SmartWood_3D

Video footage from drones for Structure-from-Motion photogrammetry – A practical and rapid assessment method for large wood accumulations in rivers?

Gabriel Spreitzer, Isabella Schalko, Robert M. Boes and Volker Weitbrecht

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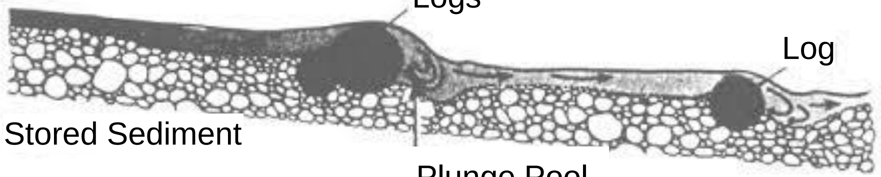
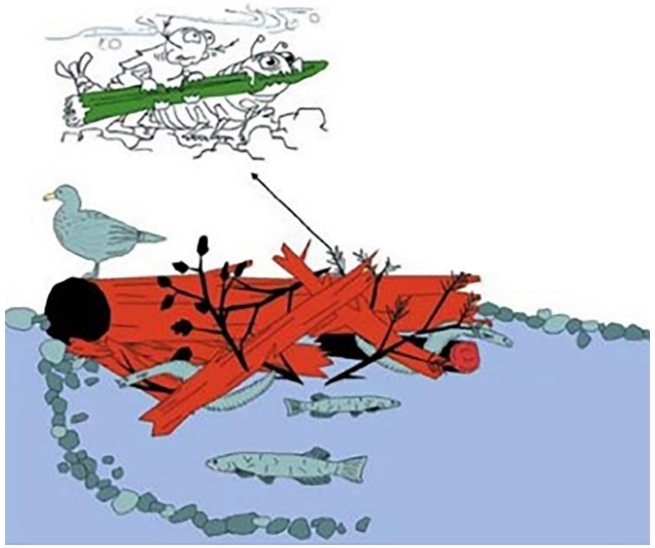
This project has gratefully received funding from the European Union's Horizon 2020 research and innovation programme, in form of a Marie Skłodowska-Curie Individual Fellowship (MSCA-IF), under grant agreement number 887254.

Wood in Rivers

- ✓ Energy dissipation
- ✓ Water aeration
- ✓ Sediment regulation
- ✓ Food supply
- ✓ Increases habitat diversity

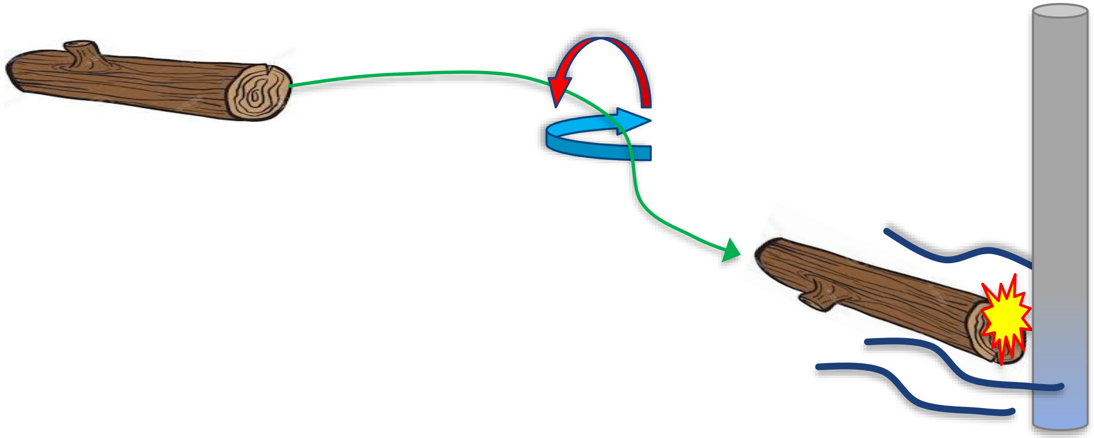


Booth et. al., Engineering Foundation Conference (1996)



