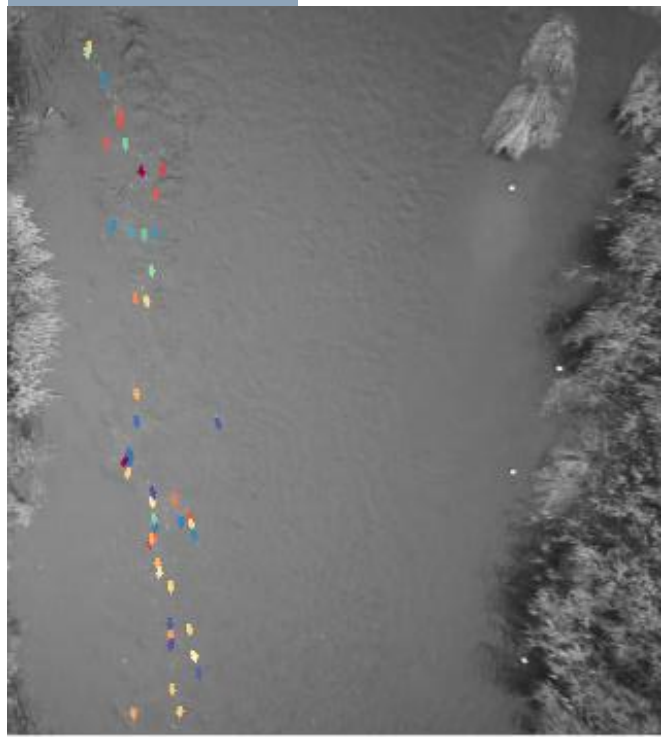
- PTV workflow
- Frame preparation → co-registration of frames (same approach as for median images)
- Mask water area
- Extract features for tracking
- Match features
- Filter false tracks

filtering tracks considering
- Main flow direction
- Steadiness of tracks
- Minimum number of frames
- Minimum and maximum plausible velocity

