FLOOD HAZARD MAPPING AND EVALUATION OF RIVER IMPACTS WITH LIDAR, DRONES AND HYDRAULIC MODELLING

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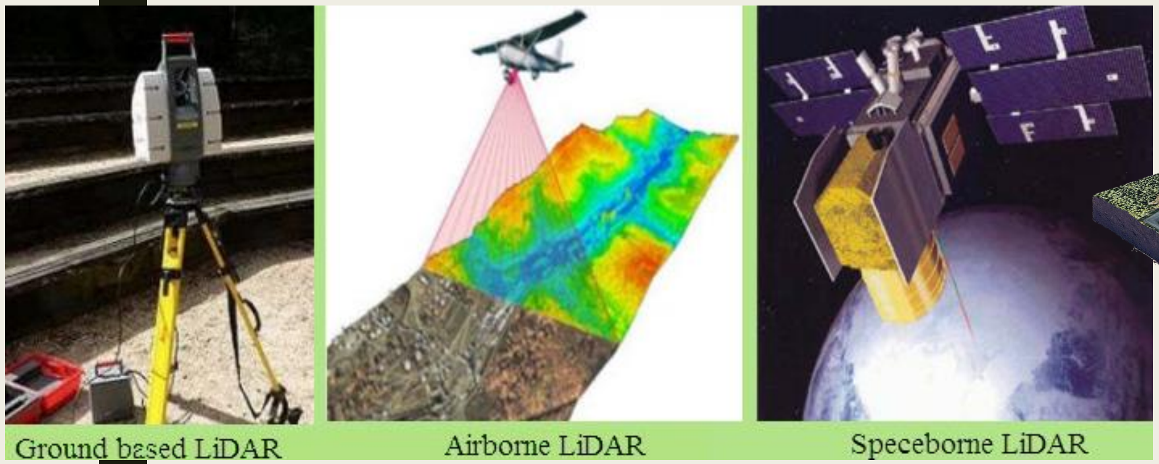
29.04.2021

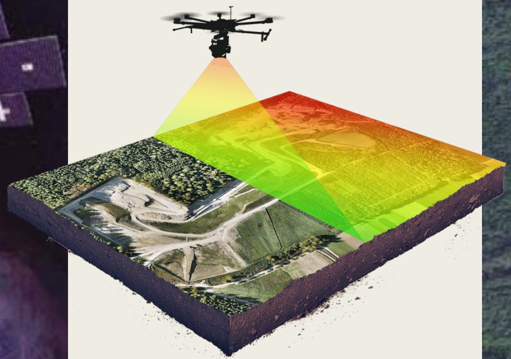
Lidar

LIght Detection And Ranging, also called laser scanning

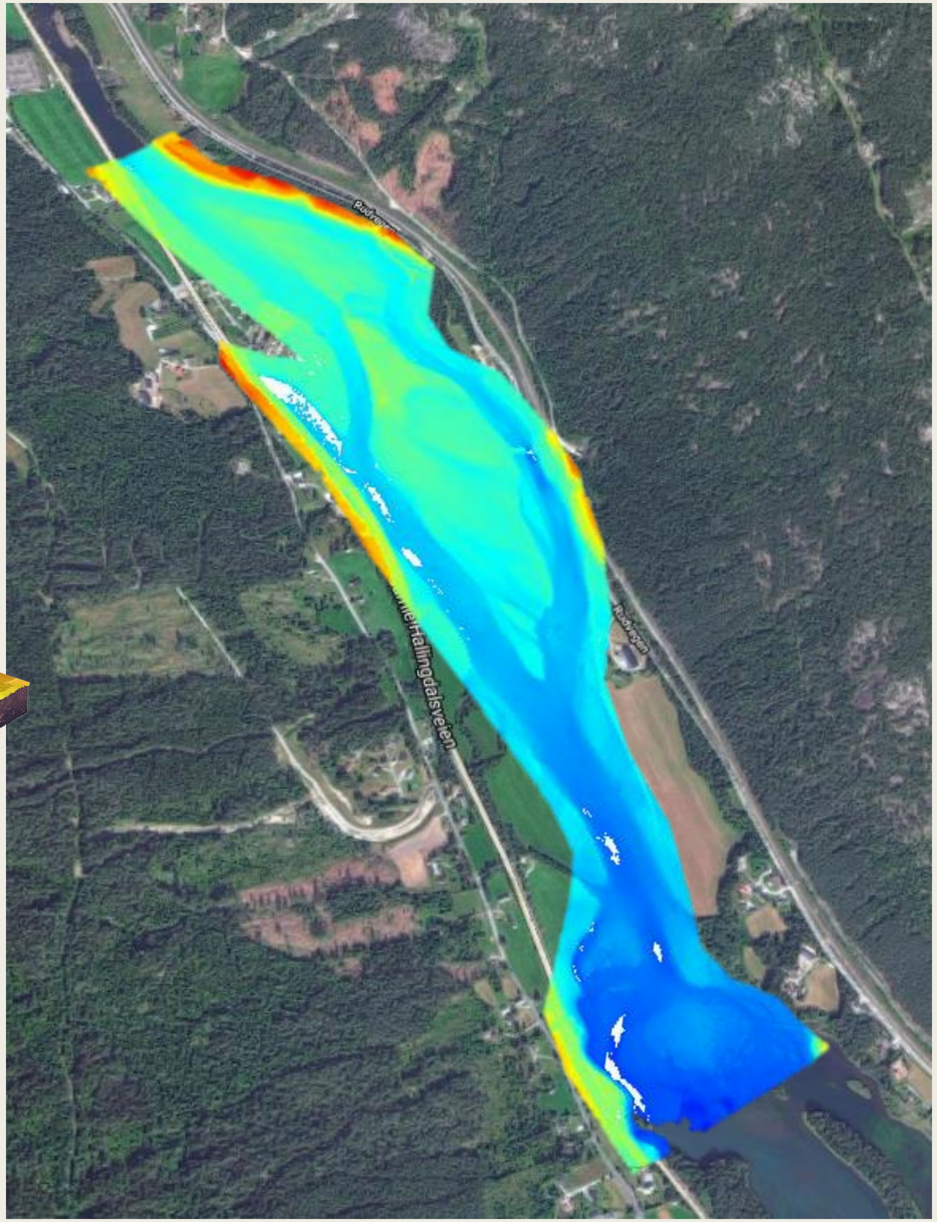
There are different types depending on: platform used, physical process or scattering process.

Based on the Platform used we find 4 types of LiDAR





Drone LiDAR



3 km long

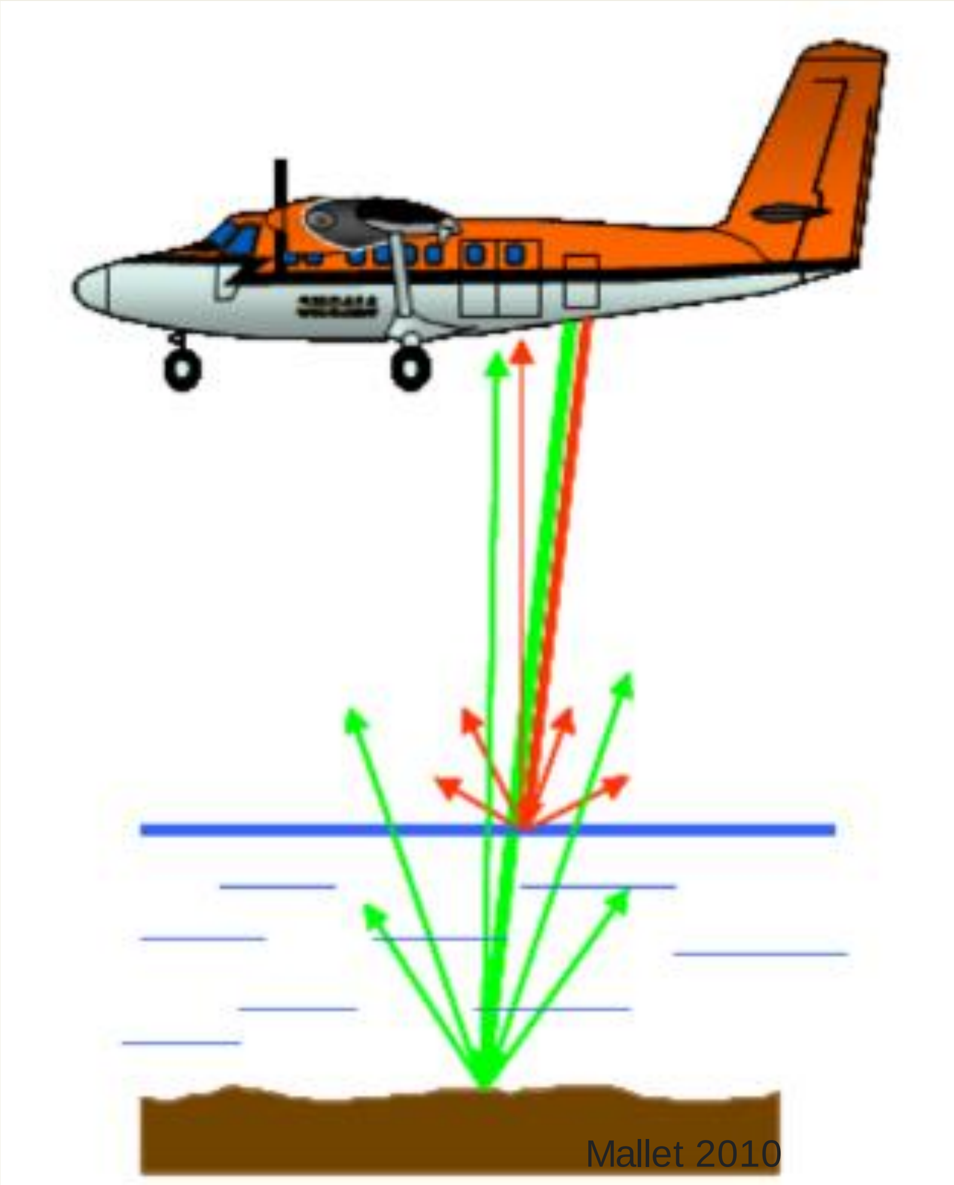
LAZ or LAS format files

Airborne Lidar

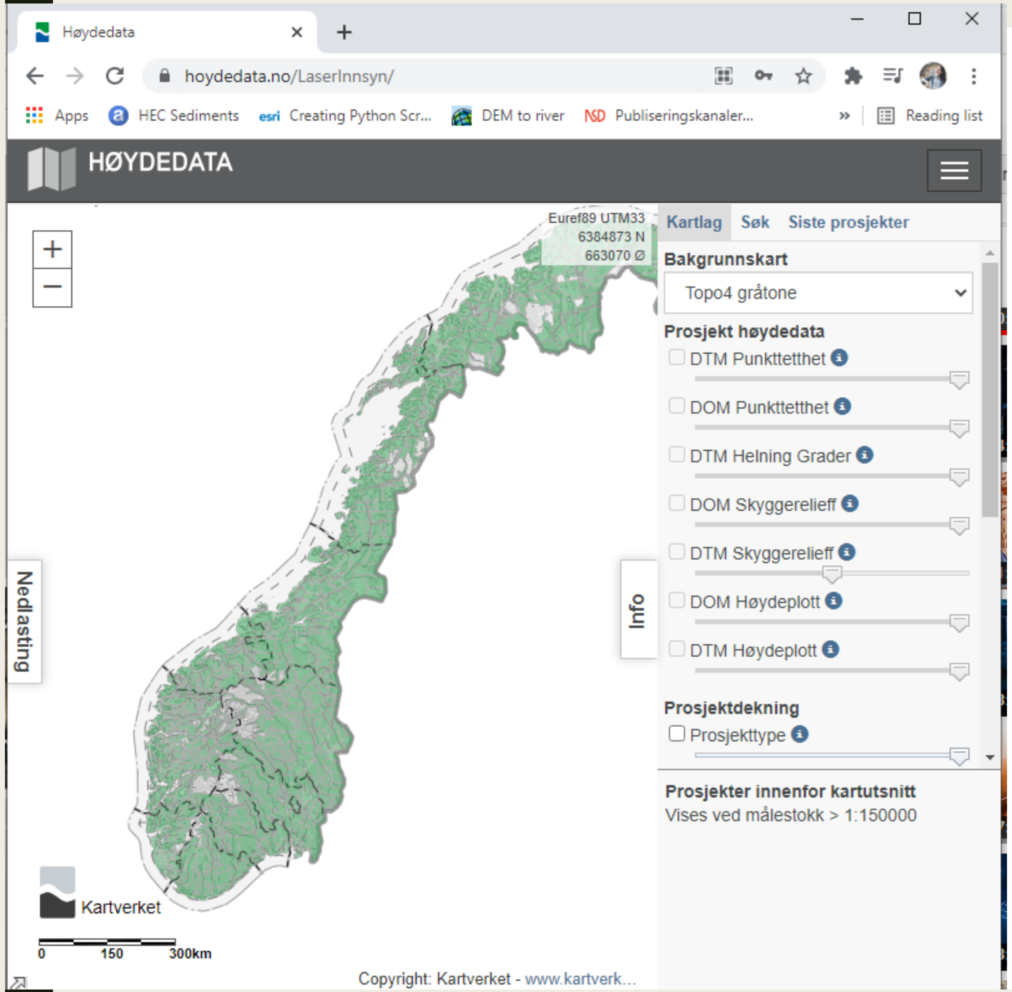
- Airborne LiDAR is one of the most effective and reliable means of terrain data collection
- Using airborne LiDAR data is becoming the most used technique for generating digital elevation models (DEM)