Brenda Baillie, Farm-Forestry New Zealand (2005)

Challenges and Research Questions

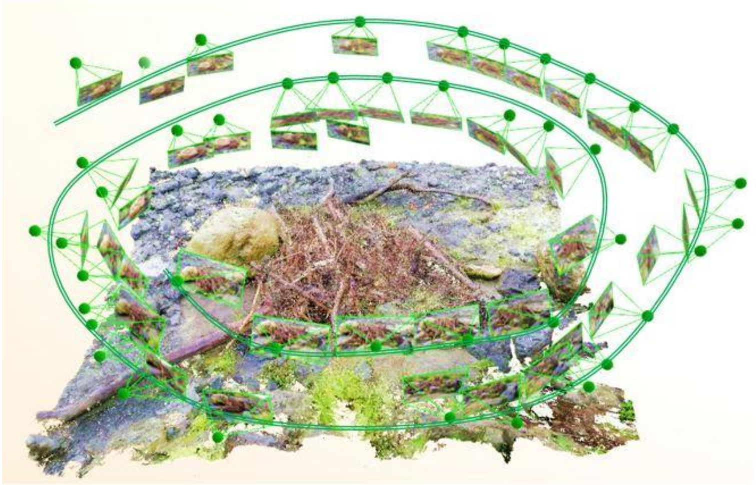


- Mobilisation and Transport
  - When and how does LW move?
- Depositional Processes
  - Key-logs, orientation and geometries?
  - Accumulation volume and porosity?
- Risks
  - Backwater effects? → change in energy gradient and flooding.
  - Changes in channel morphology? → aggradation and erosion
  - Impact forces? → damage infrastructure and instream structures.