Unfiltered Tracks

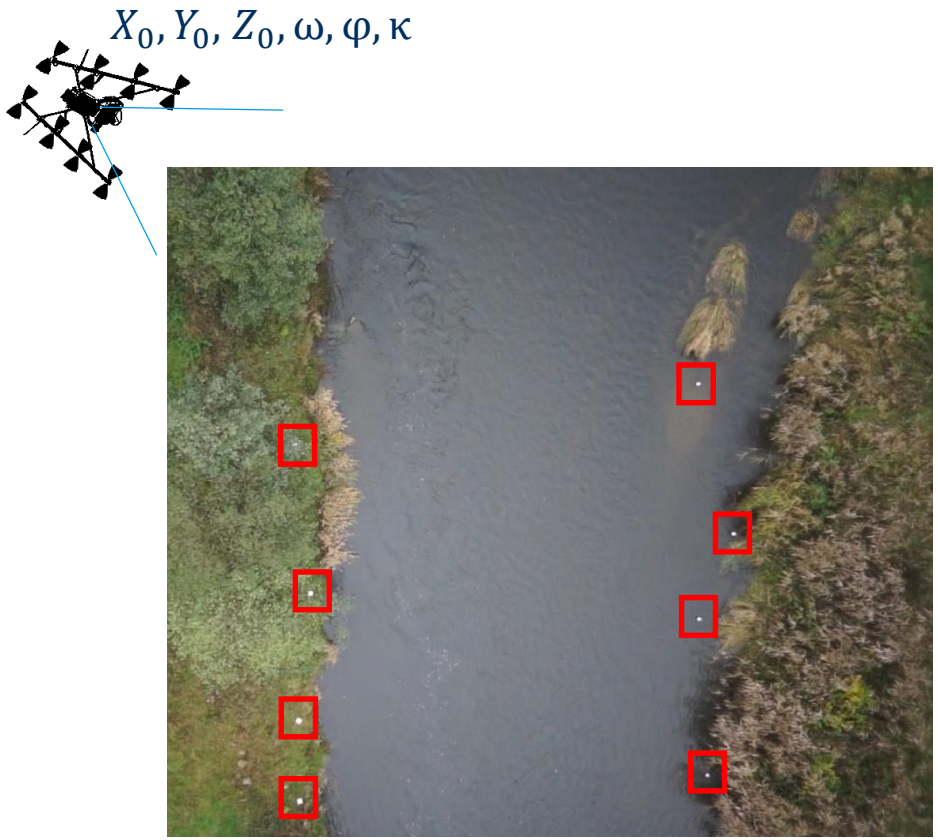


Filtered Tracks



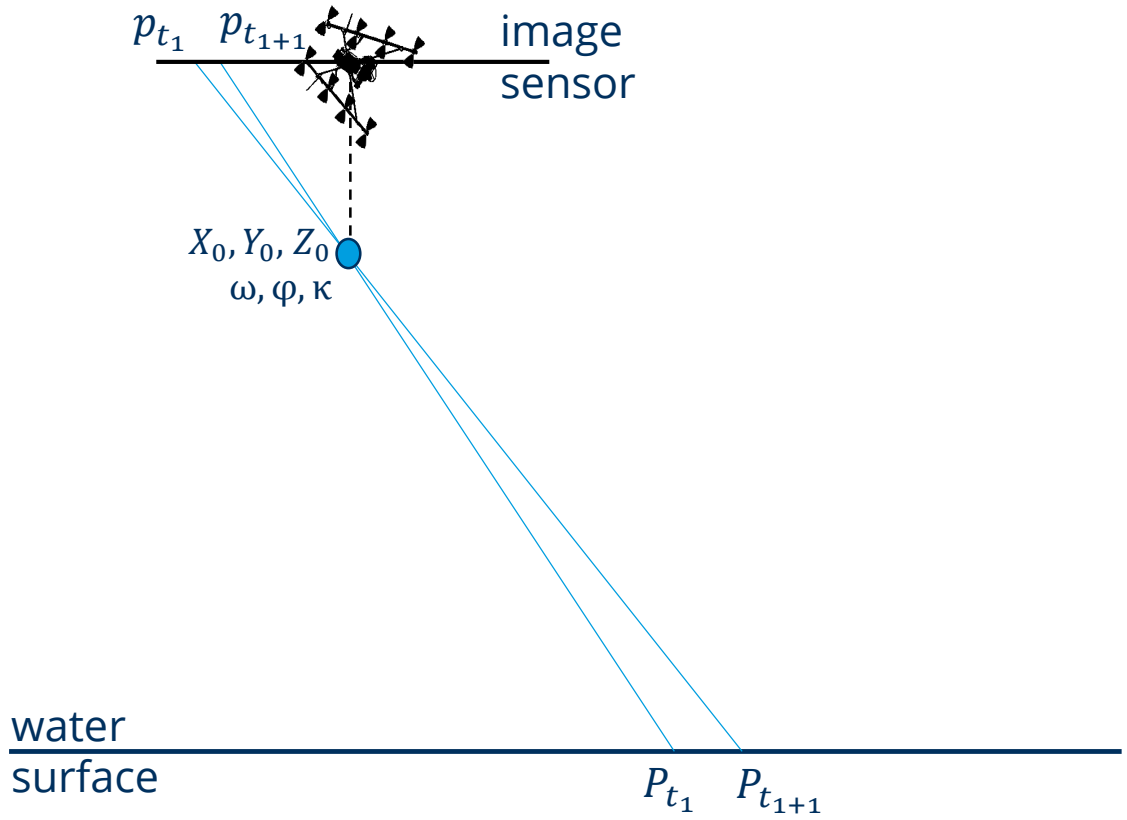
Scaling feature tracks

- PTV workflow
- Frame preparation → co-registration of frames (same approach as for median images)
- Mask water area
- Extract features for tracking
- Match features
- Filter false tracks
- Scale tracks via water surface intersection considering waterlevel and camera pose (pose estimation → get exterior orientation/position of camera)



Scaling feature tracks