According to the type of sensor we find two types of lidar

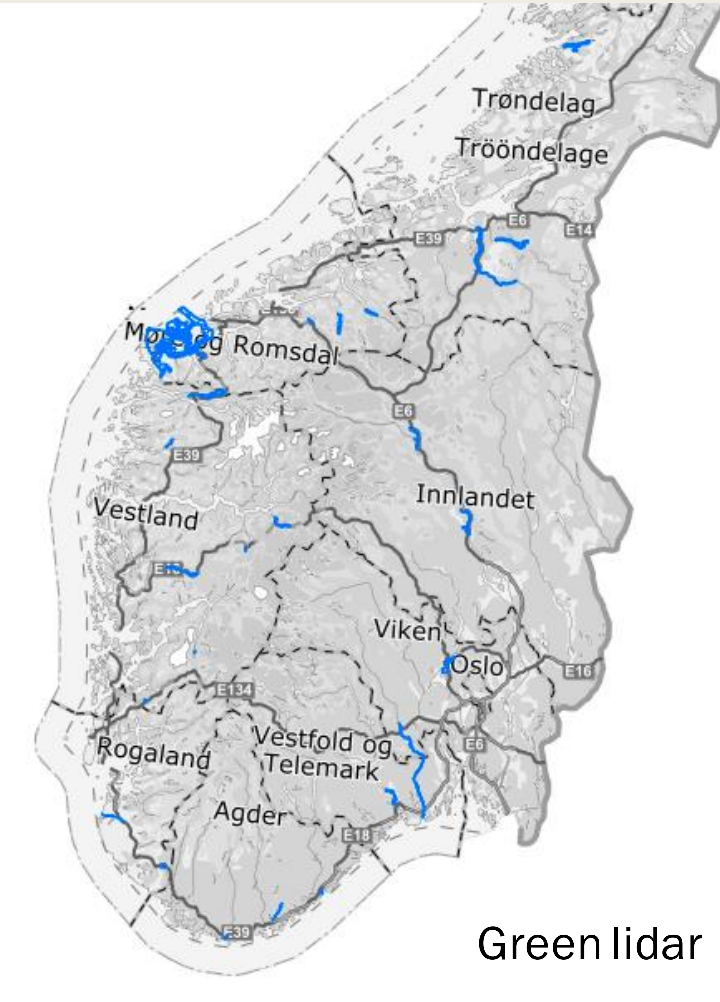
- Red lidar, does NOT penetrate water covered areas
- Green lidar, which can penetrate water covered areas



Lidar in Norway



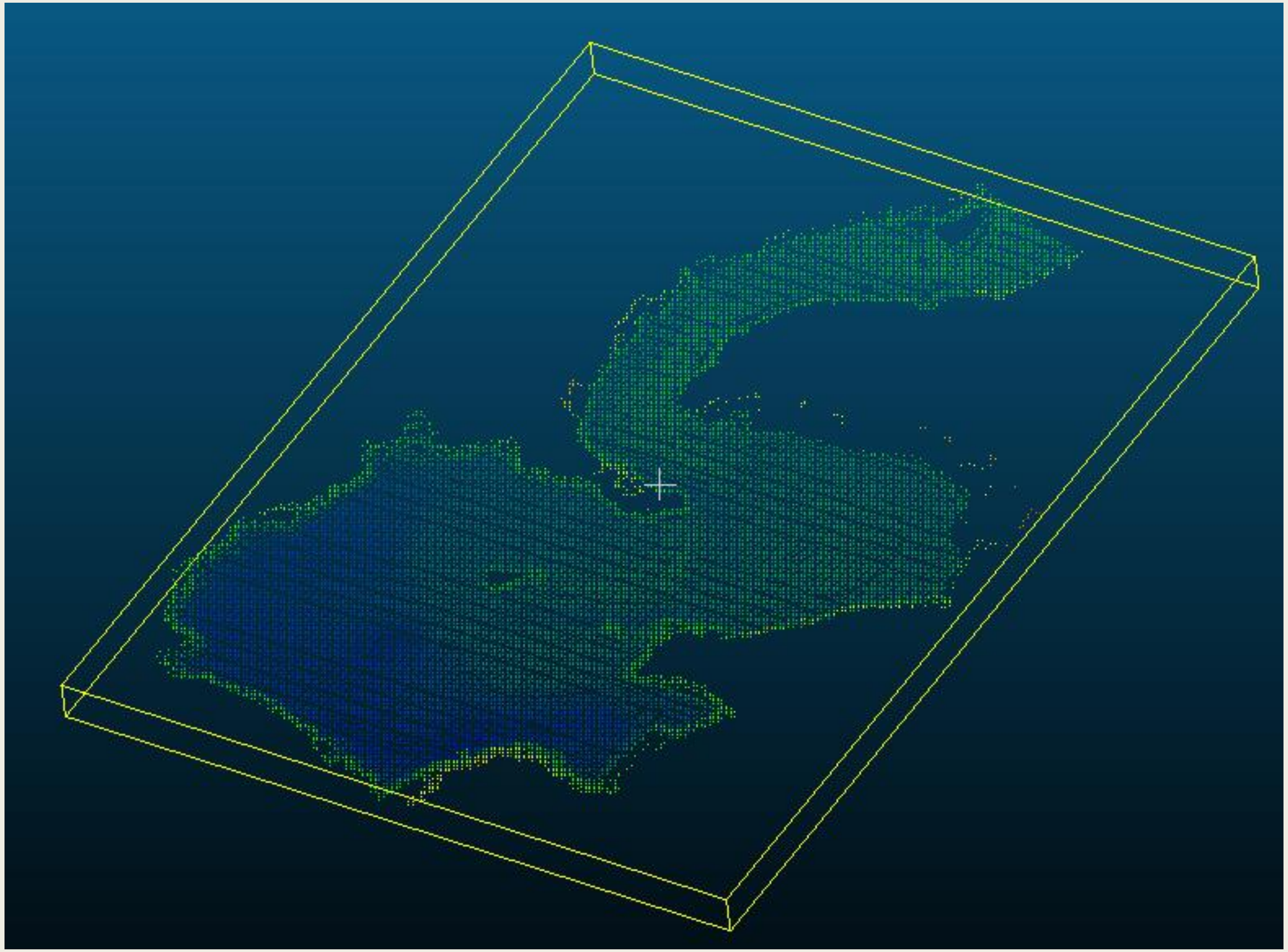
Red lidar



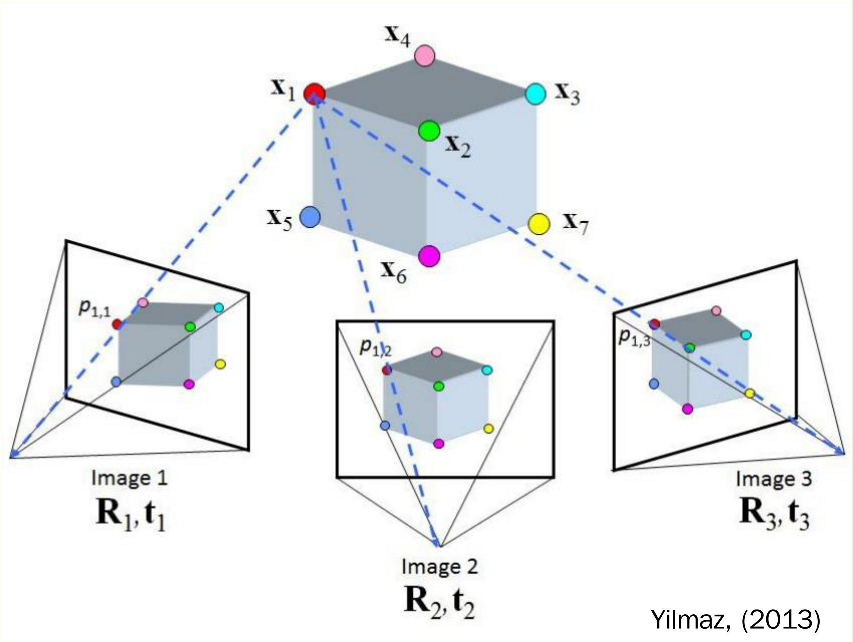
Green lidar

https://hoydedata.no/LaserInnsyn/

Ground based lidar



Drones and Structure from motion



Structure from Motion or **SfM** is a photogrammetric method for creating three-dimensional topography model from overlapping two-dimensional photographs taken from many locations and orientations to reconstruct the photographed scene.

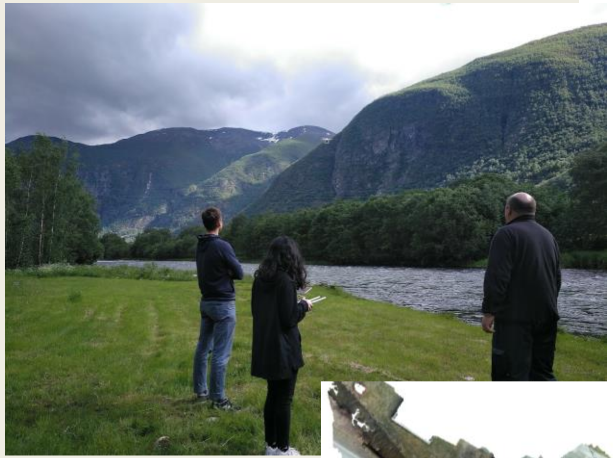
How to measure with a drone?

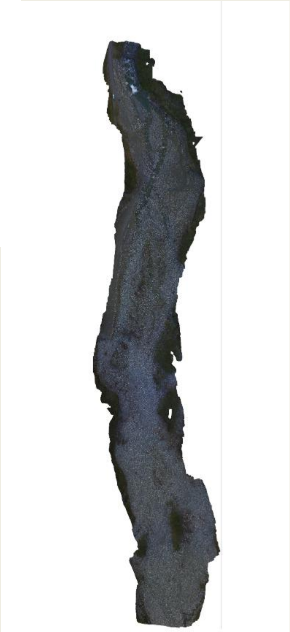
Applications

- Site recognition
- Compute wetted area for calibration
- Generate DEM for hydraulic modelling



