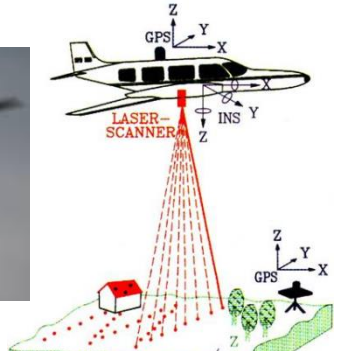
UAV-BASED REMOTE SENSING IN FLUVIAL RESEARCH

CEDREN-seminar 13 November 2014

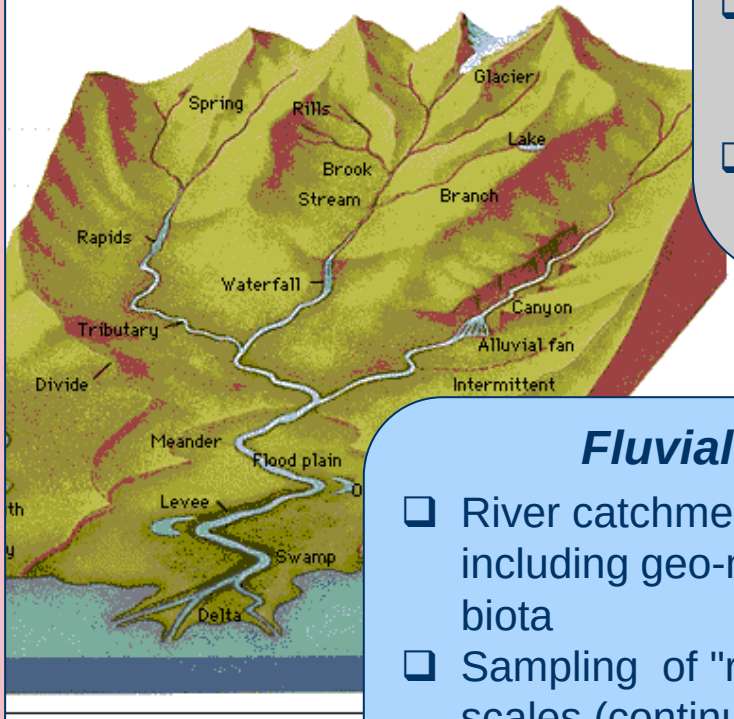
9.45 – 10.00		ARRIVAL & REGISTRATION w/coffee
10.00 – 10.25	Dr. Peggy Zinke, SINTEF ER, Trondheim	Welcome & introduction
10.25 – 10:50	Dr. Aksel Transeth, SINTEF IKT, Trondheim	UAV – Technologies and opportunities
10:50 – 11:15	Dr. Stian A. Solbø, NORUT, Tromsø	UAV remote sensing for climate and environmental research
11:15 – 11:40	Christian Haas, IAMHYDRO, Stuttgart	HyDroneS (Hydrosystem Drone Surveying) - tales from the field, state of the art and future development
11:40 - 12:40		LUNCH BREAK
12:40 – 13:05	Ass. Prof. Florin Nedelcut, UGAL, Galati, Romania	Coanda Effect aerodyne – a new concept for fluvial and ecological remote sensing
13.05 – 13:30	Prof. Jochen Aberle, NTNU-IVM, Trondheim	Use of remote sensing data in environmental hydraulics
13:30 – 13:55	Dr. Richard Hedger & Dr. Anders Foldvik, NINA, Trondheim	Remote sensing for fish ecology research – experiences and future needs
13:55 – 14:15		COFFEE BREAK
14:15 – 16:00		Discussions & workshop on future project ideas
16:00		Closing

Introduction



Unmanned aerial vehicles (UAV)

- Exist in a very wide range of sizes and purposes, rapidly growing market
- Easy to deploy at high temporal resolutions (low costs; "line of sight" ca. 70-150 m above ground)
- Use for commerical applications and research regulated by Civil Aviation Agency