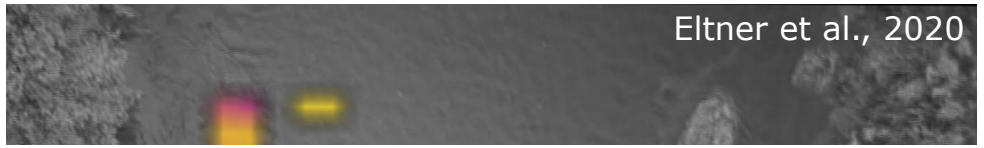
- PTV workflow
- Frame preparation → co-registration of frames (same approach as for median images)
- Mask water area
- Extract features for tracking
- Match features
- Filter false tracks
- Scale tracks via water surface intersection considering waterlevel and camera pose (pose estimation → get exterior orientation/position of camera)



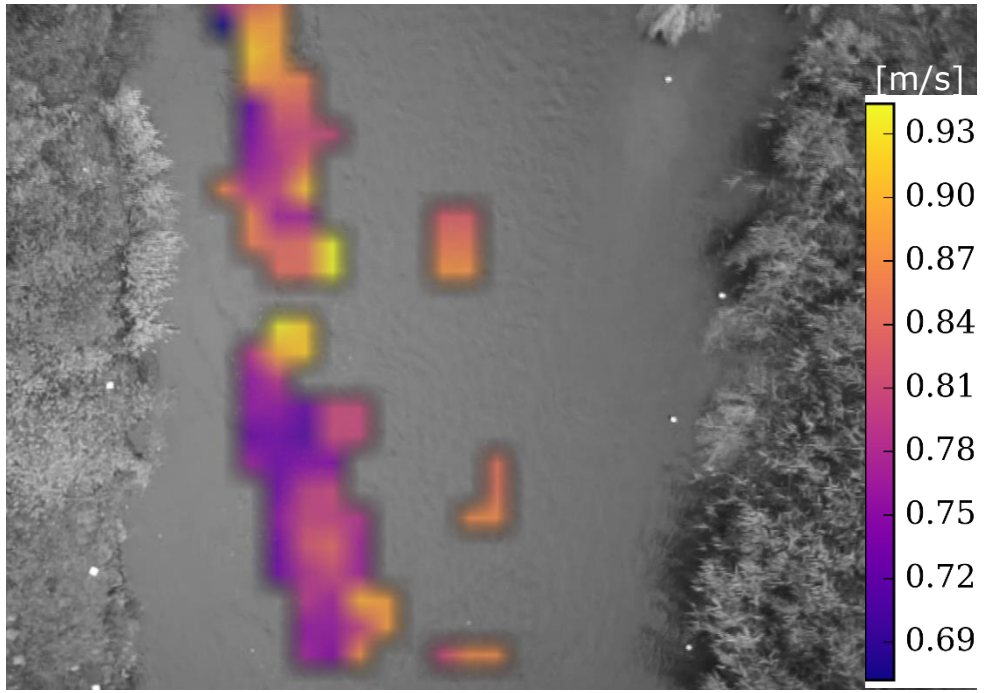
$p \ldots particle\ position\ in\ image$
$P \ldots particle\ position\ on\ water\ surface$