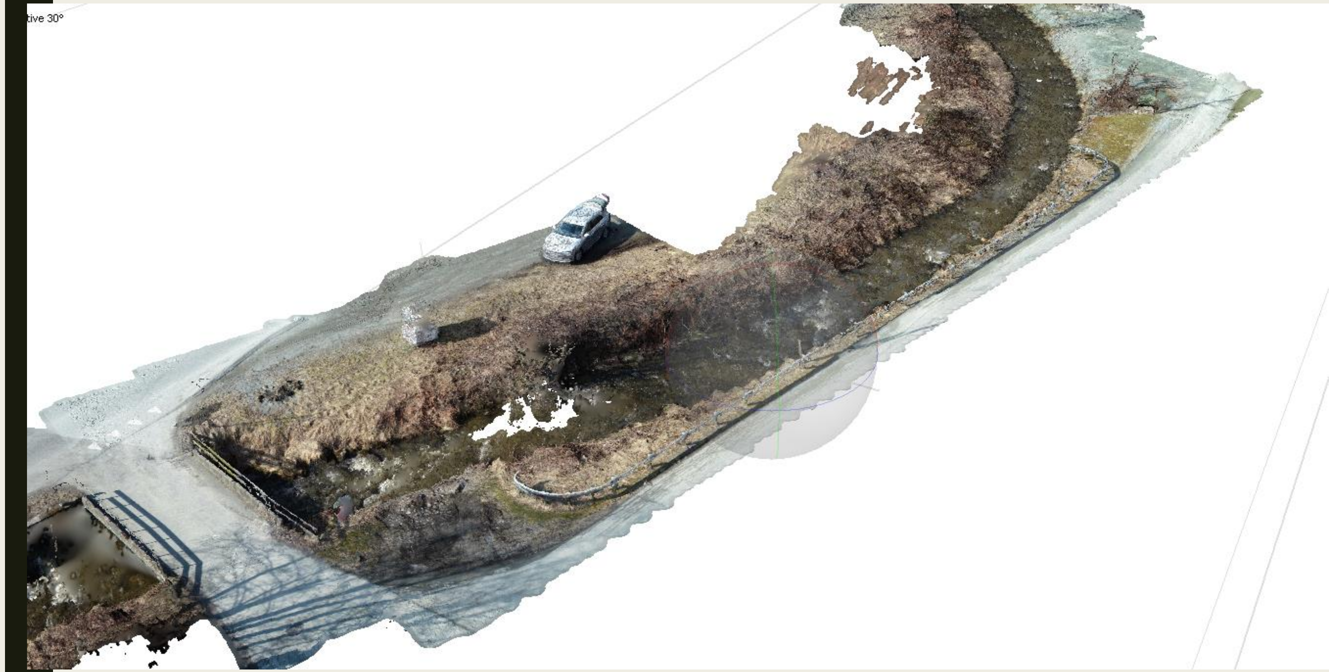




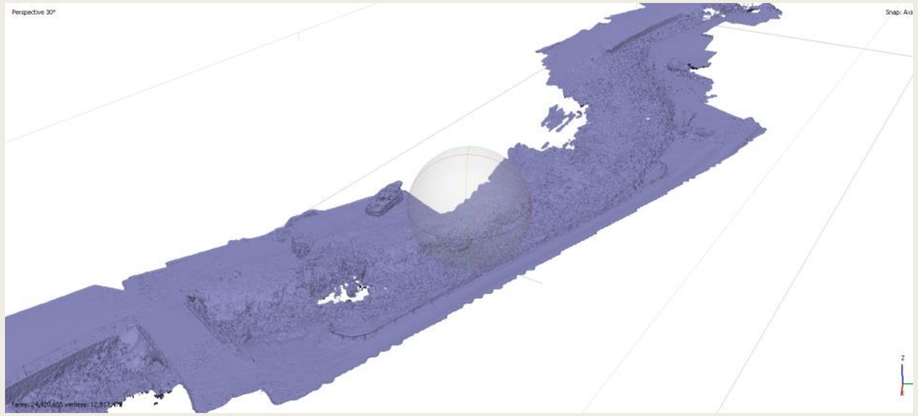



How to process the data

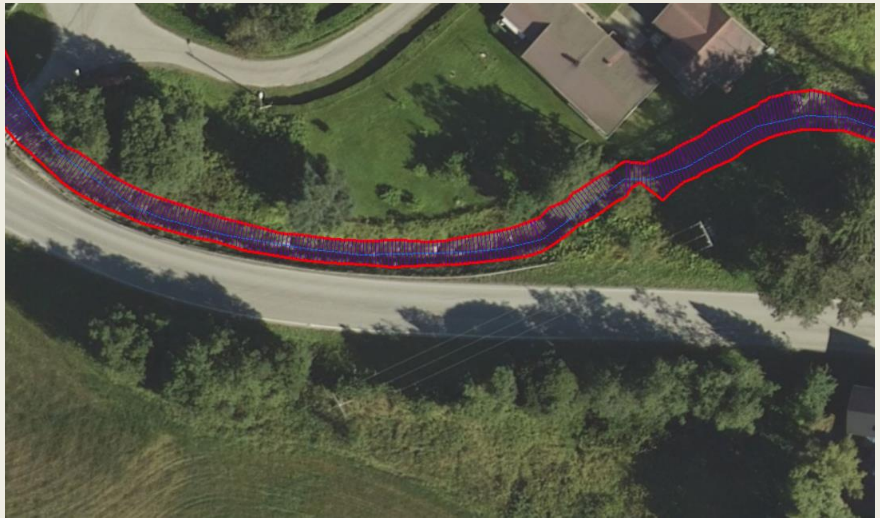
Kaldvella, Melhus



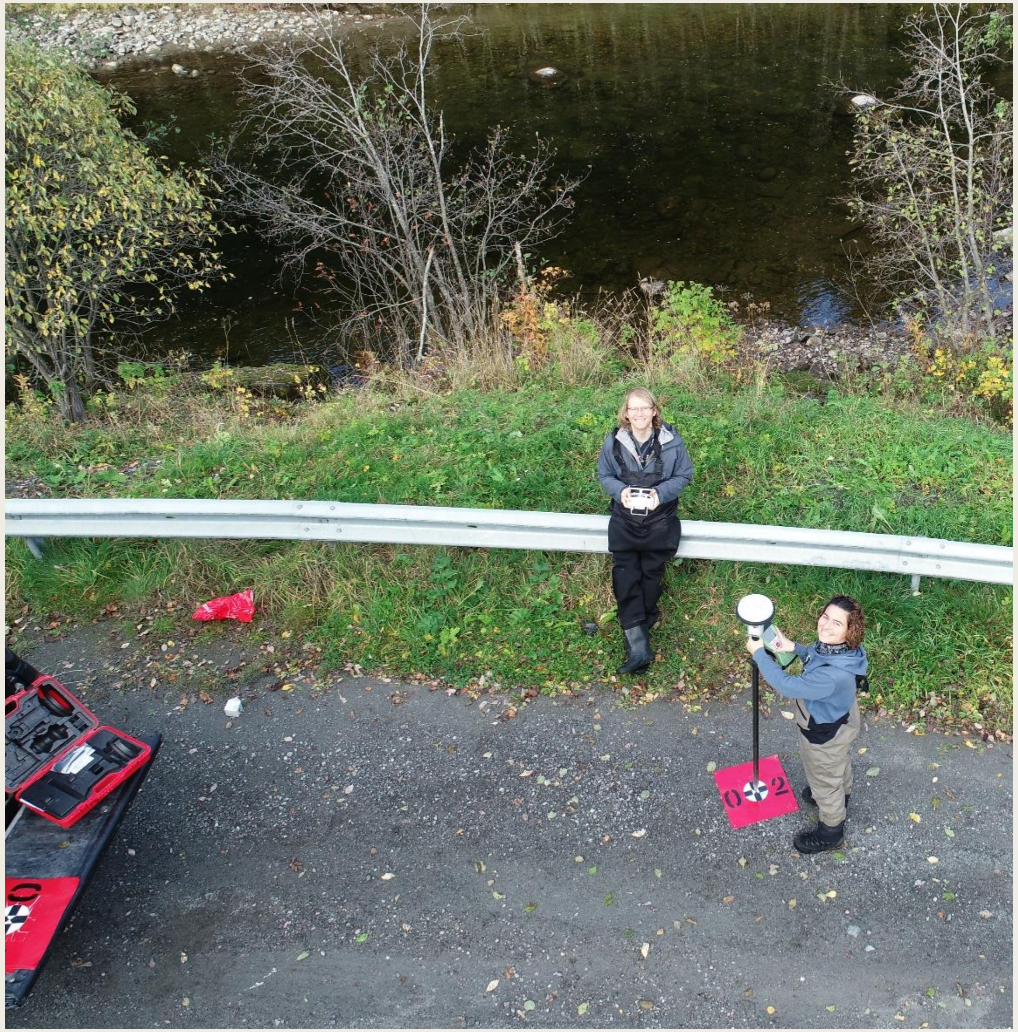
DEM



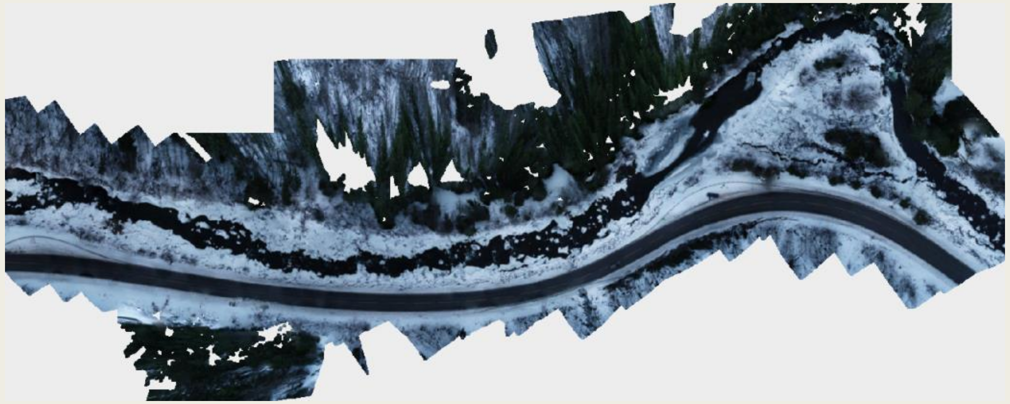
ORTHOMOSAIC

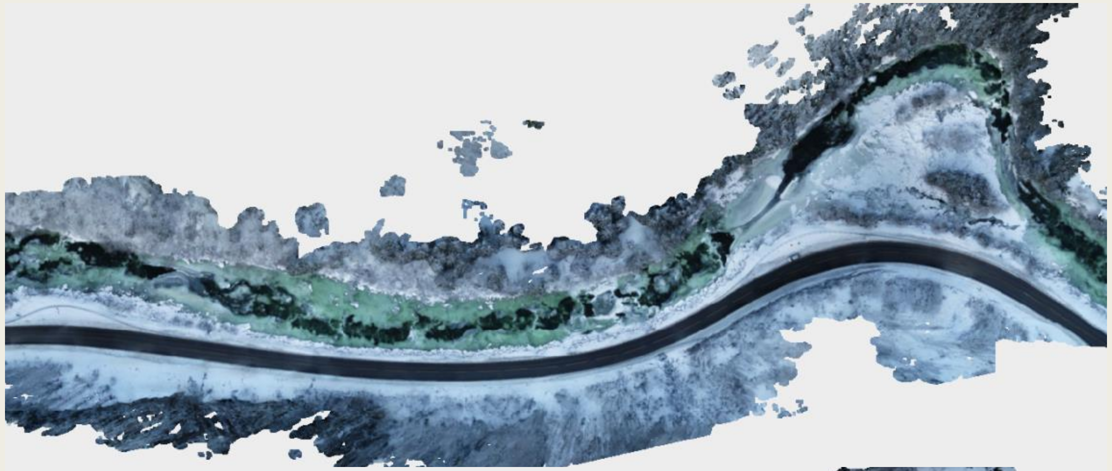


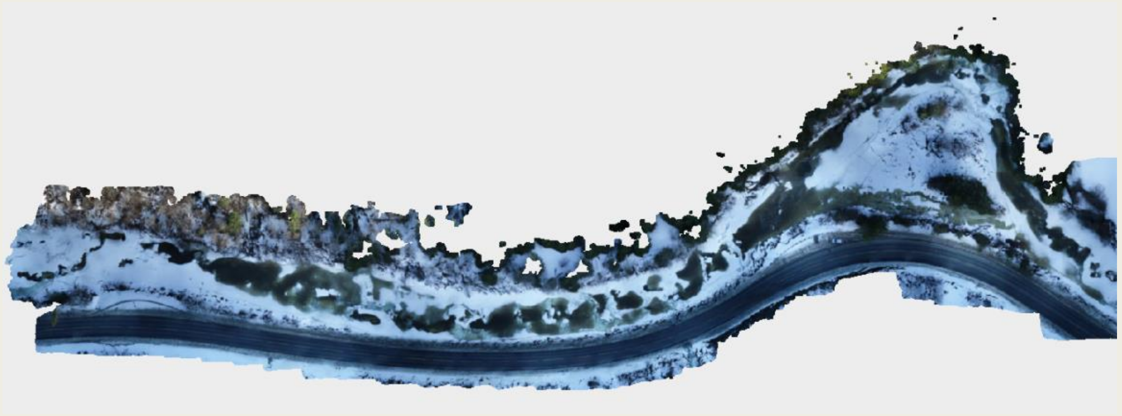
Drones and Structure from motion for ice mapping