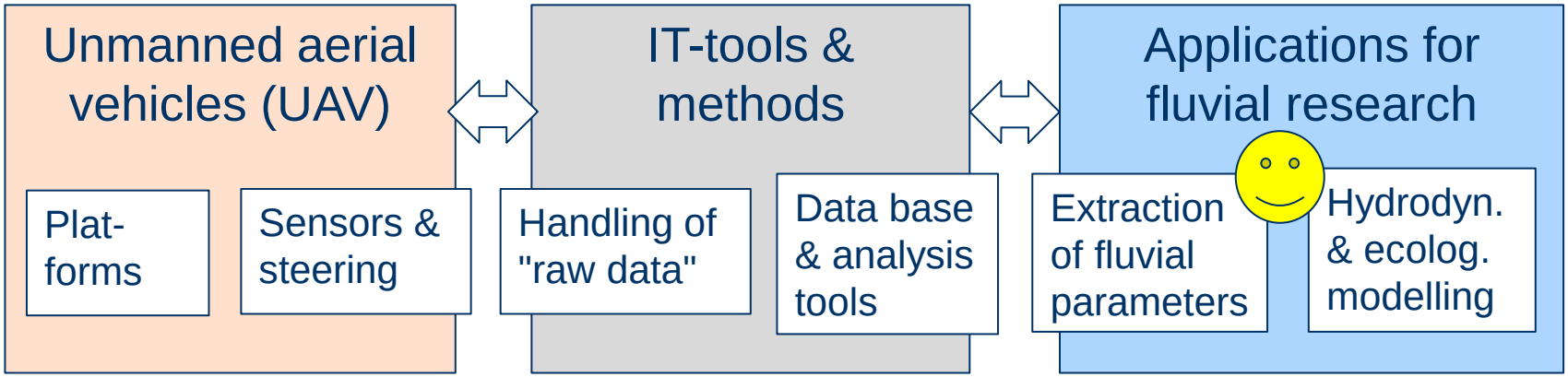
Remote Sensing

- Acquisition of information about an object through sensors that are not in physical contact with it
- Active or passive (radiation internally generated or externally emitted)
- Typical platforms: satellite, aircraft, UAV

Fluvial research

- River catchments as holistic systems, including geo-morphology, hydrology and biota
- Sampling of "river scape" data at different scales (continuous data from small scale to entire catchments)
- Traditionally much focus on river channels

UAV-based remote sensing in fluvial research



F. Nedelcut, UGAL: Coanda Effect aerodyne

A. Transæth, SINTEF-IKT: UAV Technologies

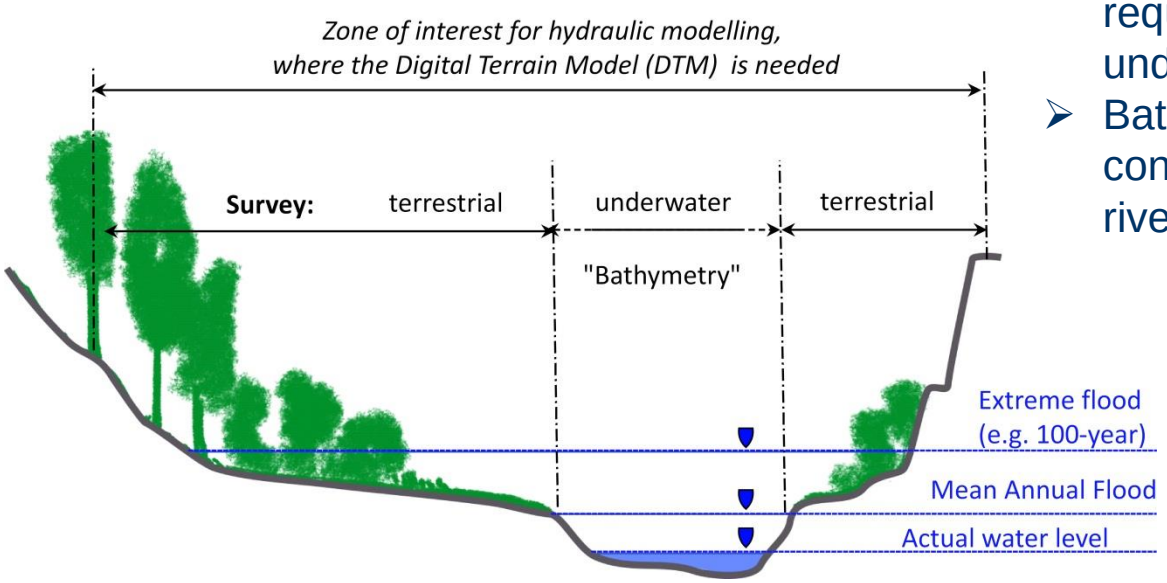
J. Aberle, NTNU: Remote sensing in env. hydraulics

R. Hedger, NINA: Remote sensing in fish ecology research

S. Solbø, NORUT: UAV appl. for clim. & env. research

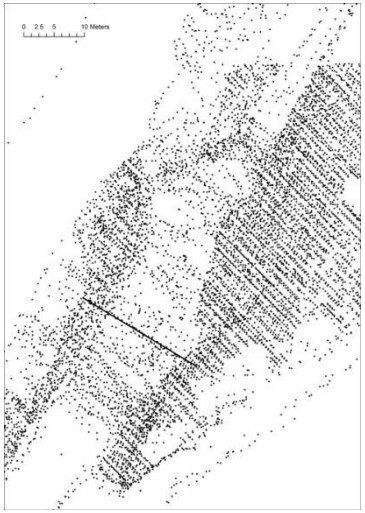
C. Haas, IAMHYDRO: HyDroneS (SfM Application)