Surveying Techniques

- Laser Scanning

- Structure from Motion (SfM) Photogrammetry

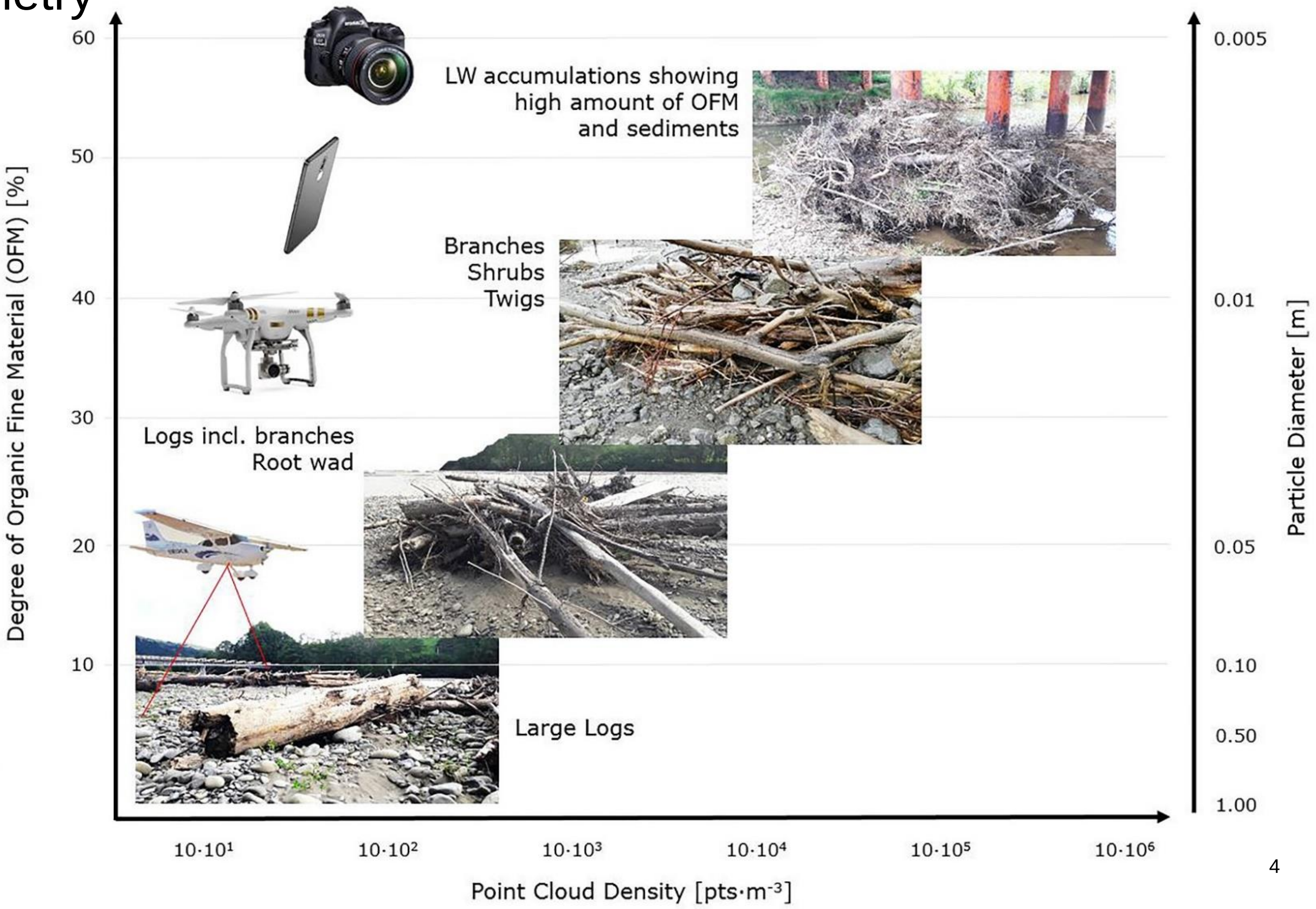


✓ Standard image sensor

✓ High photo count

✓ Low depth of field

Spreitzer et. al., Geomorphology 346 (2019)



Traditional Data Acquisition

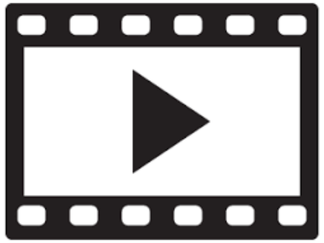
- Requires reference points (e.g., Ground Control Points, CCTags, Chequerboards)
- Requires access to the field site
- Requires time

Rapid Data Acquisition

- Structure from Motion (SfM) Photogrammetry using close-range aerial video footage

- Model scaling via

Close-Range Aerial Video Footage

+

GPS-Data From Flight Log File

Latitude/X	Longitude/Y	Altitude/Z	Compass heading (°)	Pitch (°)	Roll (°)	Gimbal heading (°)	Gimbal pitch (°)
46.4231344	9.01966602	928.861639	106.8	-0.4	0.2	105.4	-46.9
…	…	…	…	…	…	…	…

Processing

- Pix4DMapper (version: 4.5.6) – Close-range aerial video footage

✓ Load Video (~46 s) in **Pix4DMapper** and extract every 3rd image from the video → Photo count: 370 images

✓ Extract GPS-data via AIRDATA UAV software (app.airdata.com/flight) → Import into Pix4DMapper

✓ Initial processing → Default settings; Camera optimisation: 0.24; Processing time: 1h 18m

✓ Process point cloud and mesh model → Default settings; Processing times: 2h 15m and 5m