Ice quantification with drones





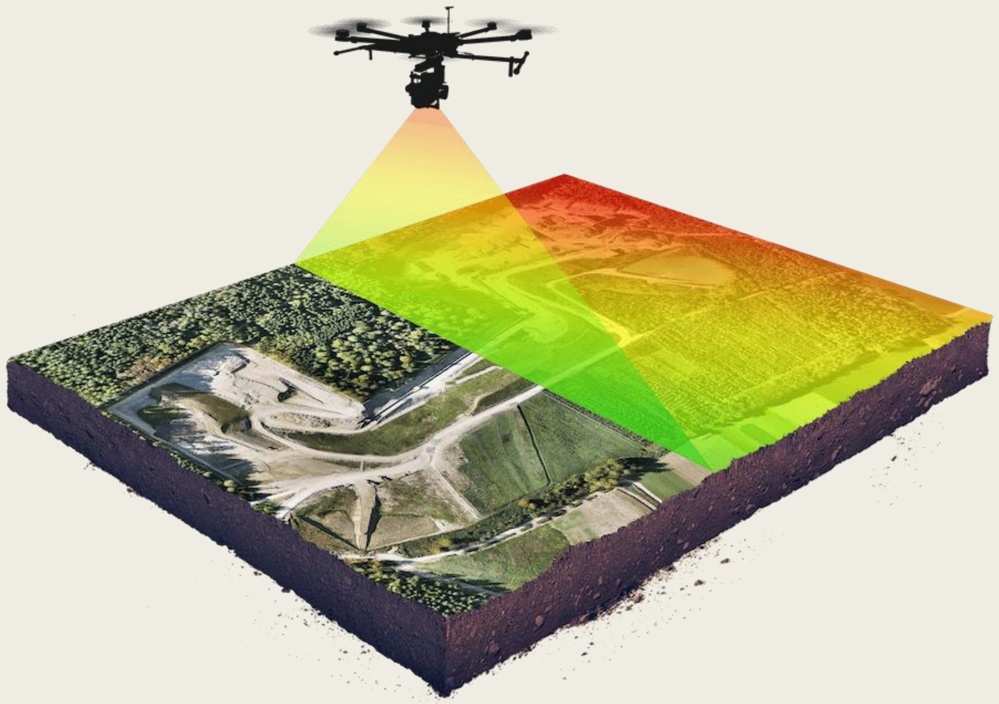


Einar Rødtang and Knut Alfredsen

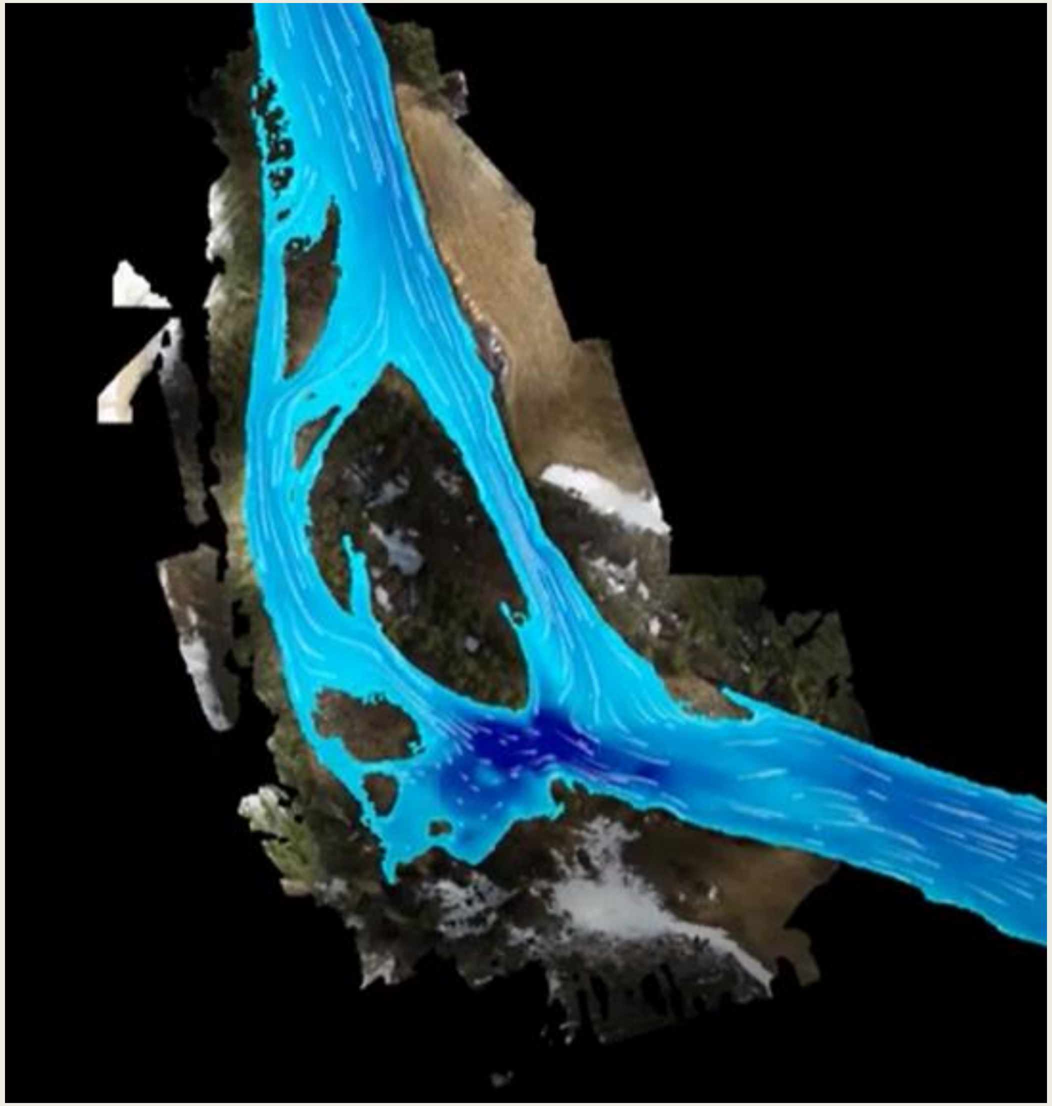
Ice impact on rivers

Site inspection with drones

Drones using lidar



Hydraulic modelling



High accuracy thanks to lidar ☺

Kvalitetskontroll !

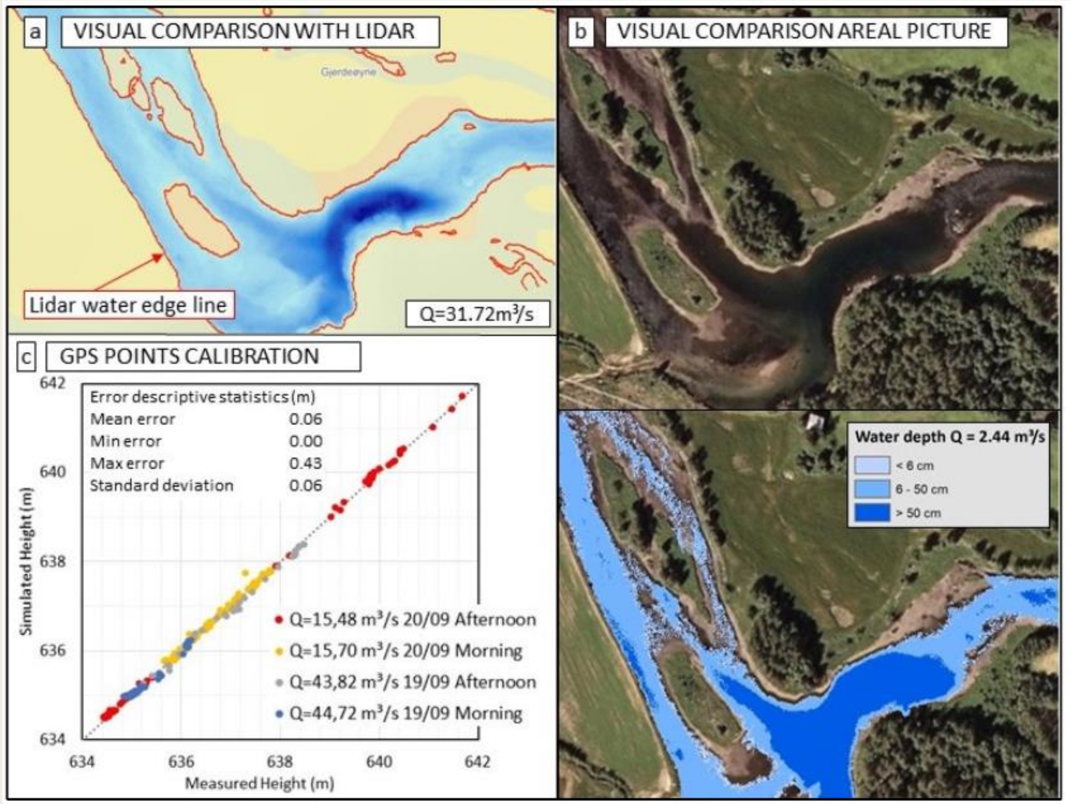
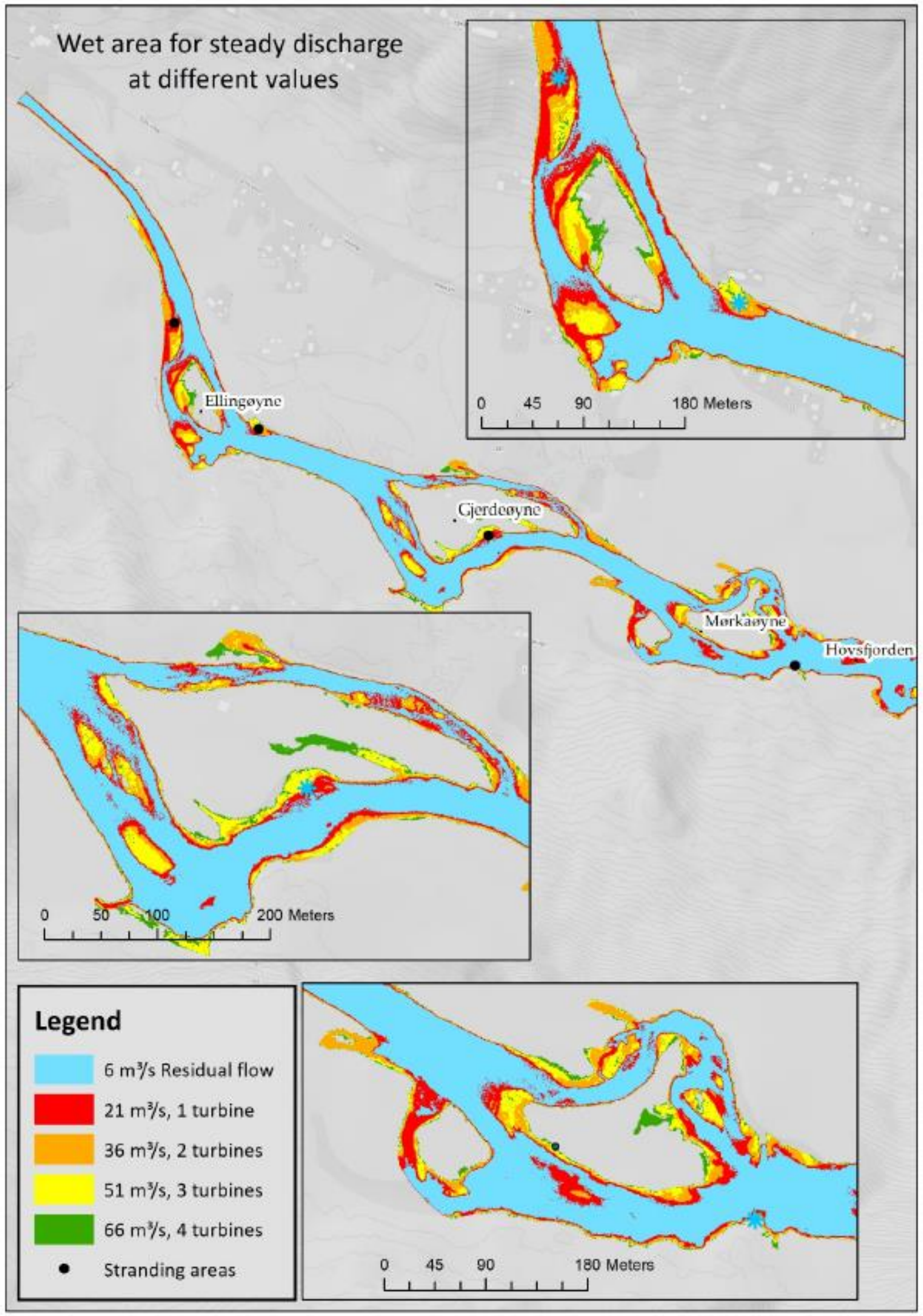


Figure 3. Calibration: (a) Comparison with LiDAR water edge recorded the day of the flight (Red) at $Q = 31\ m^3/s$, (b) Comparison with Norge i bilder picture at $2.44\ m^3/s$, (c) GPS points calibration.



Juarez et al (2019)

Evaluation of hydropeaking impact

We can evaluate the impact in the different parts of the river for different turbines scenarios

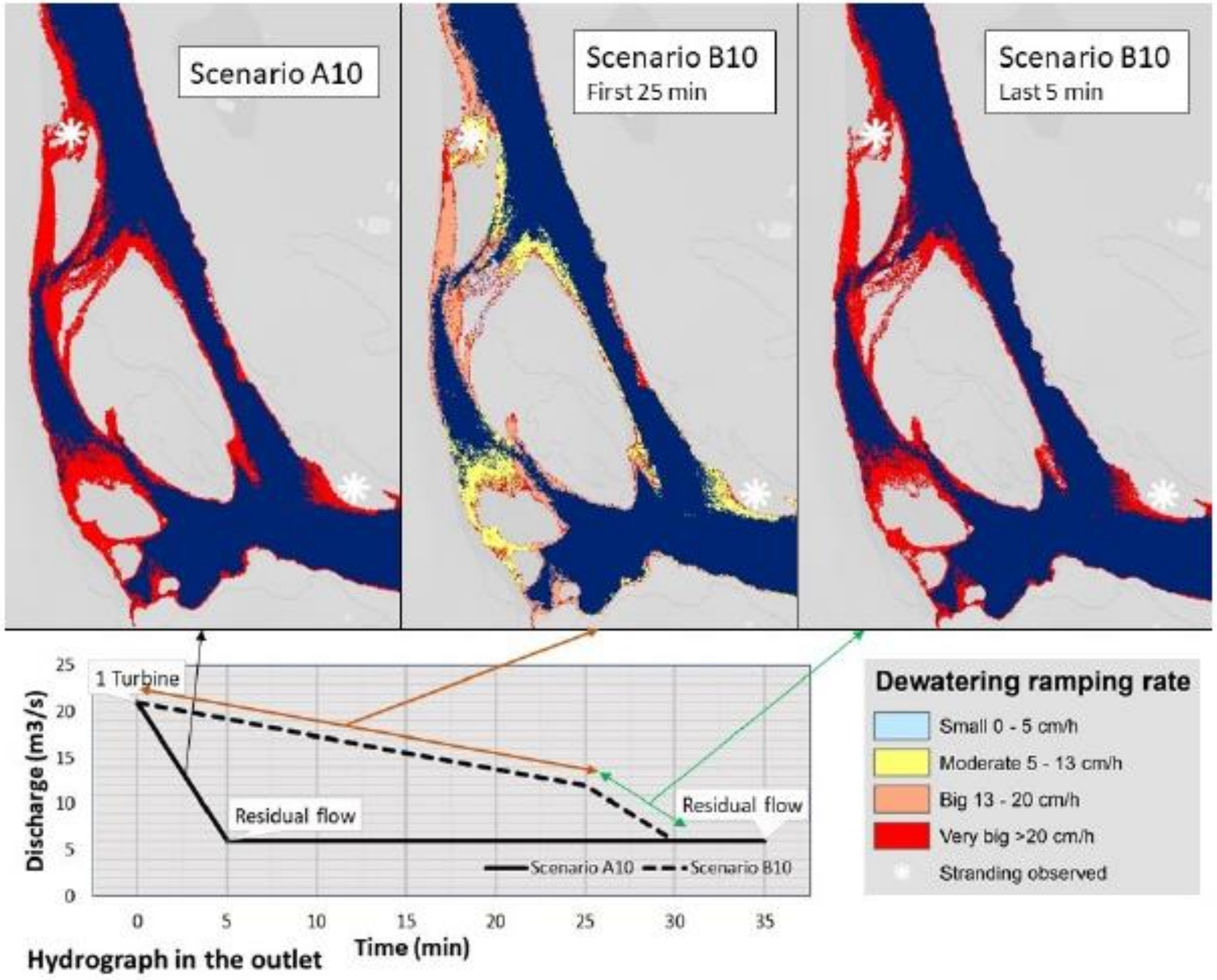


Figure 9. Dewatering rate (cm/h) in scenarios A10 and B10 in Ellingøyne, blue shows the wetted areas at the end of the ramping, the rest of the colors display the impact in the areas that are dried out during the ramping, the white stars show the areas where fish stranding has been observed.