Scaling feature tracks

- PTV workflow
- Frame preparation → co-registration of frames (same approach as for median images)
- Mask water area
- Extract features for tracking
- Match features
- Filter false tracks
- Pose estimation → get exterior orientation/position of camera
- Scale tracks
- Eventually retrieve velocity considering video frame rate

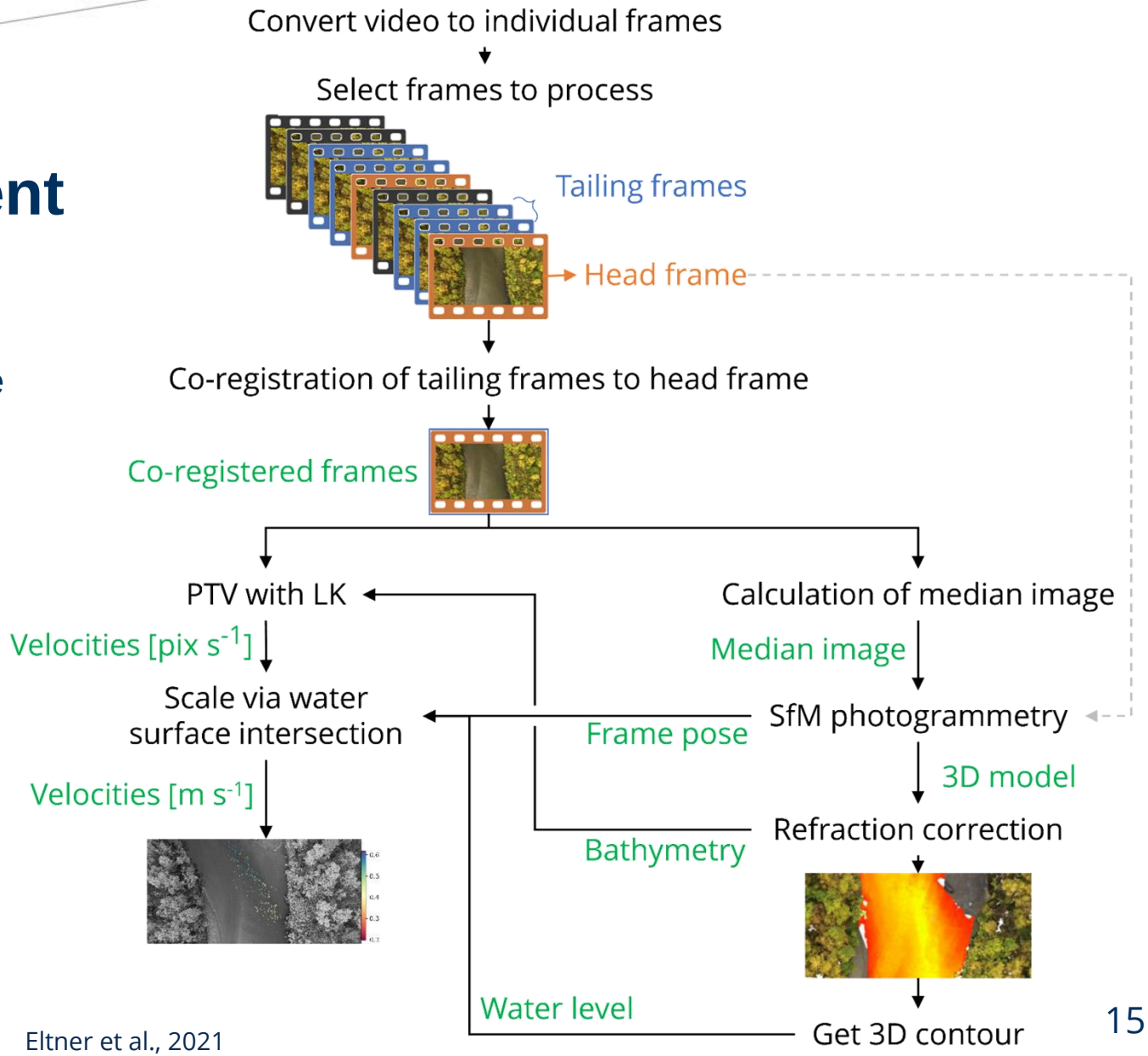


github.com/AnetteEltner/FlowVeloTool



Flow velocity measurement

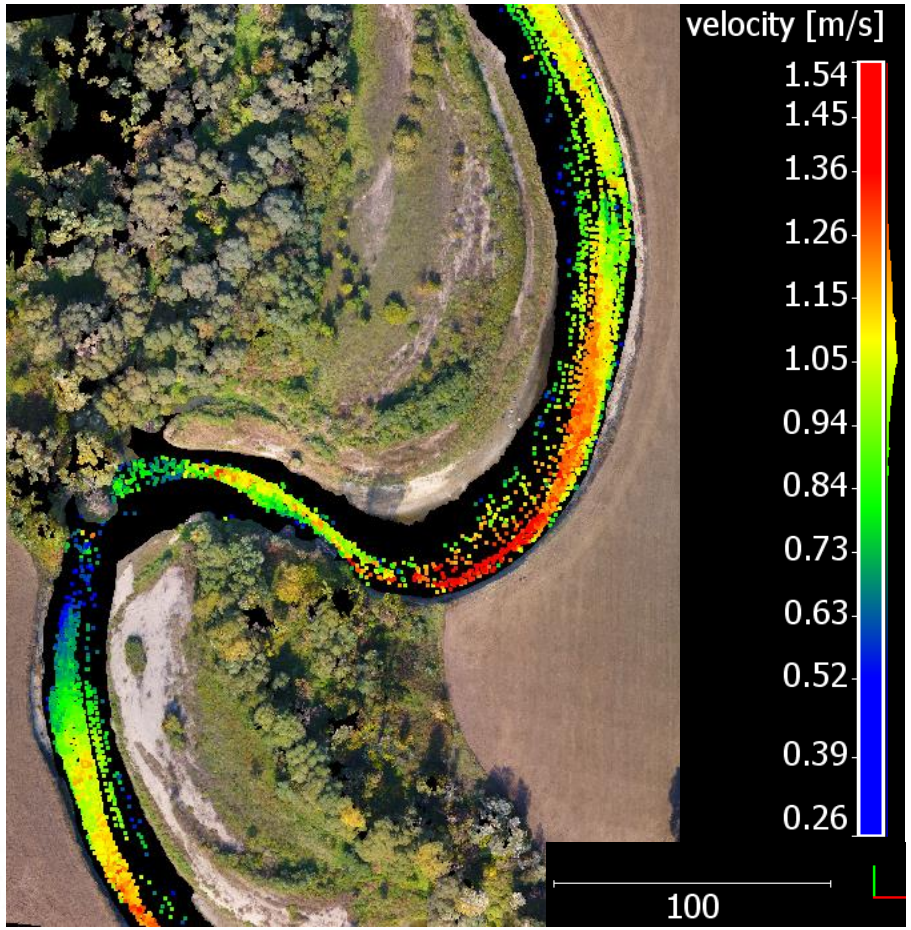
- Along river reaches
- → Tracking similar to stationary captured videos, but scaling different in regard to pose estimation and water level assignment