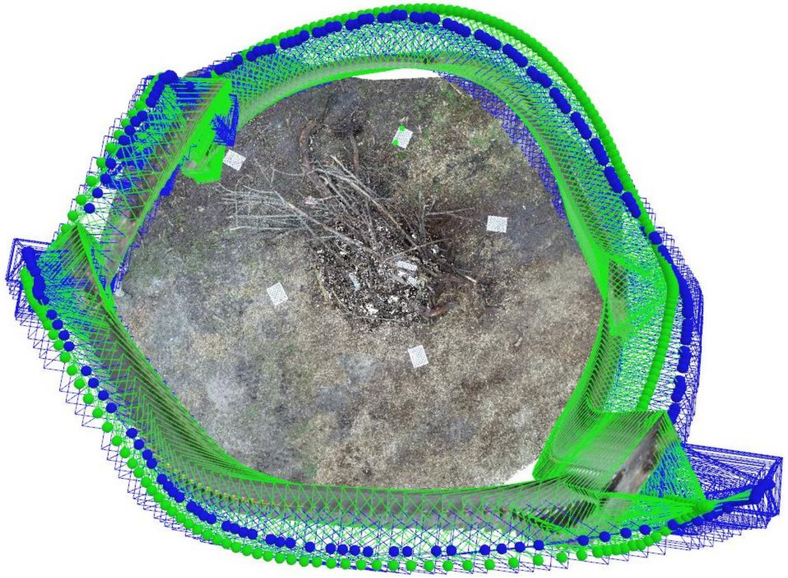
✓ Digital surface model (DSM) generation → Settings: Noise filtering: no; Surface smoothing: yes, Type: sharp