Juarez et al (2019)

Hydraulic modelling

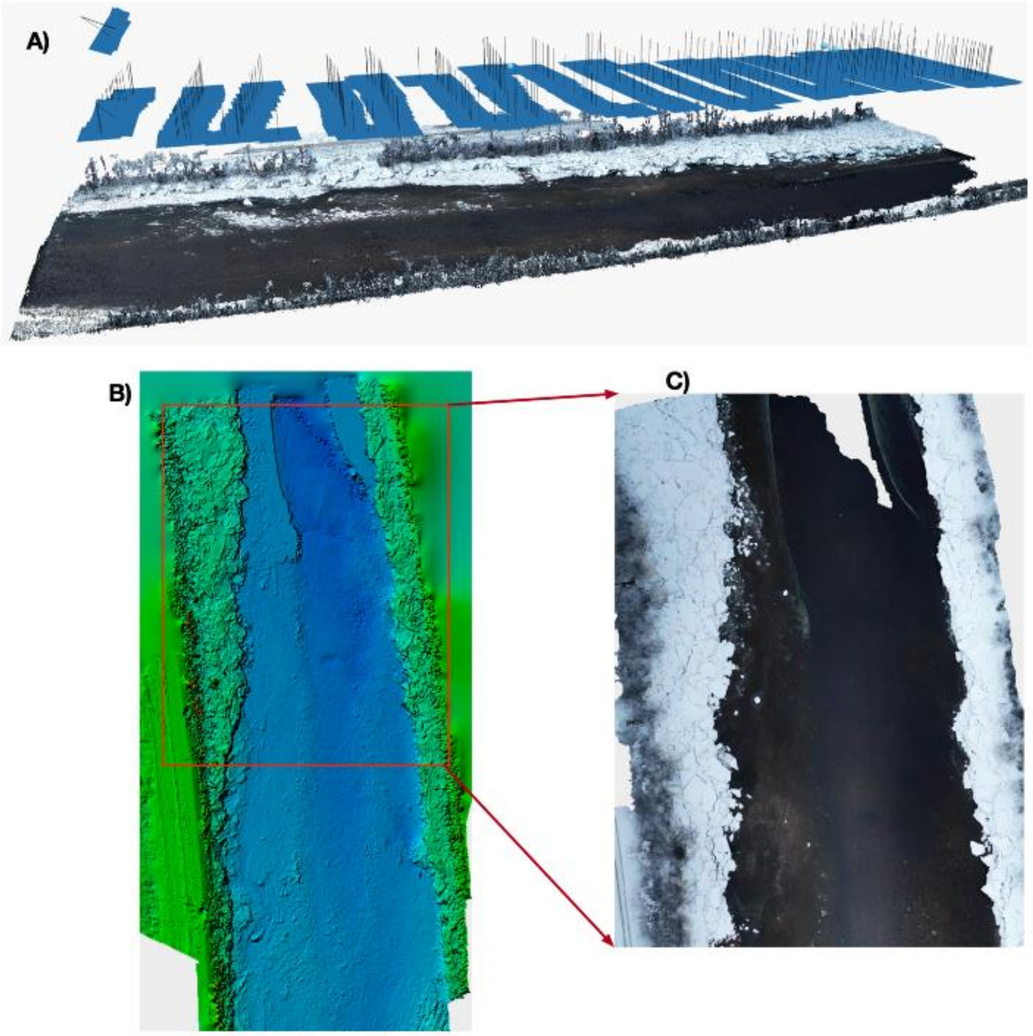
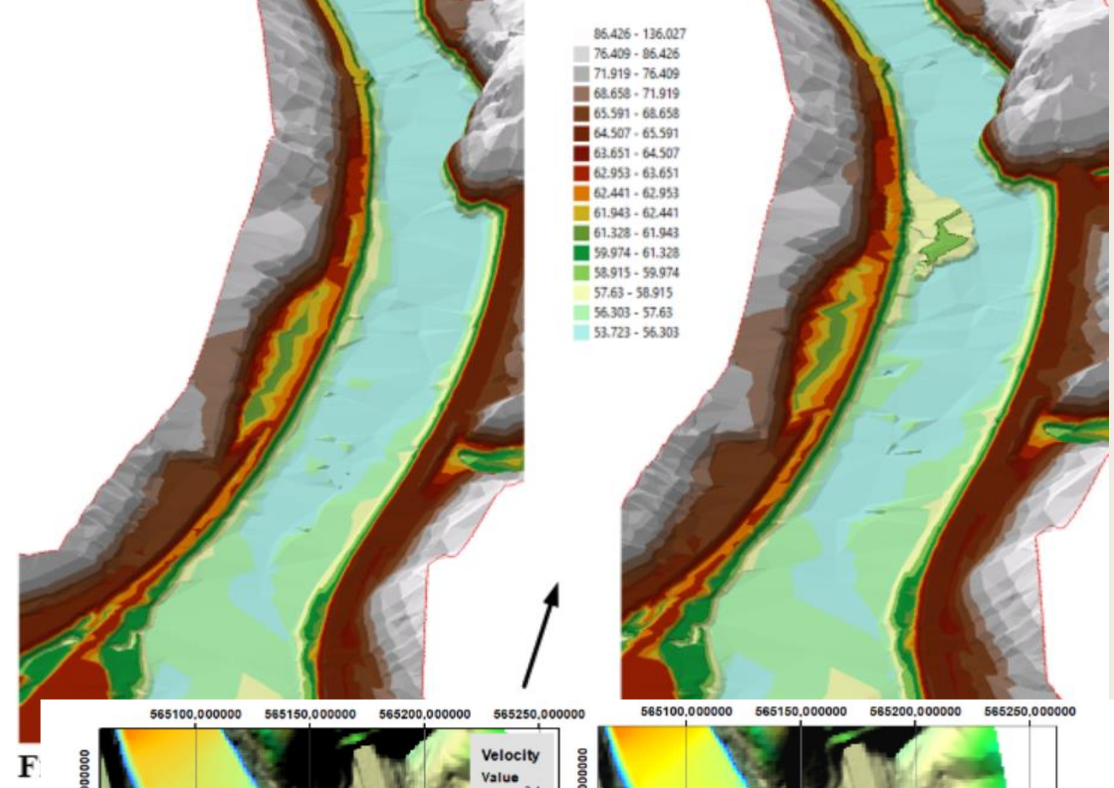


Figure 3 Dense point cloud with camera positions marked as blue squares (A), generated DEM from the dense point cloud (B) and orthophotomosaic showing the grounded ice (C).

Alfredsen et al (2020)



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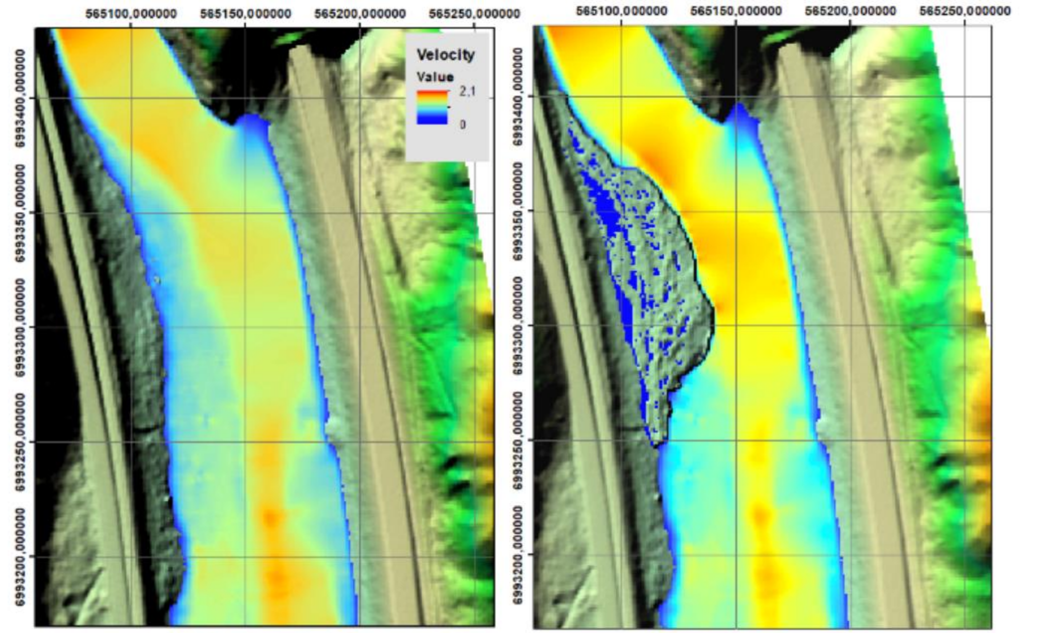
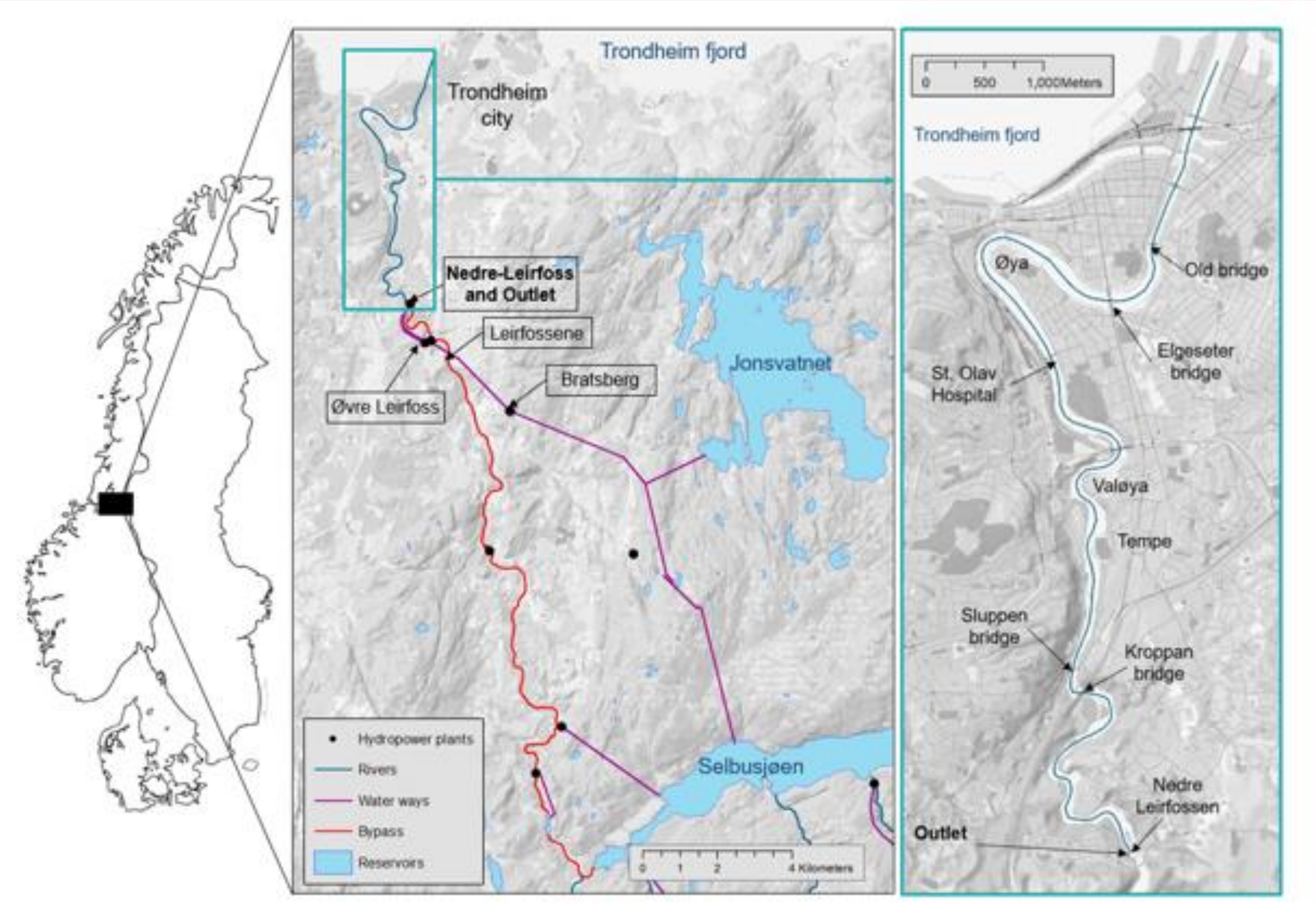


Figure 5 Simulated velocity for the 2017 case. River without ice in the left panel and river with grounded ice in the right panel. The discharge is 90 m^3s^{-1}.