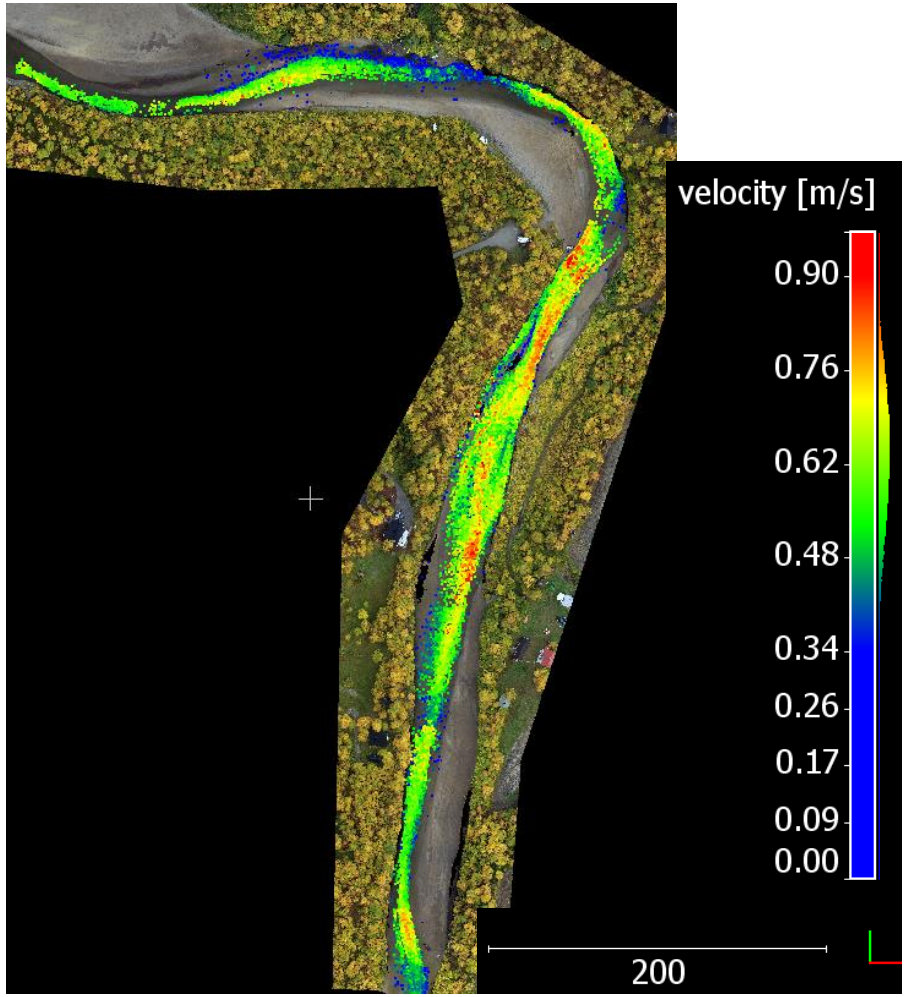
Eltner et al., 2021

Flow velocity measurement

Sajo

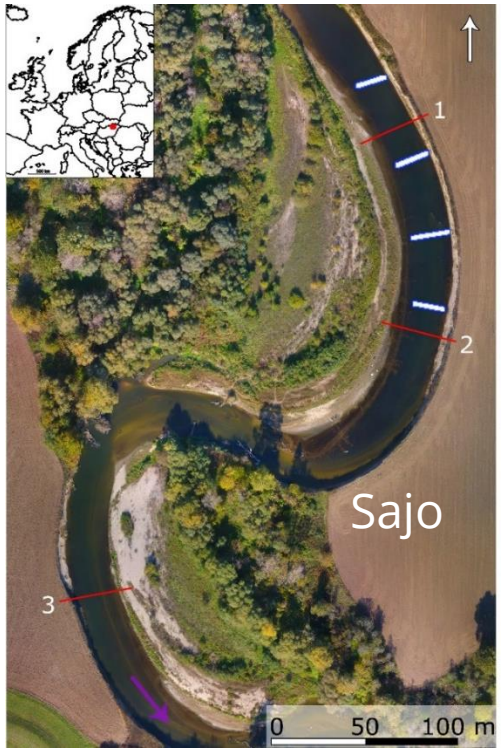


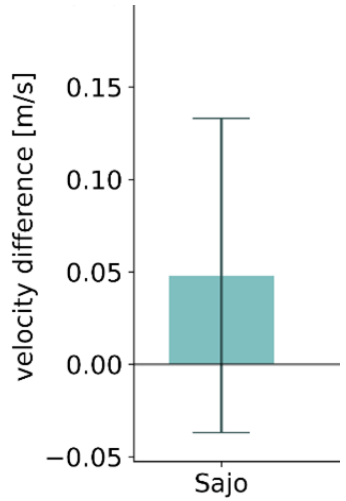
Pulmanki



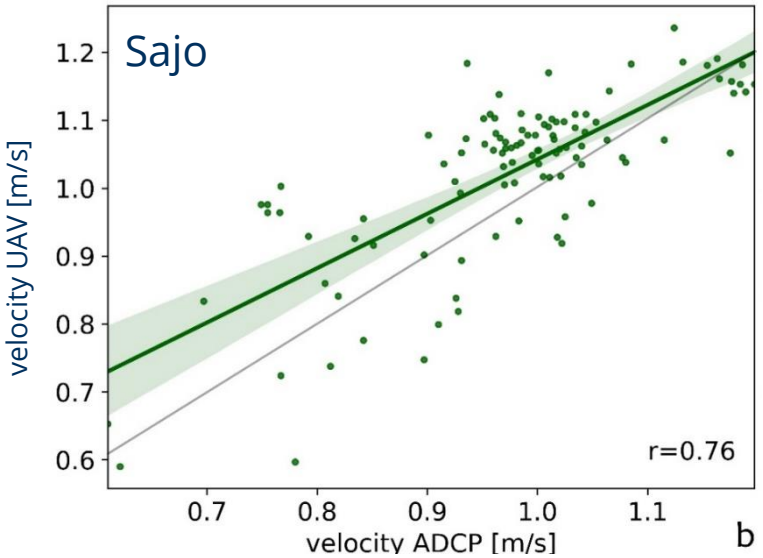
Flow velocity measurement

- At entire river reaches → accuracy assessment



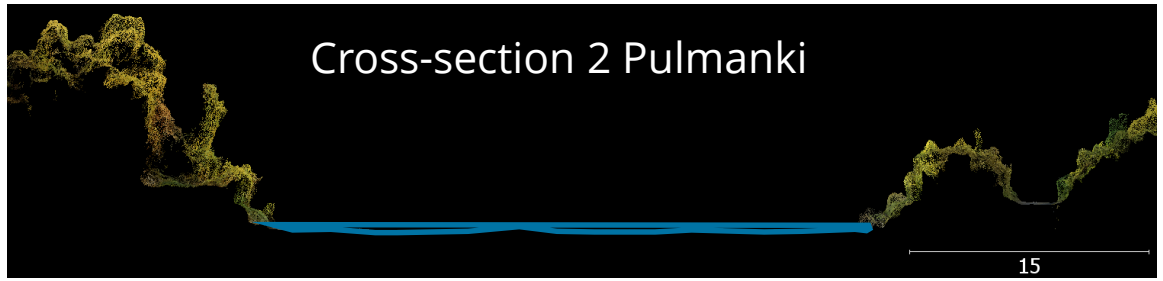


Eltner et al., 2021