Fluvial research

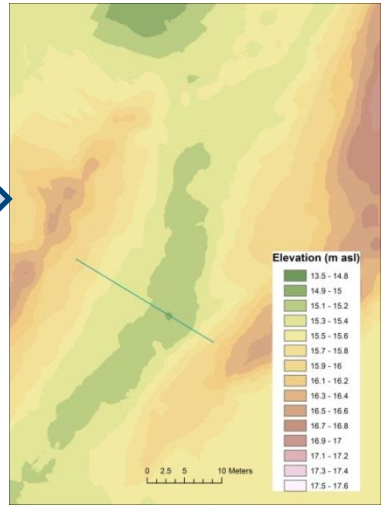


- Use of hydrodynamic models requires detailed knowledge of underwater-morphology!
- Bathymetry-surveys are time-consuming and may be dangerous in rivers with strong currents.

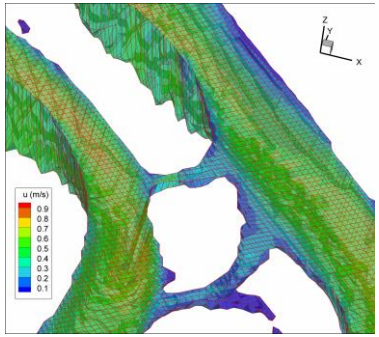
Bathymetry = the underwater equivalent to topography in oceans, lakes and rivers



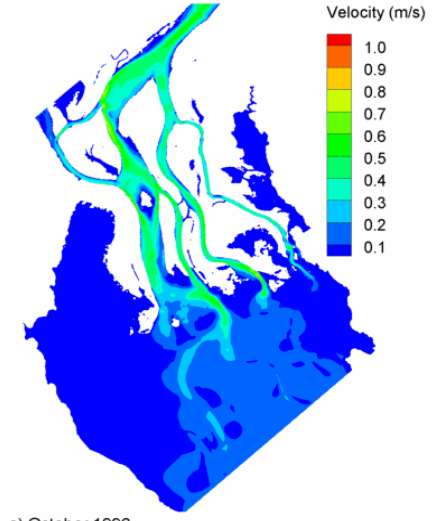
Elevation points



Digital terrain model



Hydrodynamic model (flow & sediments)



a) October 1996
Lake Stage at Mørkfoss 101.37 m ASL

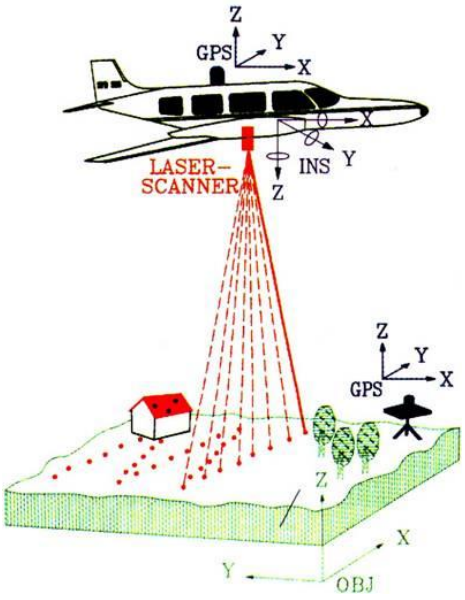
Direct survey

- Traditional levelling instruments (e.g. Theodolites, Total stations)
- Global Positioning System (GPS)
- Laser Scan (Terrestrial, mobile)

- Traditional depth-sounding methods (e.g. Hand lead-line)
- Echo-sounder (Single/Multi-beam)
- Acoustic Doppler Current Profiler (ADCP)

Terrestrial survey methods can be used
in shallow water.