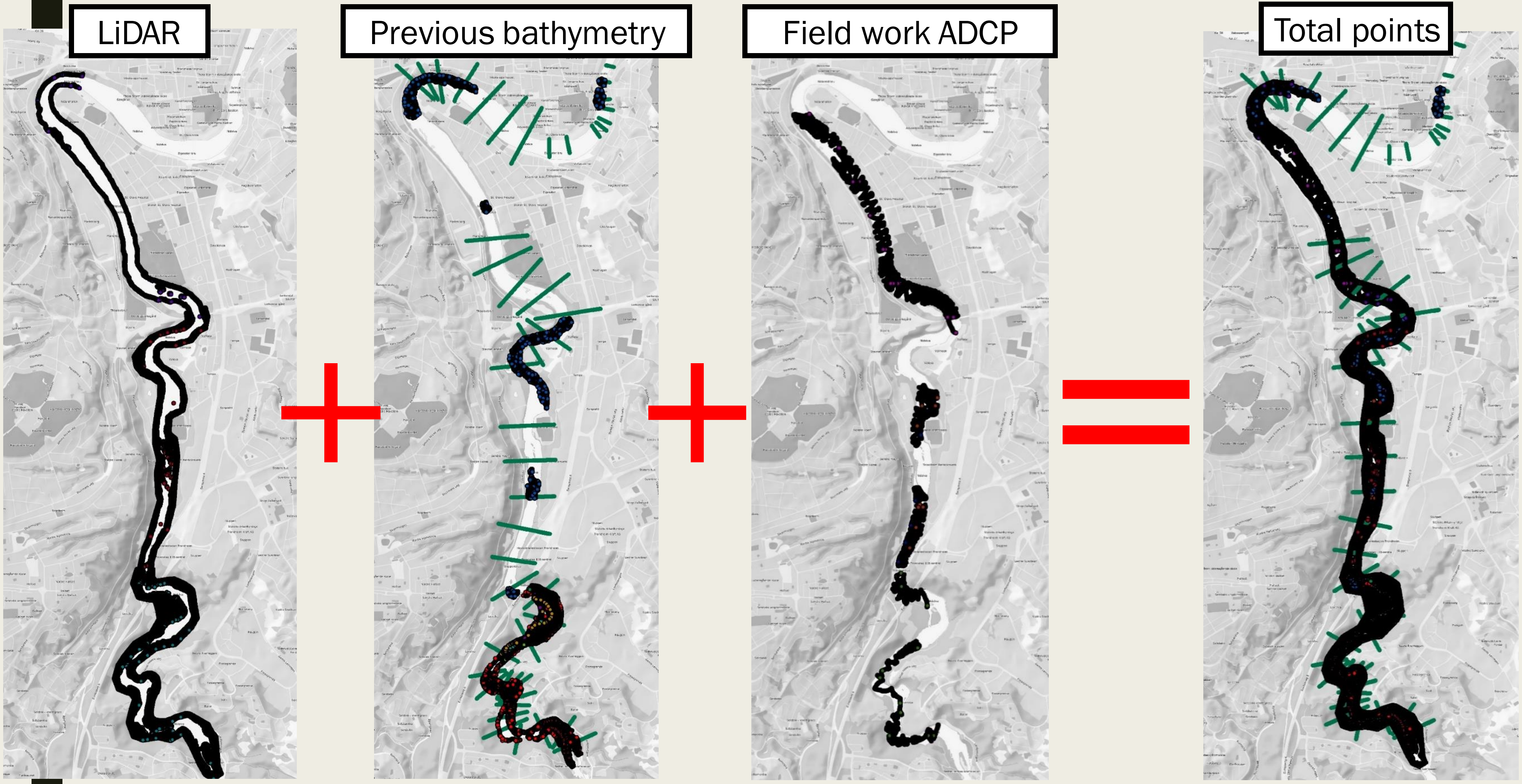
Hydroflex project,



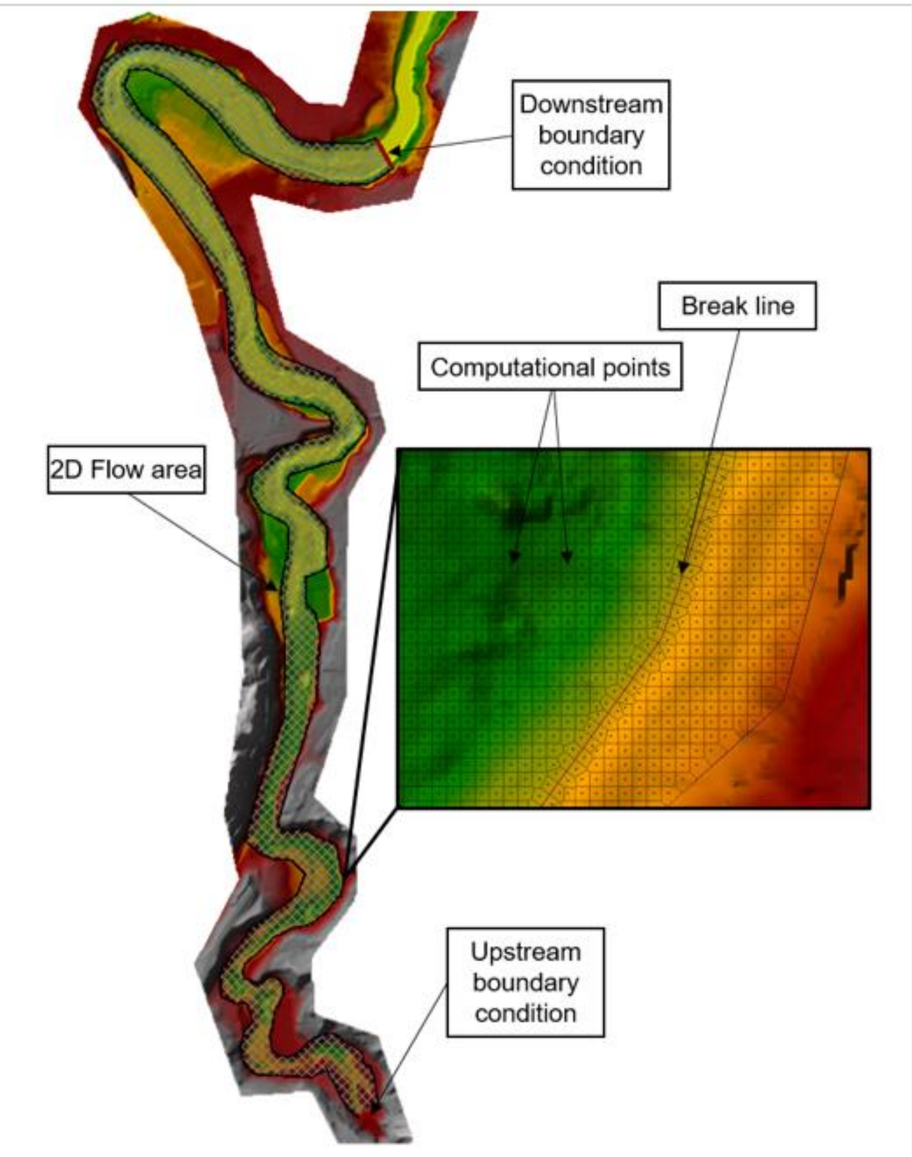
- Study of hydropeaking impacts in river Nidelva for the fluctuations in Bratsberg power plant

HydroFlex

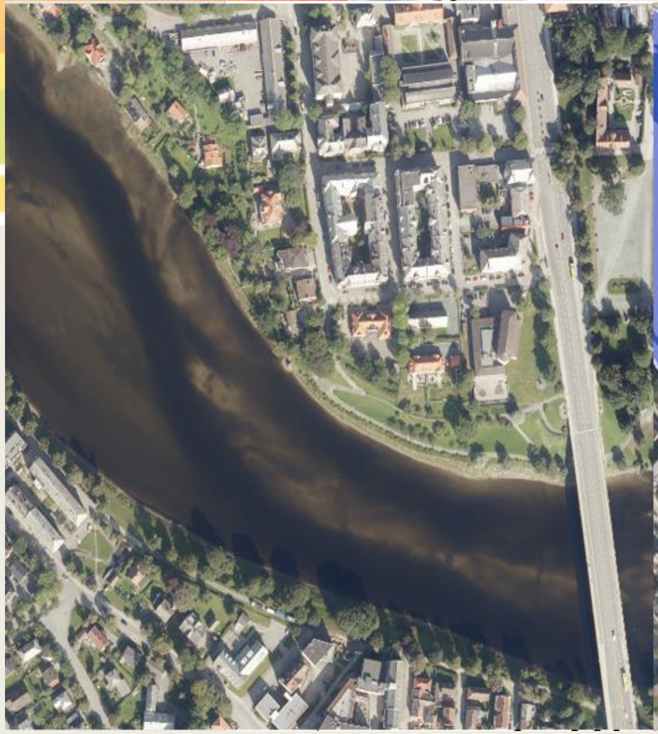
https://www.h2020hydroflex.eu/

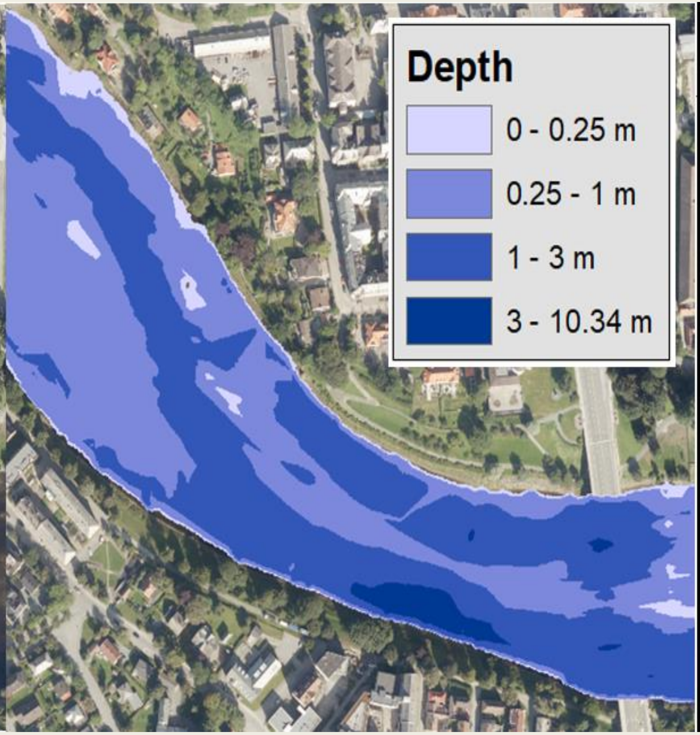

LiDAR
Previous bathymetry
Field work ADCP
Total points

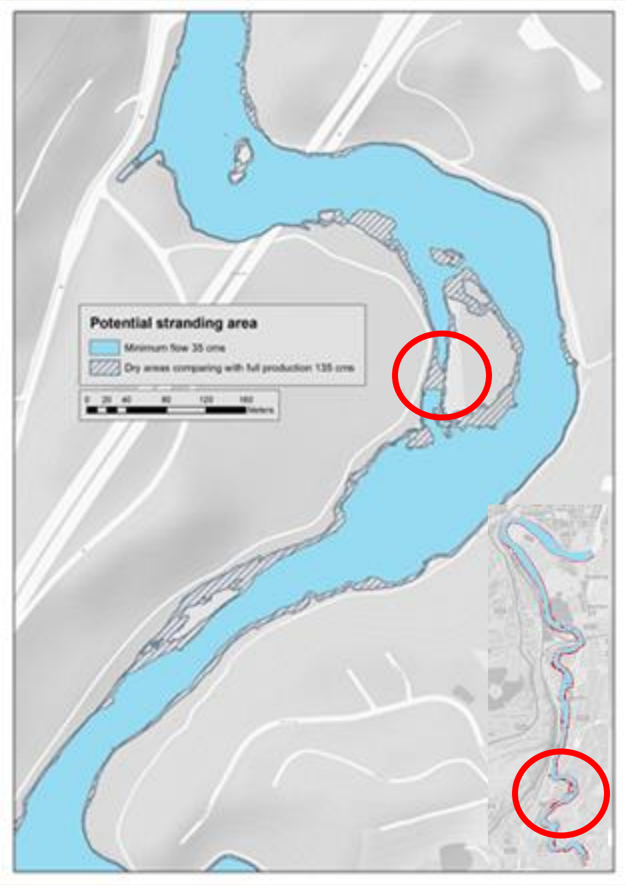
Fieldwork in Nidelva measuring with ADCP sailed by a kayaker. Example of kayak tracks and points measured with ADCP.