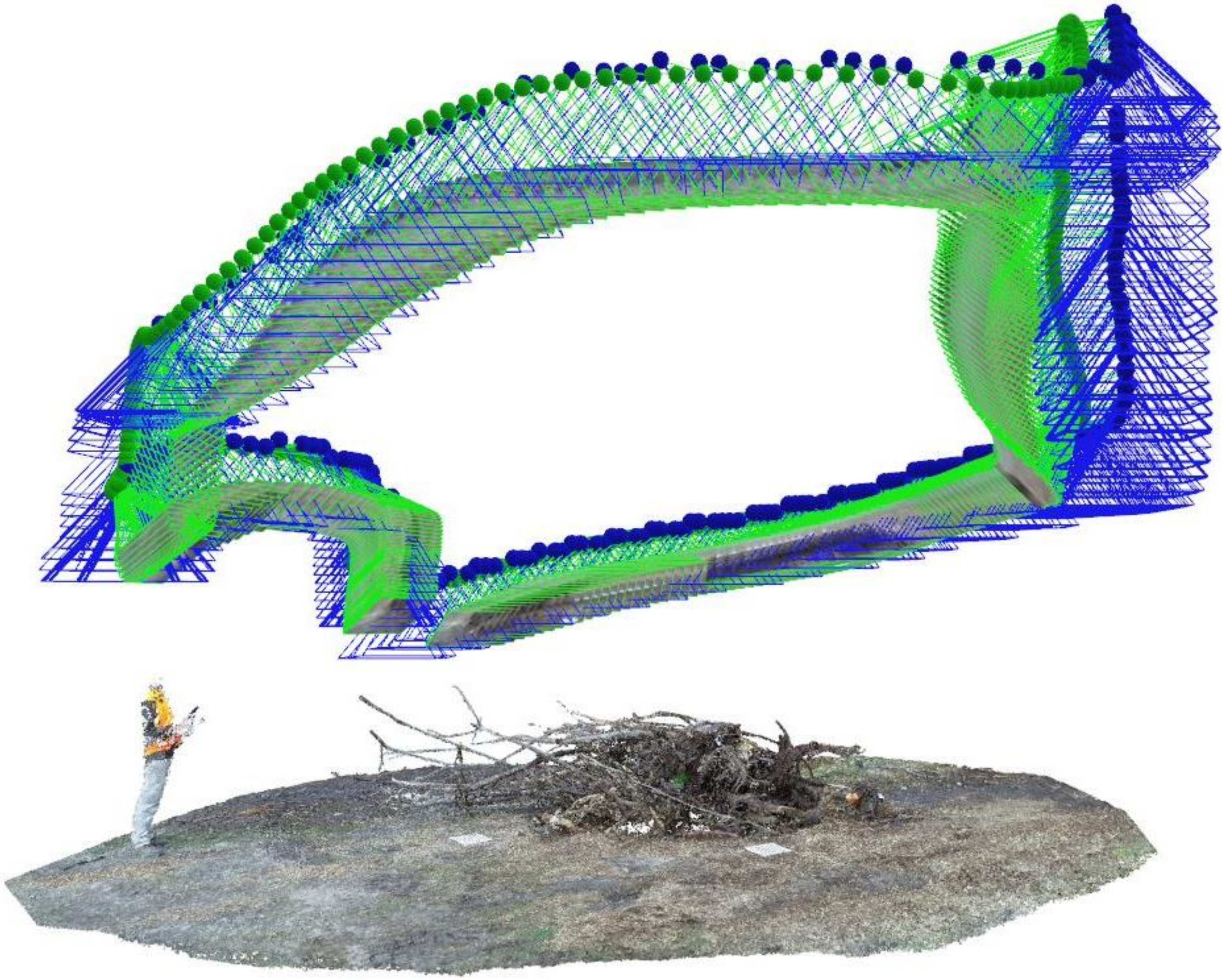
→ Processing time: 10m

✓ Obtain reference measurements from chequerboards (checkpoints) to control for relative model accuracy

Results

- SfM photogrammetry from video footage
  - ✓ Flight route: circular
  - ✓ Video length: 46 seconds
  - ✓ Images extracted: 370
  - ✓ Final scaling: GPS-data
  - ✓ Total processing time: 4h





Green: Computed camera location via Pix4DMapper

Blue: Camera location from GPS

Results

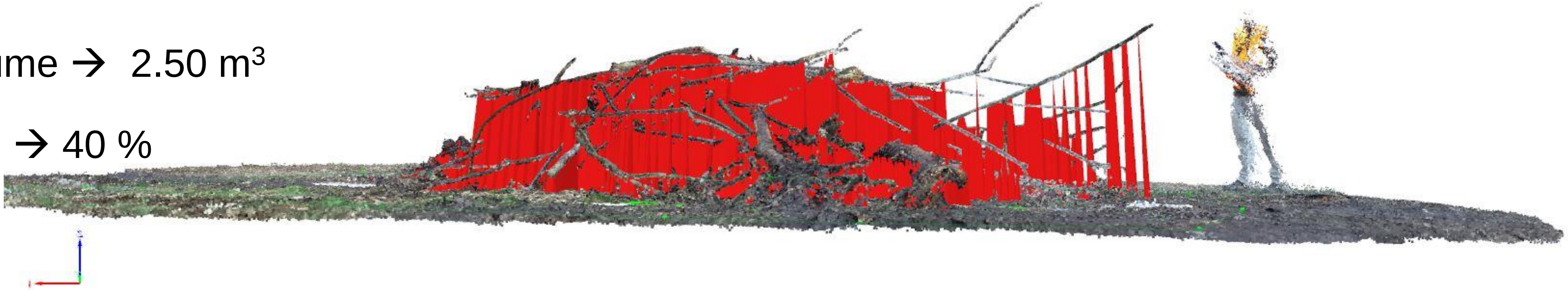
- SfM photogrammetry from video footage (46 s video; 370 extracted images; scaled from GPS; 4h)

Point Cloud → 11M Points

2.5D Volume → 4.19 m^3

3D Volume → 2.50 m^3

Porosity* → 40 %



Relative Model Accuracy → (-) 0.03 m/m

Porosity* = 100 · $\frac{V_{2.5D} - V_{3D}}{V_{2.5D}}$

* Note: Porosity estimate based on Spreitzer et al., Journal of Hydrology 581 (2020)