Discharge measurement

- For different extracted cross-sections and compared to discharge measured with ADCP

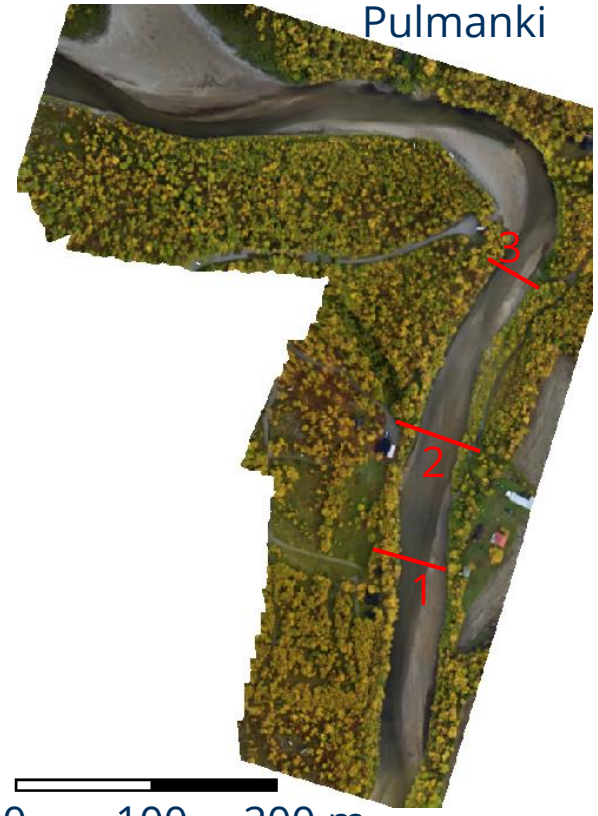


	reference	cross section 1	cross section 2	cross section 3
discharge [m³/s] Pulmanki	*3.24*	2.61 (-5%/+31%)	3.08 (-51%/+9%)	2.98 (-15%/+11%)
discharge [m³/s] Sajo	*11.9*	12.52 (+/-4%)	11.32 (+/-3%)	11.51 (+/-5%)