Point	0.020	0.030	0.035	0.040	0.045	0.050	0.055	0.060	0.065	0.070	0.075	0.080	0.090	0.100
	Manning value													
42	1.01	0.88	0.74	0.61	0.55	0.50	0.44	0.39	0.35	0.30	0.26	0.22	0.14	0.07
41	1.01	0.83	0.75	0.67	0.60	0.54	0.48	0.42	0.36	0.31	0.26	0.21	0.11	0.03
40	1.01	0.82	0.70	0.63	0.56	0.49	0.42	0.36	0.30	0.24	0.18	0.13	0.03	-0.07
39	1.02	0.82	0.73	0.65	0.57	0.50	0.43	0.36	0.30	0.24	0.18	0.13	0.03	-0.07
38	1.03	0.82	0.73	0.65	0.57	0.49	0.42	0.35	0.29	0.23	0.17	0.12	0.01	-0.09
37	1.02	0.81	0.72	0.63	0.55	0.48	0.41	0.34	0.27	0.21	0.15	0.10	-0.01	-0.11
36	0.73	0.61	0.55	0.49	0.43	0.37	0.31	0.26	0.20	0.15	0.09	0.04	-0.06	-0.15
35	0.24	0.12	0.07	0.02	-0.02	-0.07	-0.11	-0.16	-0.20	-0.24	-0.28	-0.33	-0.41	-0.49
34	0.35	0.21	0.15	0.10	0.04	-0.01	-0.07	-0.12	-0.17	-0.22	-0.26	-0.31	-0.40	-0.49
33	-0.07	-0.15	-0.14	-0.16	-0.19	-0.21	-0.23	-0.25	-0.27	-0.29	-0.31	-0.33	-0.37	-0.41
31	0.06	-0.07	-0.13	-0.18	-0.24	-0.28	-0.33	-0.38	-0.42	-0.46	-0.50	-0.54	-0.61	-0.67
30	0.31	0.16	0.10	0.04	-0.01	-0.07	-0.12	-0.16	-0.21	-0.25	-0.29	-0.33	-0.41	-0.48
29	0.34	0.17	0.10	0.03	-0.03	-0.09	-0.15	-0.20	-0.25	-0.30	-0.35	-0.39	-0.48	-0.56
28	0.37	0.19	0.12	0.04	-0.02	-0.09	-0.15	-0.20	-0.26	-0.31	-0.36	-0.41	-0.50	-0.59
27	0.35	0.17	0.09	0.02	-0.05	-0.12	-0.18	-0.24	-0.30	-0.36	-0.41	-0.46	-0.56	-0.65
26	0.31	0.12	0.04	-0.04	-0.11	-0.17	-0.24	-0.30	-0.36	-0.41	-0.46	-0.52	-0.61	-0.71
25	0.48	0.27	0.19	0.11	0.03	-0.04	-0.10	-0.16	-0.23	-0.28	-0.34	-0.39	-0.49	-0.59
24	0.51	0.30	0.21	0.13	0.05	-0.02	-0.09	-0.16	-0.22	-0.28	-0.33	-0.39	-0.49	-0.59
23	0.55	0.31	0.22	0.13	0.04	-0.04	-0.12	-0.19	-0.26	-0.32	-0.38	-0.45	-0.56	-0.67
21	0.14	0.01	0.02	-0.02	-0.06	-0.09	-0.13	-0.17	-0.20	-0.24	-0.28	-0.31	-0.38	-0.45
20	0.21	0.13	0.08	0.03	-0.02	-0.06	-0.11	-0.16	-0.20	-0.25	-0.29	-0.33	-0.41	-0.49
19	0.29	0.16	0.10	0.05	-0.01	-0.06	-0.11	-0.16	-0.21	-0.26	-0.31	-0.35	-0.44	-0.52
18	0.34	0.20	0.10	0.04	-0.03	-0.08	-0.14	-0.20	-0.25	-0.30	-0.35	-0.40	-0.50	-0.59
17	0.40	0.24	0.16	0.10	0.03	-0.04	-0.10	-0.16	-0.22	-0.27	-0.33	-0.38	-0.48	-0.58
16	0.38	0.20	0.12	0.05	-0.02	-0.08	-0.15	-0.21	-0.27	-0.32	-0.38	-0.43	-0.54	-0.63
15	0.42	0.24	0.16	0.09	0.02	-0.05	-0.11	-0.17	-0.23	-0.29	-0.34	-0.40	-0.50	-0.60
14	0.41	0.22	0.14	0.07	0.00	-0.07	-0.14	-0.20	-0.26	-0.32	-0.38	-0.43	-0.54	-0.64
13	0.38	0.17	0.08	-0.01	-0.09	-0.17	-0.25	-0.32	-0.39	-0.45	-0.52	-0.58	-0.69	-0.80
12	0.51	0.28	0.18	0.09	0.00	-0.08	-0.16	-0.24	-0.32	-0.39	-0.45	-0.52	-0.64	-0.75
11	0.39	-0.06	-0.13	-0.19	-0.25	-0.30	-0.36	-0.41	-0.46	-0.51	-0.56	-0.61	-0.70	-0.79
10	0.26	0.11	0.04	-0.02	-0.09	-0.15	-0.20	-0.26	-0.31	-0.37	-0.42	-0.47	-0.57	-0.66
9	0.30	0.14	0.08	0.01	-0.05	-0.11	-0.17							
8	0.32	0.13	0.06	0.00	-0.07	-0.13	-0.19							
7	0.34	0.20	0.05	-0.02	-0.09	-0.16	-0.22							
6	0.35	0.27	0.22	0.17	0.12	0.06	0.01							
5	0.43	0.28	0.22	0.16	0.10	0.05	0.00							
4	0.55	0.44	0.39	0.34	0.29	0.25	0.21							
3	0.57	0.46	0.40	0.36	0.31	0.27	0.22							
2	0.55	0.43	0.38	0.33	0.28	0.24	0.20							
1	0.55	0.43	0.38	0.33	0.28	0.24	0.20							
Mean error	0.47	0.30	0.23	0.16	0.10	0.04	-0.02							

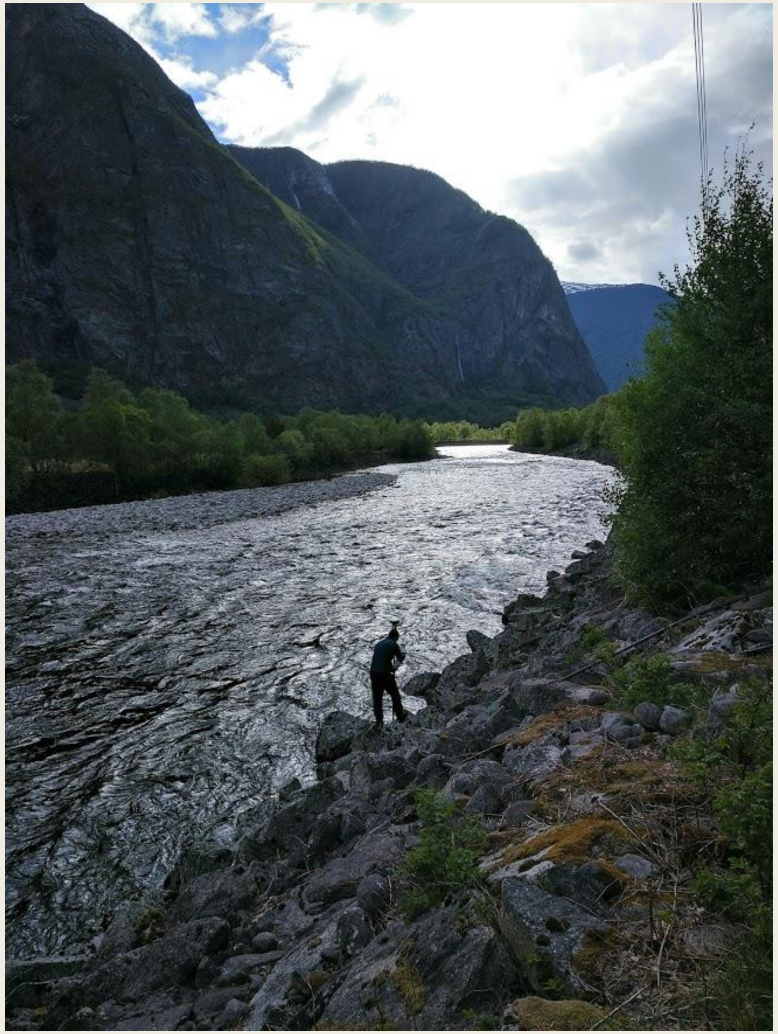




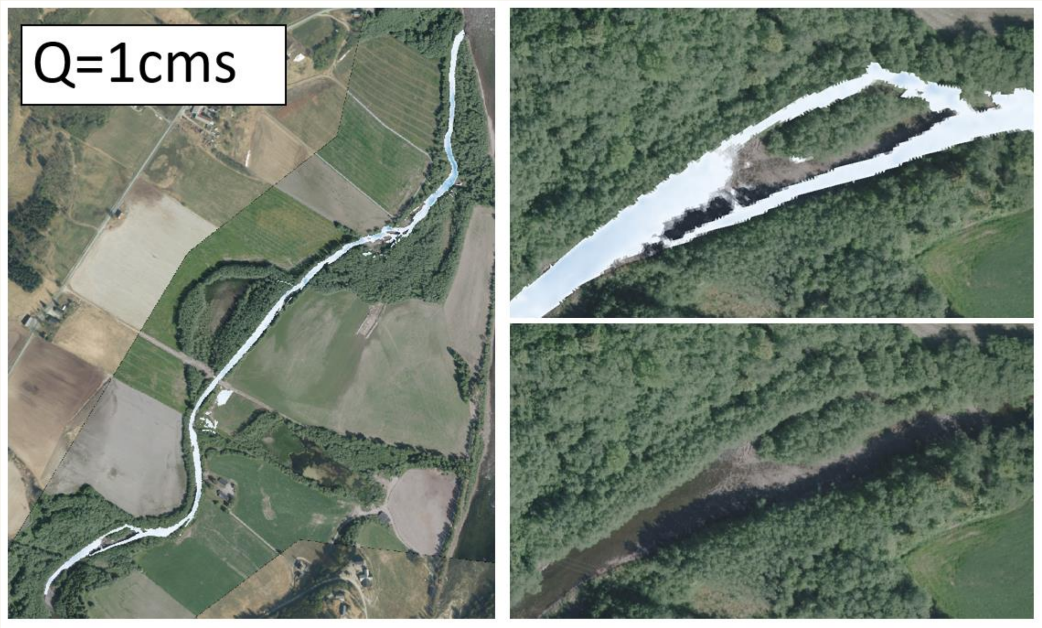

Potential stranding area
Minimum flow 35 cms
Dry areas comparing with full production 135 cms