Results

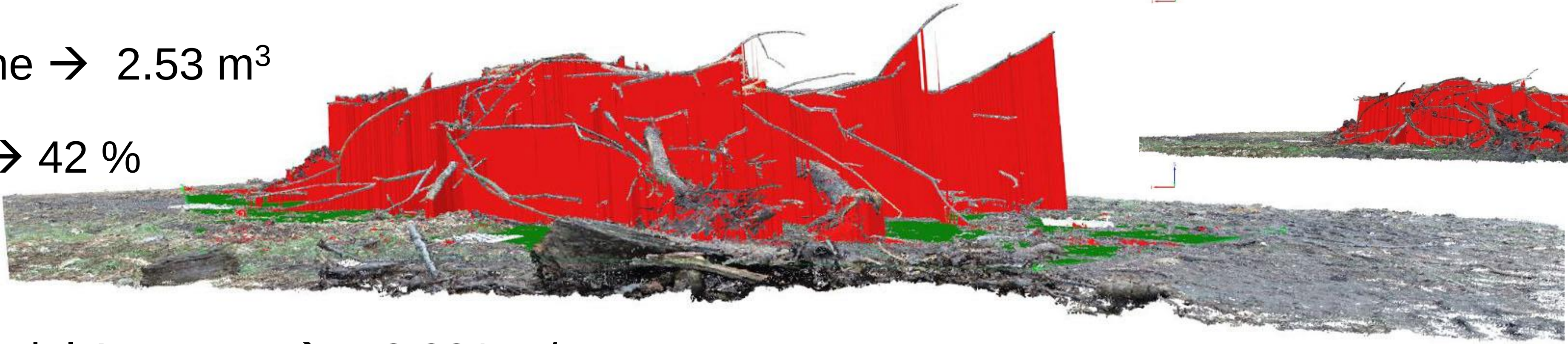
- Traditional SfM photogrammetry from high resolution imagery (326 images; traditionally scaled, 8h)

Point Cloud → 68M Points

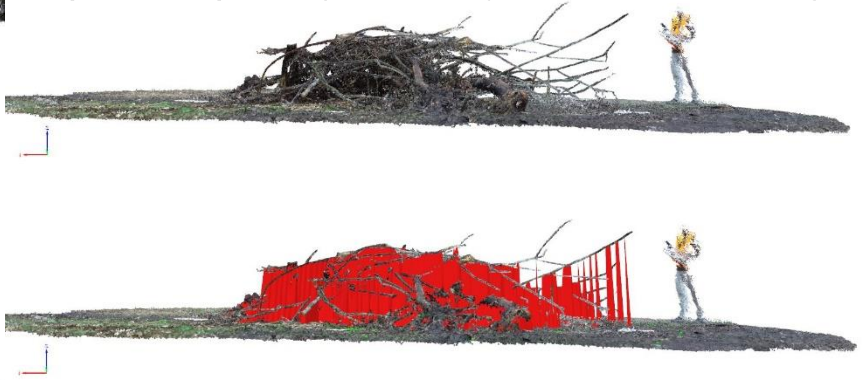
2.5D Volume → 4.39 m^3

3D Volume → 2.53 m^3

Porosity* → 42 %



Rapid SfM photogrammetry from video footage



Relative Model Accuracy → <0.001 m/m

* Note: Porosity estimate based on Spreitzer et al., Journal of Hydrology 581 (2020)

Comparison of Results

- Video footage vs. traditional SfM photogrammetry

	Video Footage	Traditional Imagery	Conclusion (pro video footage)
Scaling via	GPS-data	Chequerboards	significant cost and time benefits
Point Count	11M	68M	6x less points to handle
2.5D Volume	4.19 m^3	4.39 m^3	<5% 2.5D Volumetric deviation
3D Volume	2.50 m^3	2.53 m^3	<1.5% 3D Volumetric deviation
Porosity	40%	42%	<5% deviation in porosity
Model Accuracy	(-) 0.03 m/m	<0.001 m/m	Lacking in accuracy

Discussion - Rapid Data Acquisition

- Rapid data acquisition: 46 second flight time
- Scaling from GPS-data → No additional GCP, CCTags, or checkerboards required
- No access to immediate field site necessary
- Some challenges involved (not fully explored to date as video footage does not provide GPS-data)
  - No user-friendly GUI available to date
  - Expected inaccuracies due to manual GPS-data extraction and merging with the video footage (extracted images).
  - Further development is required in order to simplify the process of GPS-data extraction and merging with video footage (must be synchronised in time). Software developer may consider a built-in video clipping tool, with access to the flight record log file, which can then be trimmed and extracted together. Significant advance for rapid surveying and mapping.