Change in discharge due to water level error of 2 cm

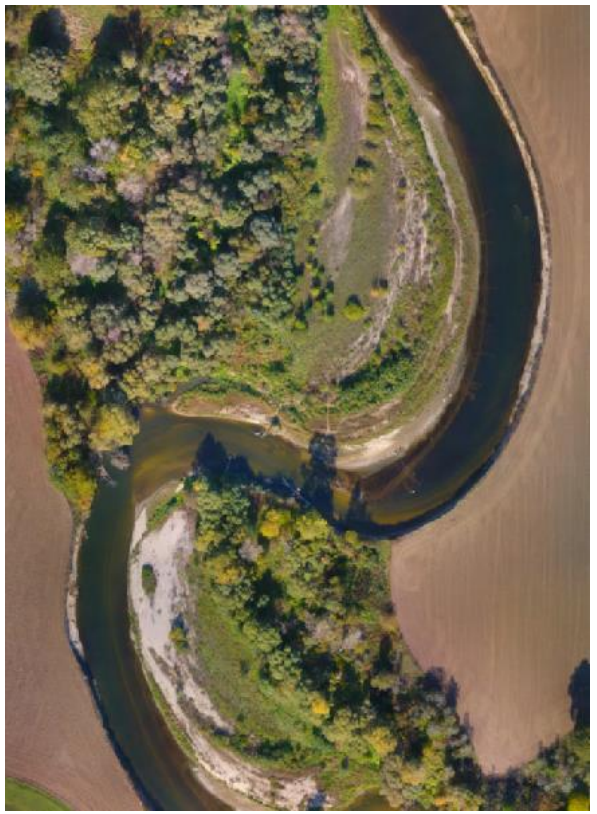
Sajo

Pulmanki



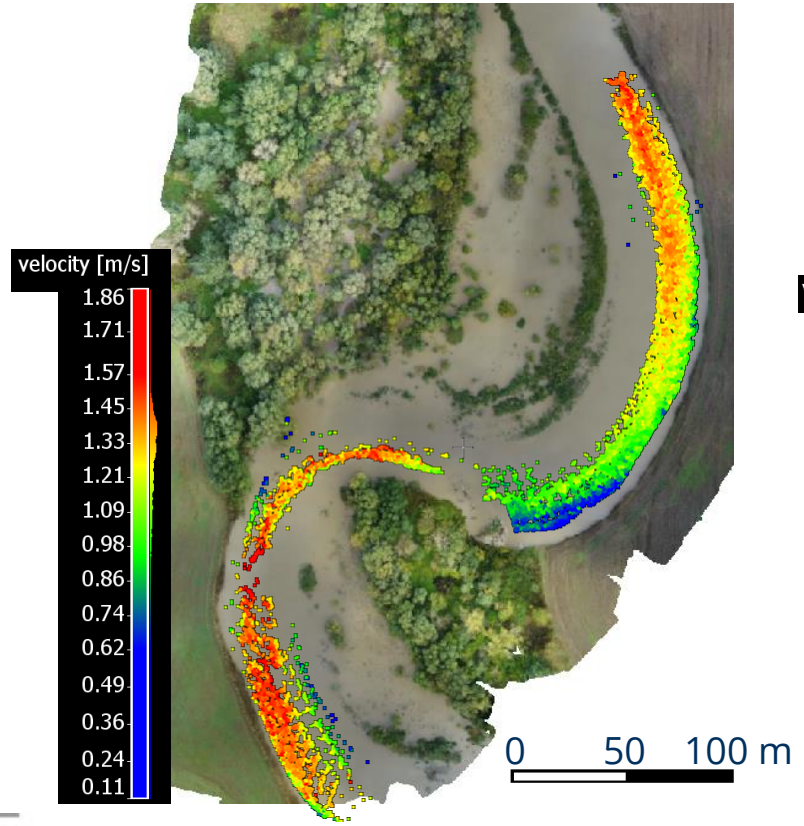
Next steps to do…

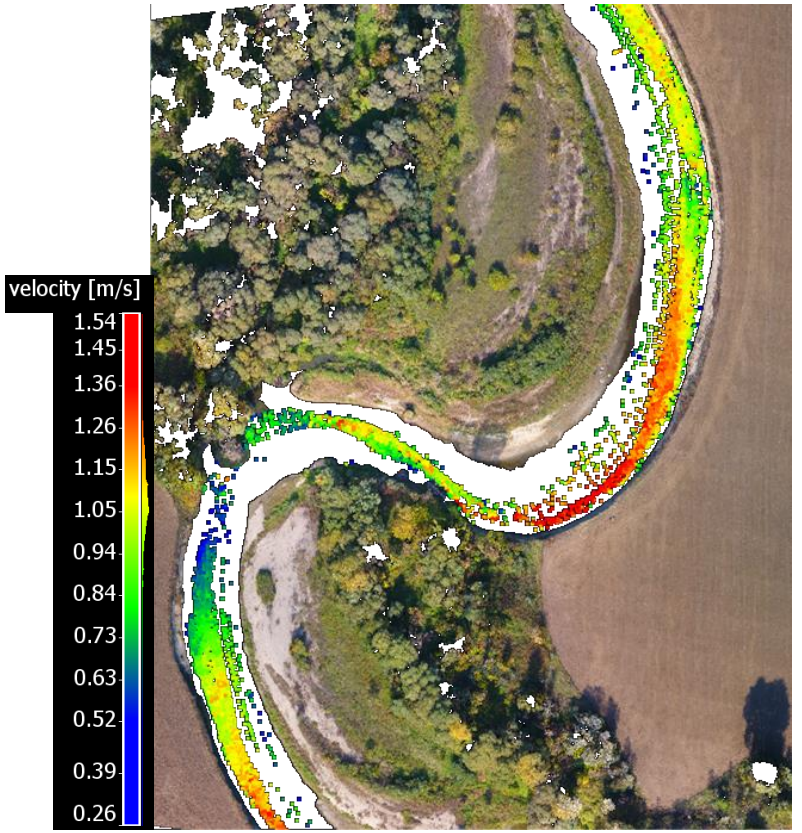
- Assess change of flow patterns in flood scenarios