Remote sensing techniques

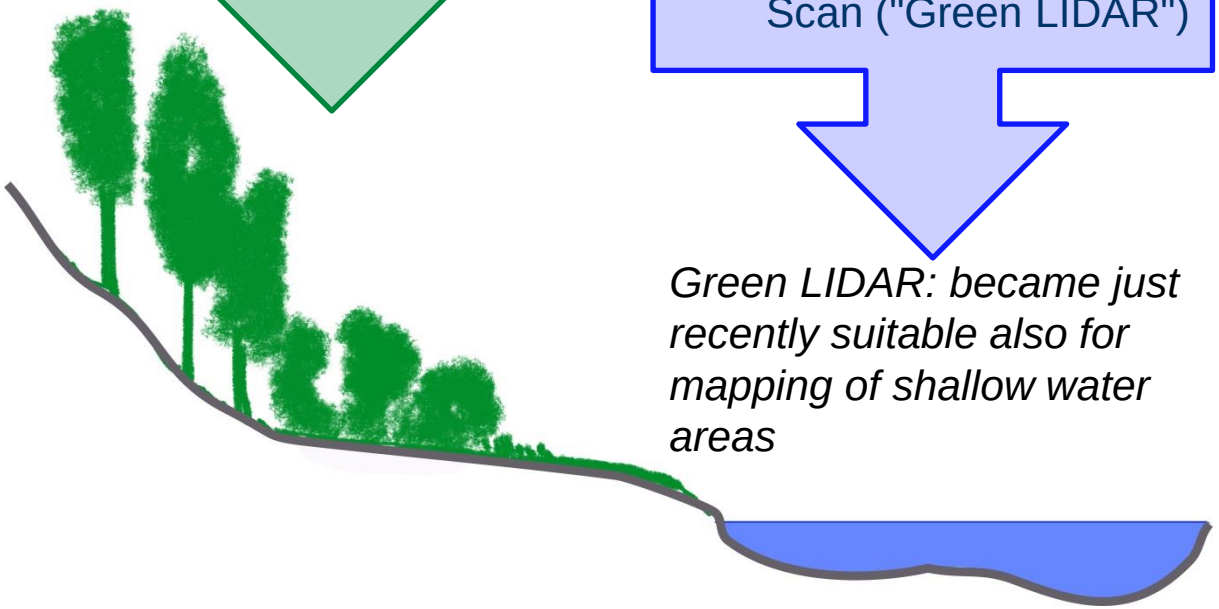


Laser measures aircraft-ground distance with high accuracy; Reflections from vegetation etc. have to be filtered out

- Photogrammetry
- Interferometric Synthetic Aperture Radar (IFSAR)
- Airborne Laser Scan

Optical methods: use the connection between water depth and light attenuation

- Optical methods based on aerial photography
- Bathymetric Laser Scan ("Green LIDAR")

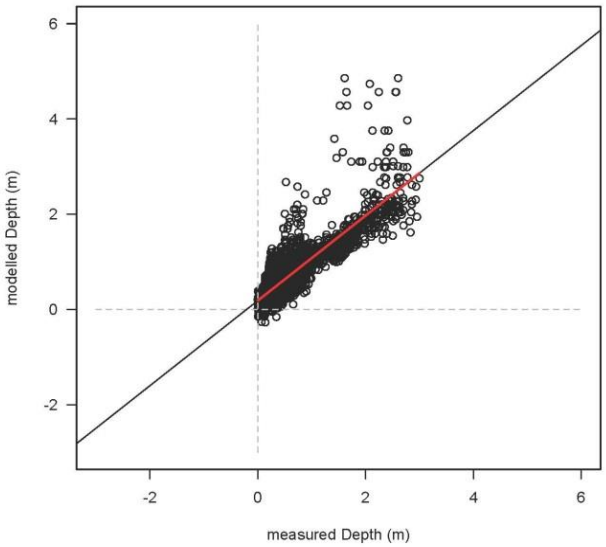


Green LIDAR: became just recently suitable also for mapping of shallow water areas

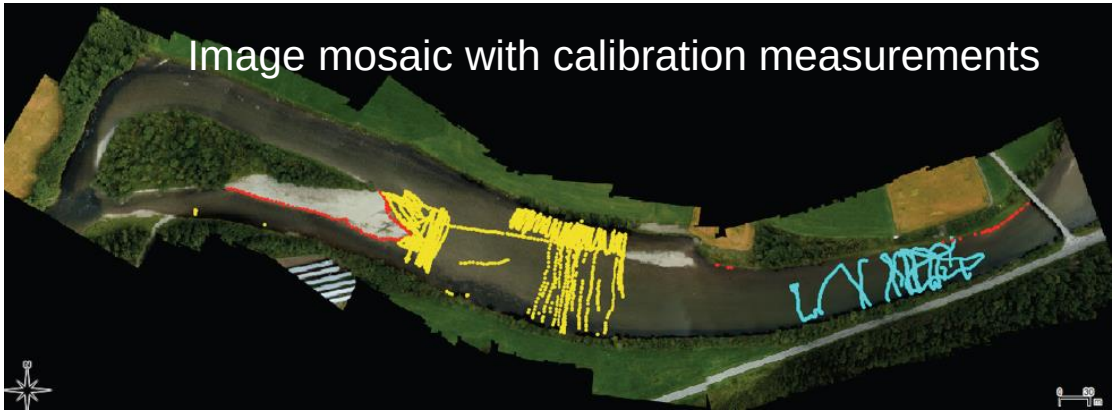
Optical bathymetric models – pilot study 2011 (CEDREN EnviPeak)

Principle:
Deeper water is darker in an aerial image than shallower water (if the water is clear!).