Aims and Outlook

- Employ innovative surveying techniques in LW research

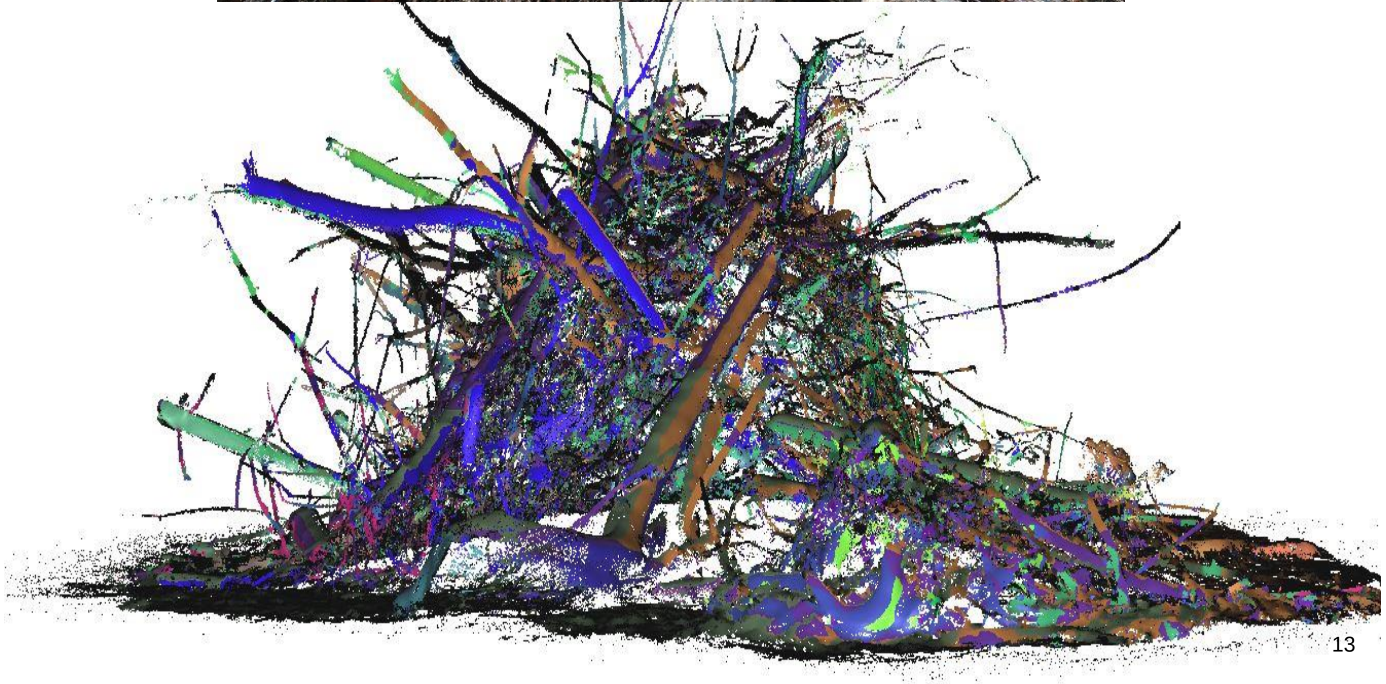
- Provide an efficient workflow-pipeline

- Cooperation with and support from software developing companies - meet our needs and create new opportunities

- Improve quality of 3D-models

- Merge gained results for comprehensive understanding of LW dynamics in rivers

Site Photo, Val Malvaglia (2020)



Thank you for your attention!

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