Next steps to do…

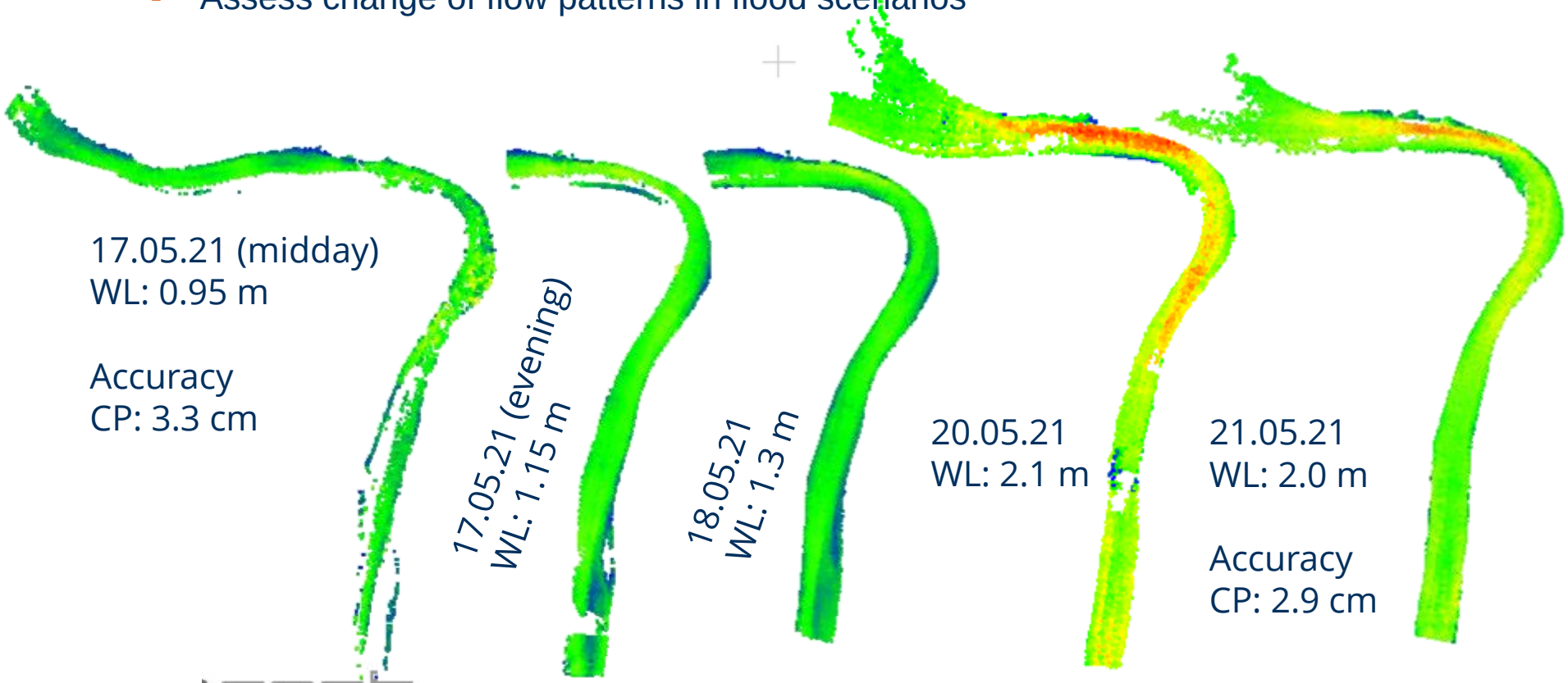
- Assess change of flow patterns in flood scenarios

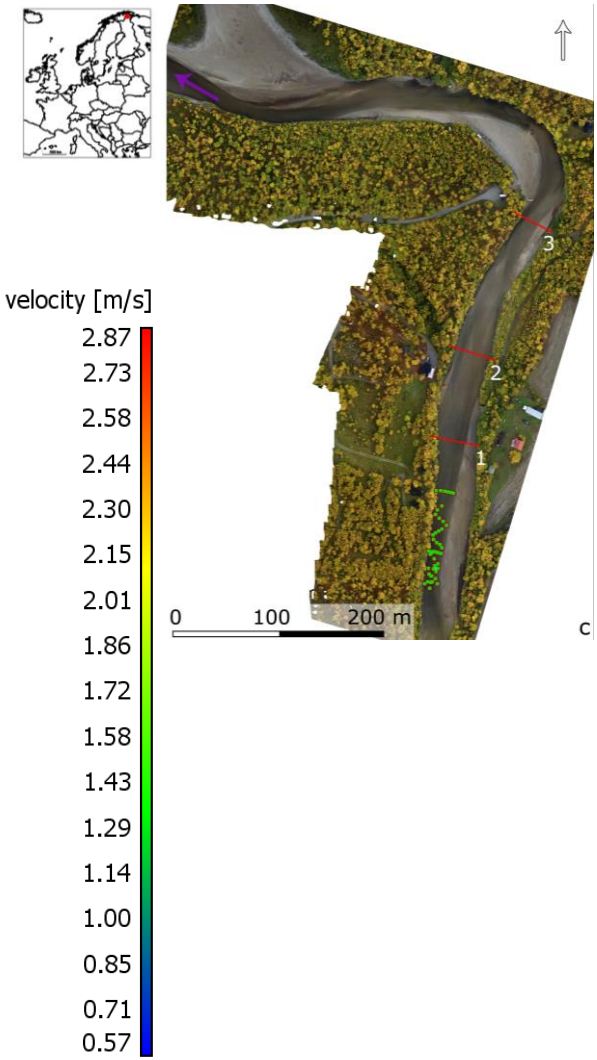




Next steps to do…

- Assess change of flow patterns in flood scenarios





Thank you for your attention