Challenge:
To get absolute depth values, not relative depths



Method by Lyzenga (1981) and Flener (2013): Removes all information from the image that is not "depth" (e.g. substrate colour, turbidity); requires some directly measured depth values for calibration.

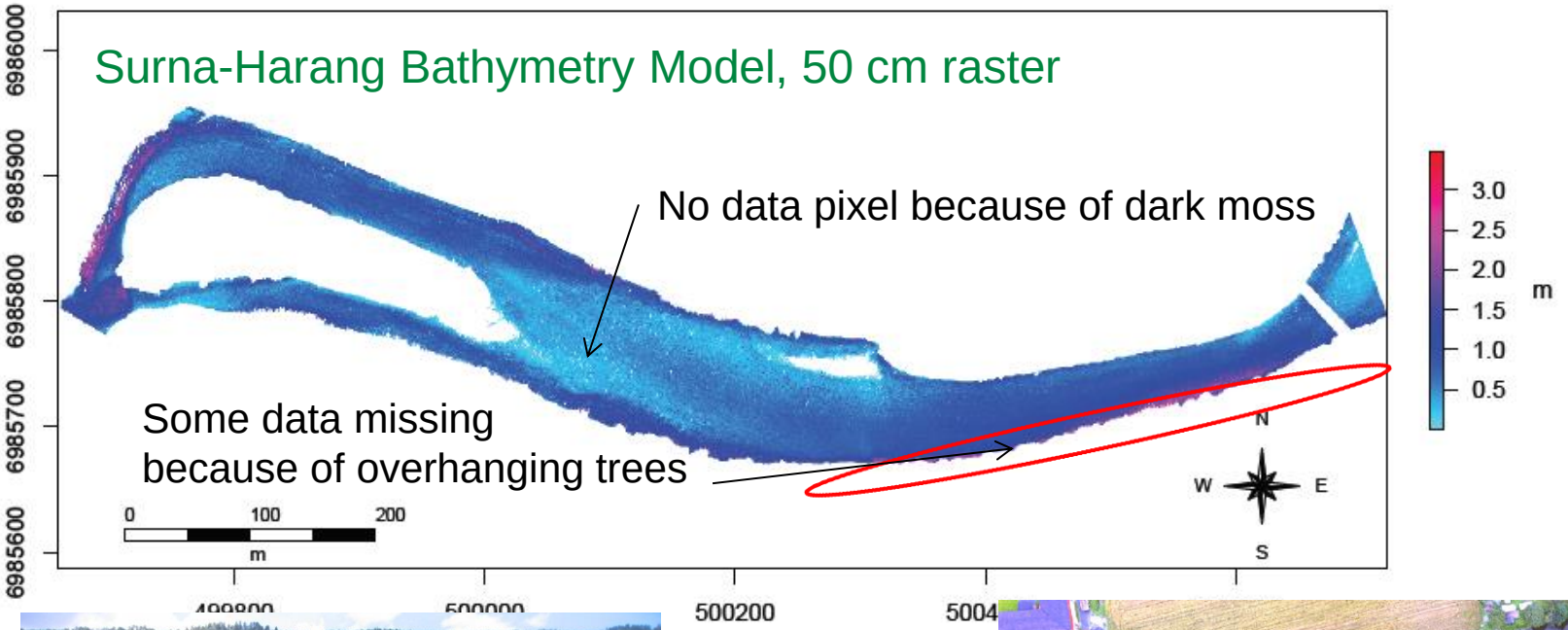


Optical bathymetric models – pilot study 2011 (CEDREN EnviPeak)

- Setting up ground control points
- Taking aerial images (here: UAV)
- Calibration measurements (manual GPS, vessel-based ADCP)

Weather conditions needed: dry, ± cloudy
(no sun-reflections on the water surface); clear water