$Q = 35\ m^3/s$

GPS points

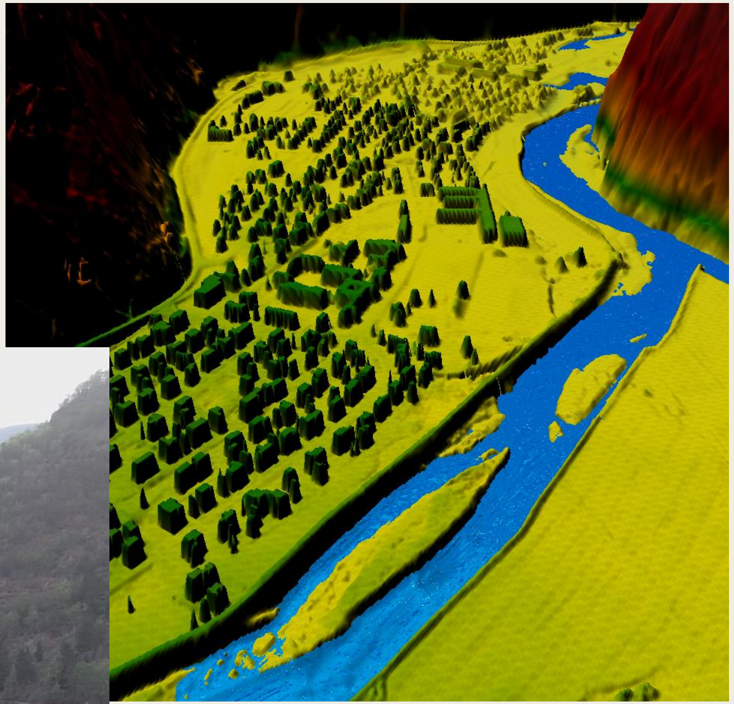


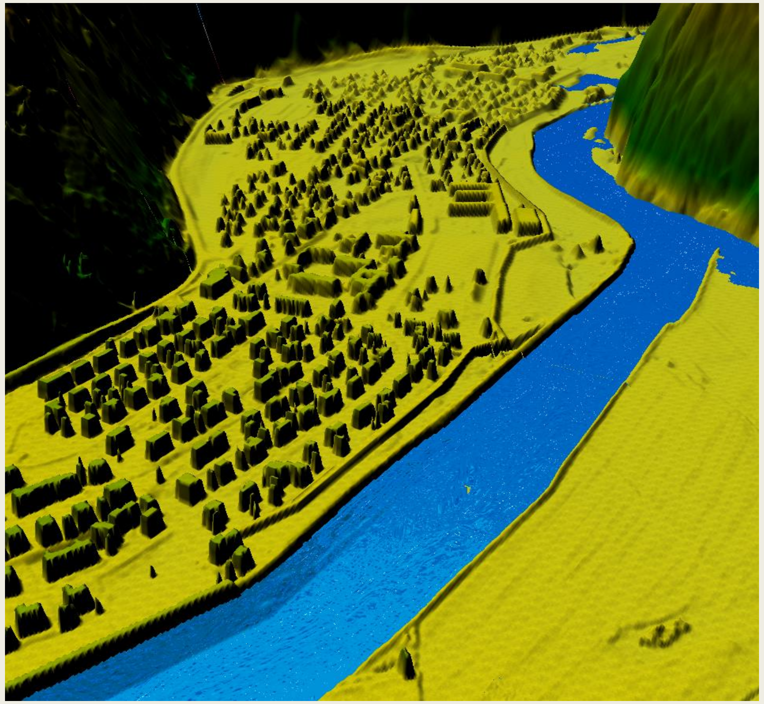
Evaluation of flood hazard in Gaua

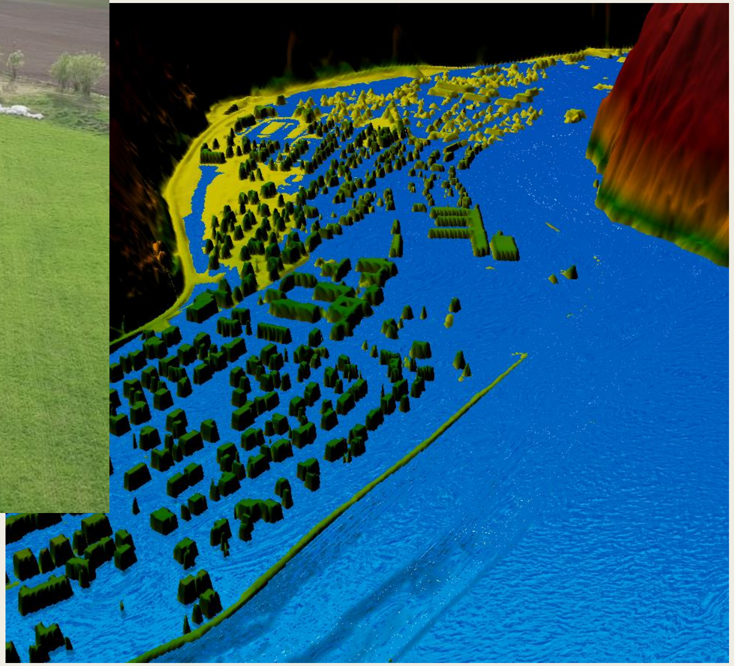


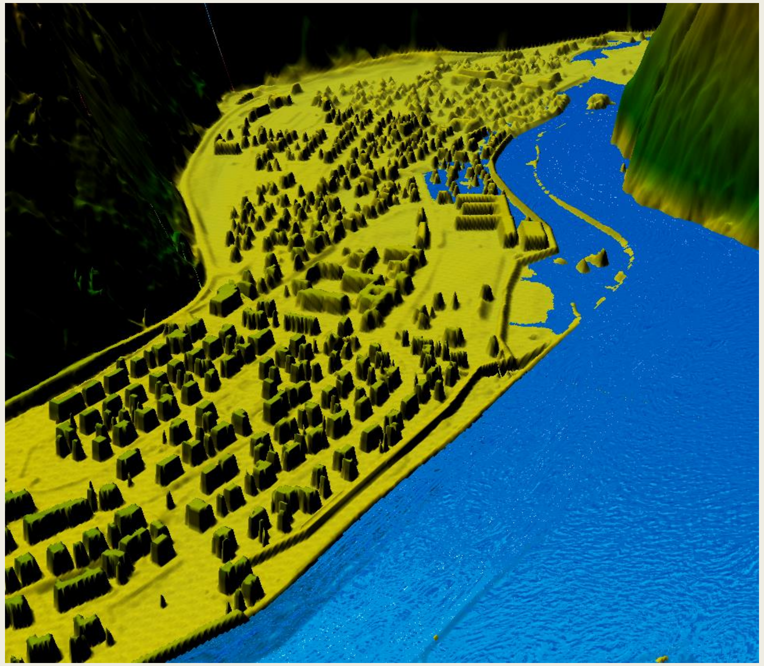
Quick clay overlapping with river erosion ->> ☹

Flood hazard Lærdal river

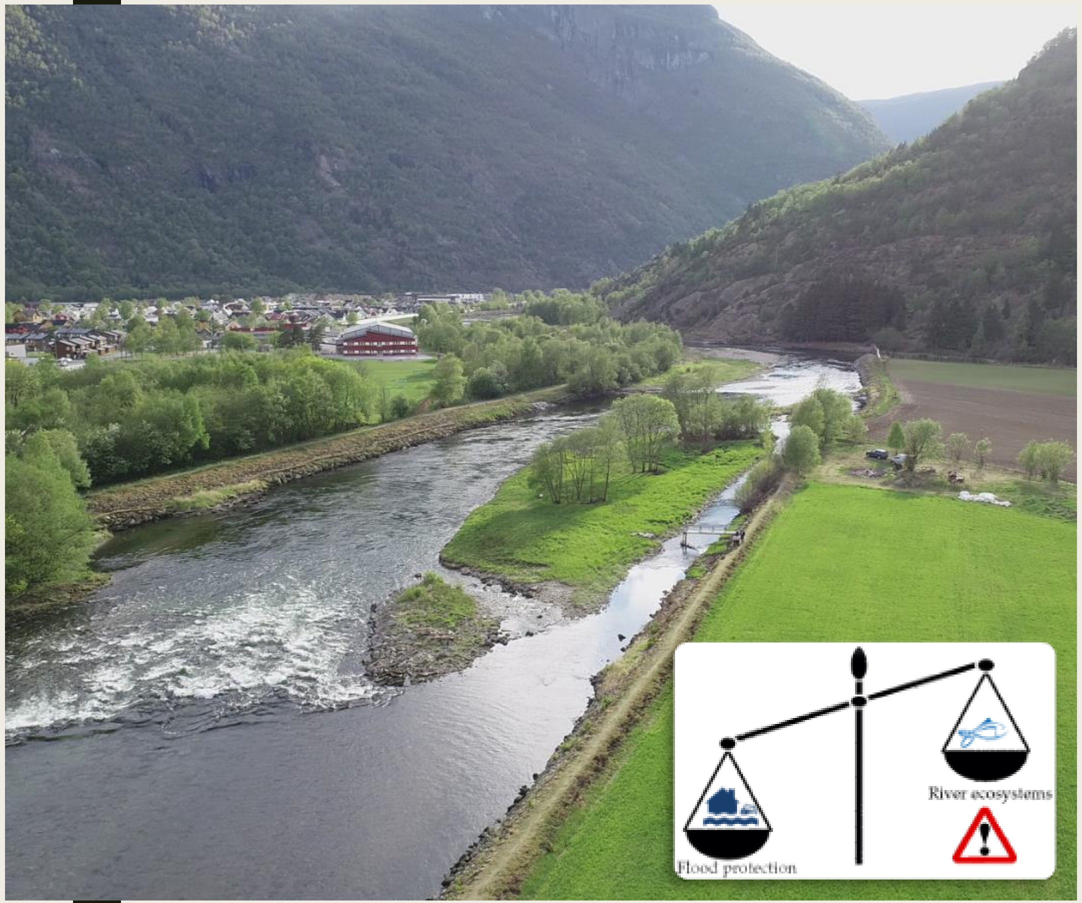


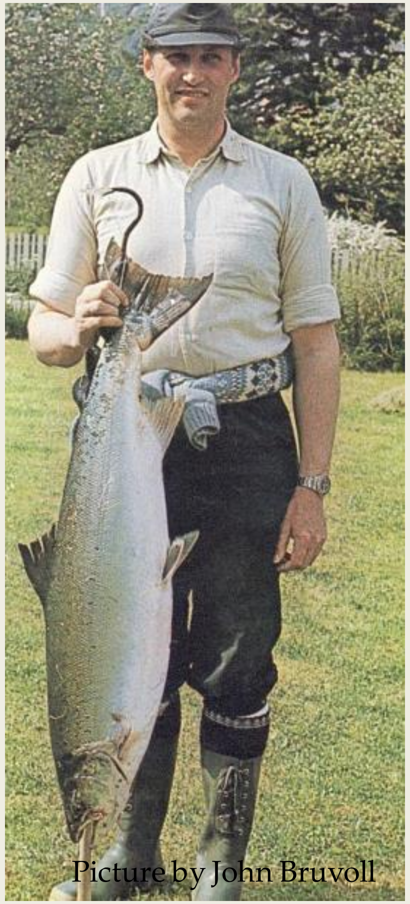




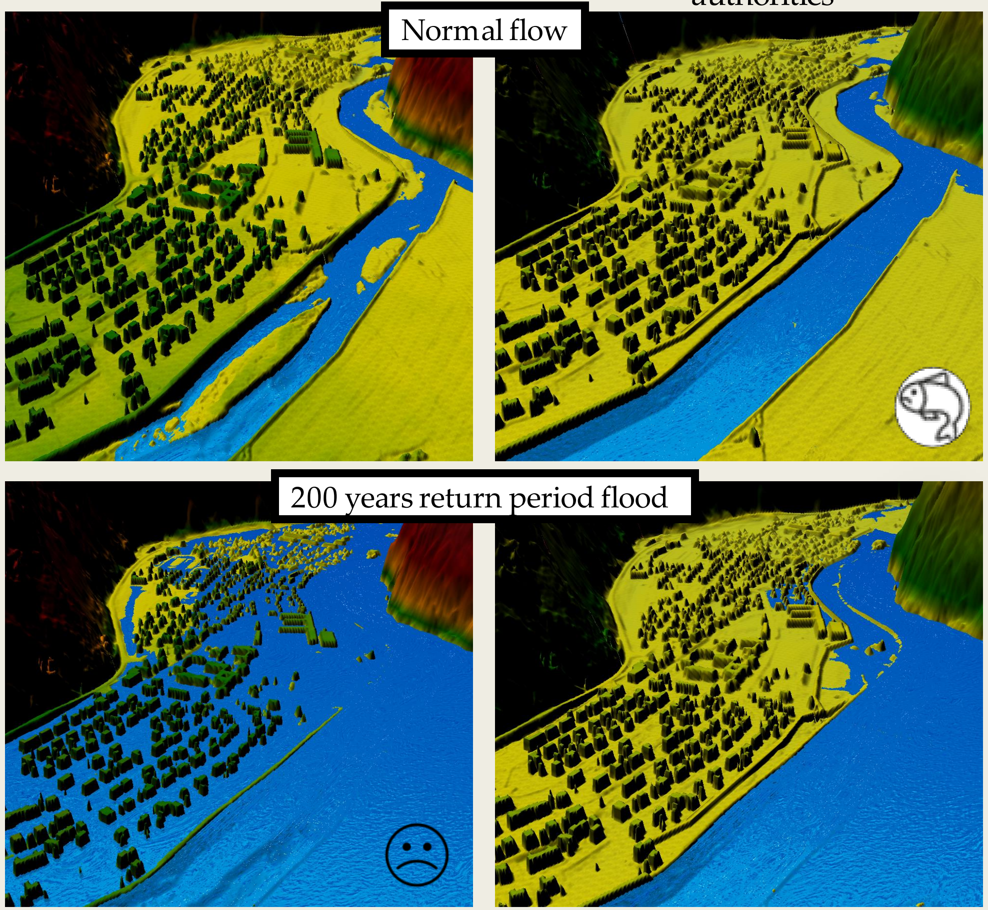


A conflict between traditional flood measures and maintaining river ecosystems? A case study in river Lærdal, Norway





Current situation | Proposed measures by authorities



We suggest: using 2D-hydraulic models and remote sensing data to find a compromise solution.

Our studies show that: flood measures may be in serious conflict with environmental protection. We can find a compromise by putting more emphasis on flood control structures away from the riverine habitats, but future work should also evaluate other potential nature-based measures to control future floods.

Ana Juarez, Knut Alfredsen, Morten Stickler, Ana Adeva-Bustos, Rodrigo Suarez, Sonia Seguín-García and Bendik Hansen

28.04.2021


1964
1999
2020
20m
20m
Norgeibilder.no

River restoration

- We believe there is a big potential for river restoration using hydraulic model and lidar data, also monitored by drone data.
- The latest tools in HEC-RAS 6 have allow for easier terrain modifications.
- Also increasing potential for studying sediment transpot.

Takk for oppmerksomheten! ☺