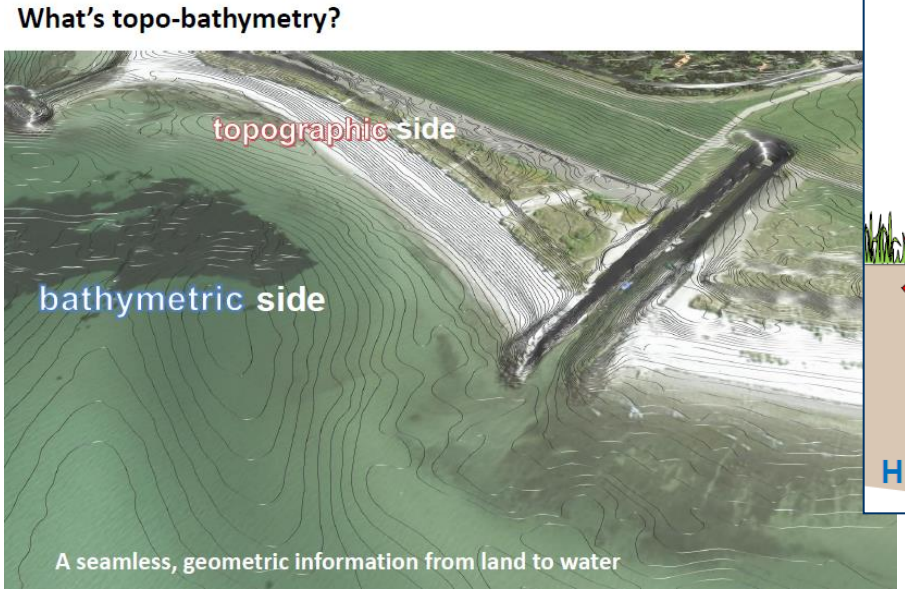
Optical bathymetric models – pilot study 2011

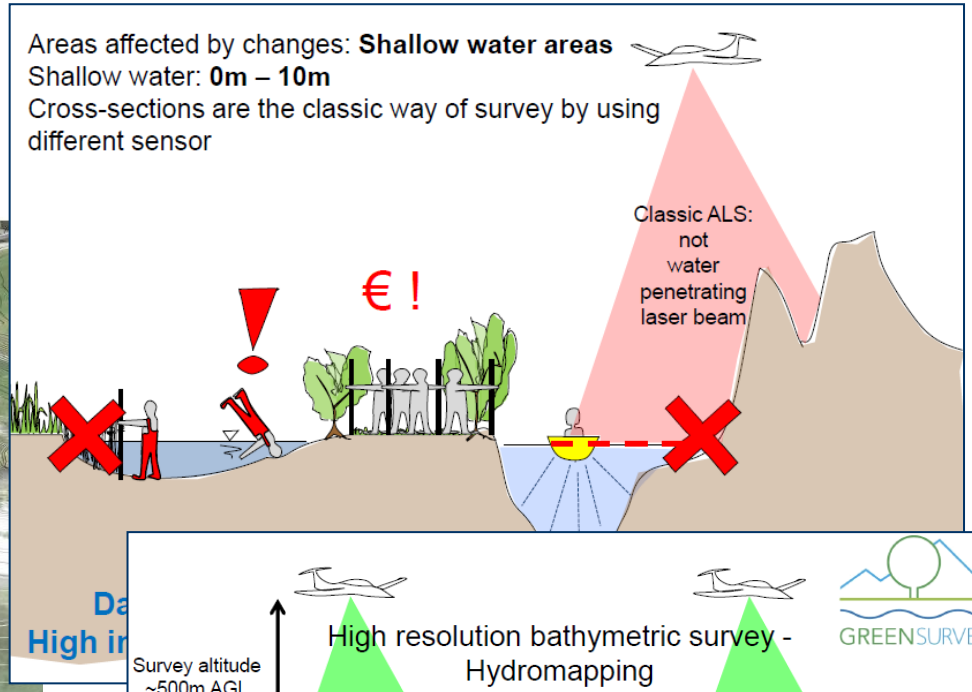


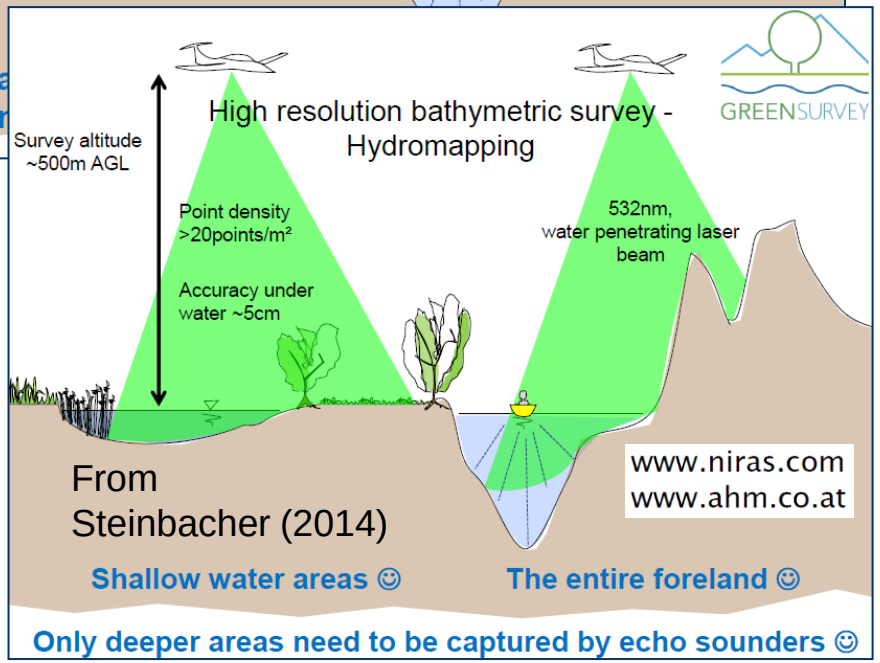
Artefacts
because of
strong cloud
reflectance

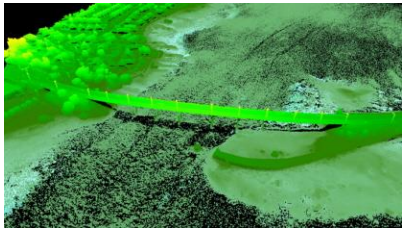
Example Green Laser Application

Airborne Hydro Mapping (AHM)





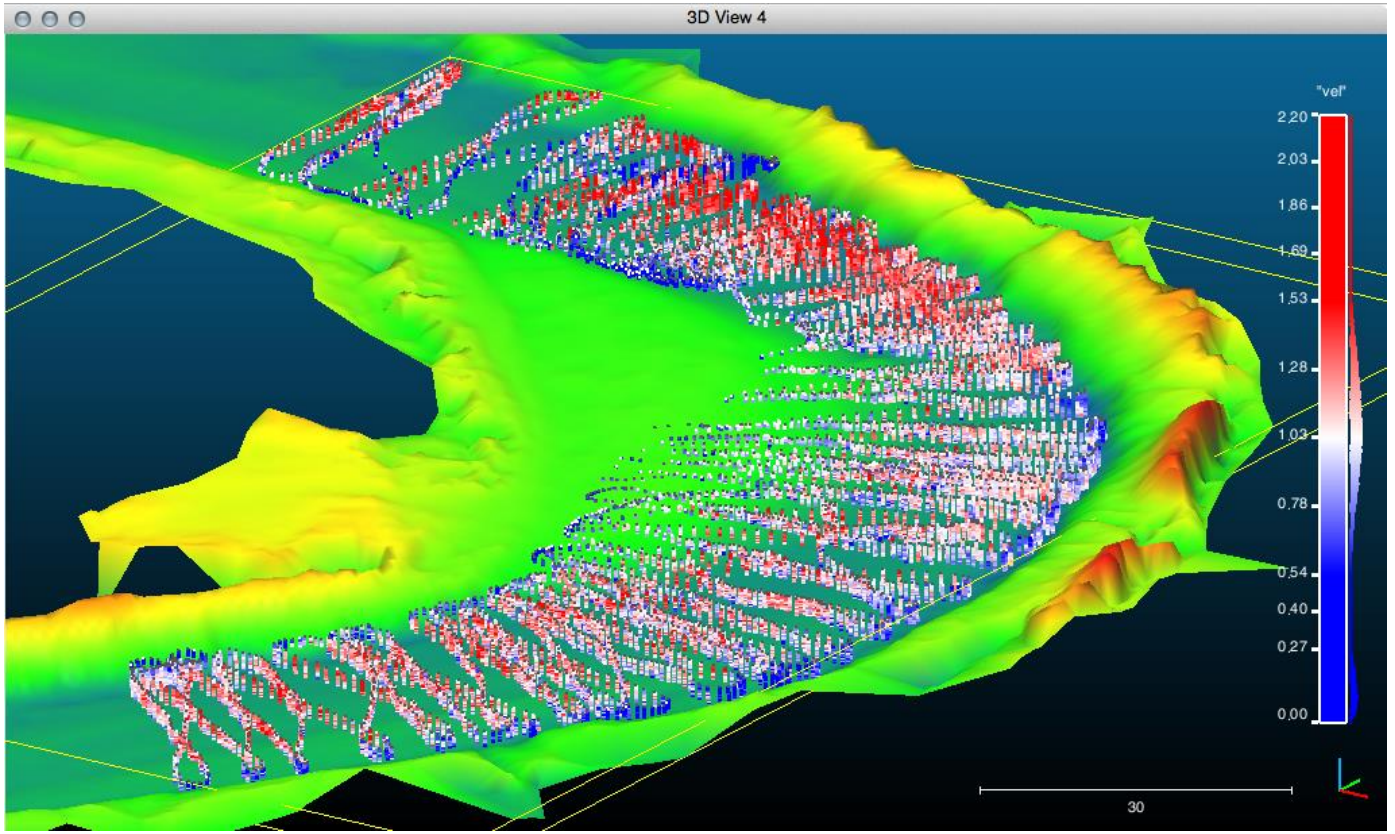




http://kartverket.no/Om-Kartverket/Nyheter/Testar-lasermaling-av-kystsona/

Combination of vessel-based measurements and UAV

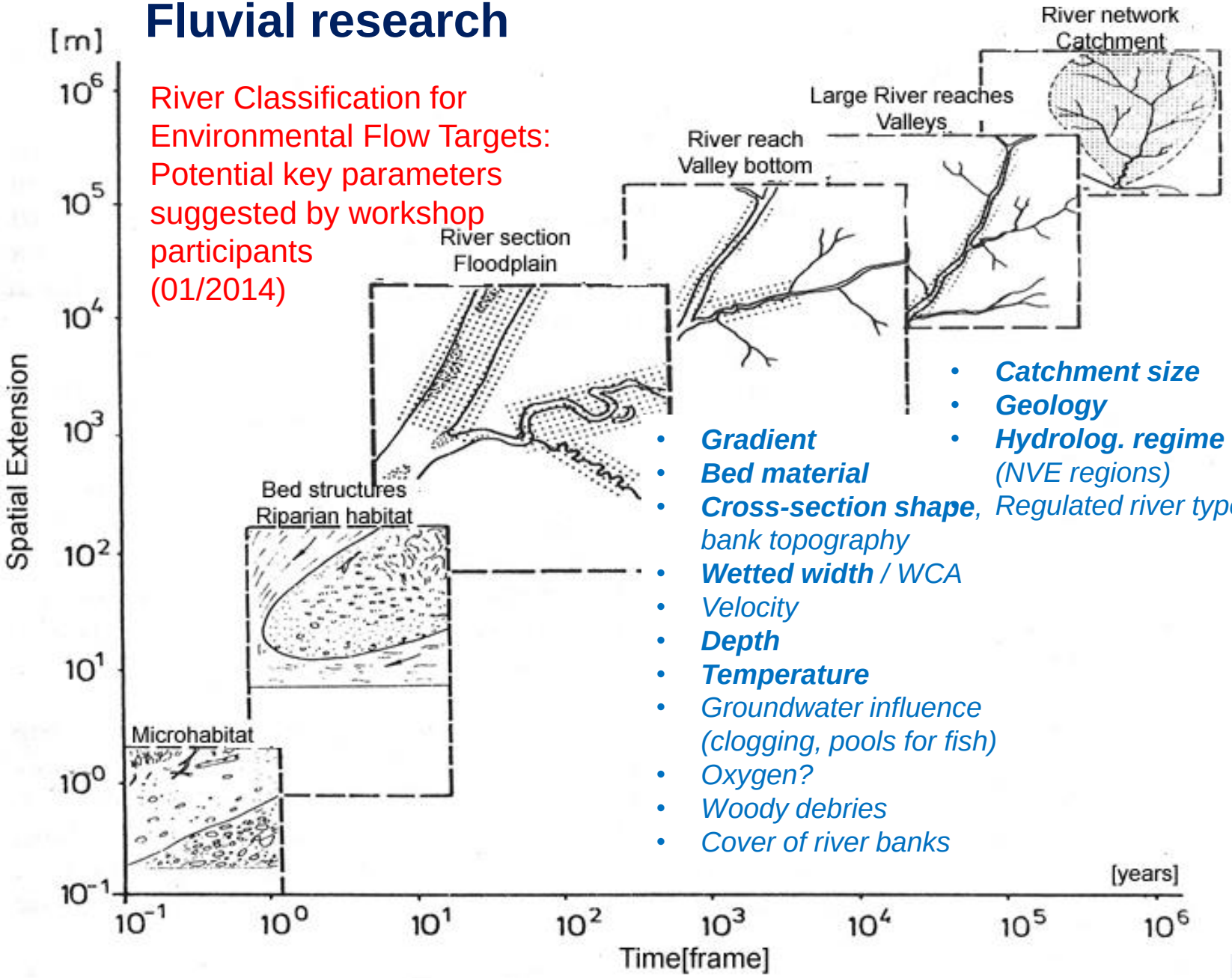
Advanced IT- and GIS tools for fluvial data analysis



C. Flener, Uni Turku, Finland & GWM-Engineering :
"3D flow velocities (m/s) from ADCP as a 3D point cloud on top of a seamless topography that is created from mobile LiDAR and UAV-based bathymetry"

Fluvial research

River Classification for Environmental Flow Targets: Potential key parameters suggested by workshop participants (01/2014)



- ***Catchment size***
- ***Geology***
- ***Hydrolog. regime*** *(NVE regions) Regulated river types*
- ***Gradient***
- ***Bed material***
- ***Cross-section shape****, bank topography*
- ***Wetted width*** */ WCA*
- *Velocity*
- ***Depth***
- ***Temperature***
- *Groundwater influence (clogging, pools for fish)*
- *Oxygen?*
- *Woody debries*
- *Cover of river banks*

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