# Laser Bathymetry for near-natural rivers: From point cloud to DTM

## [Laser Bathymetrie für naturnahe Flussläufe: Von der Punktwolke zum DGM]

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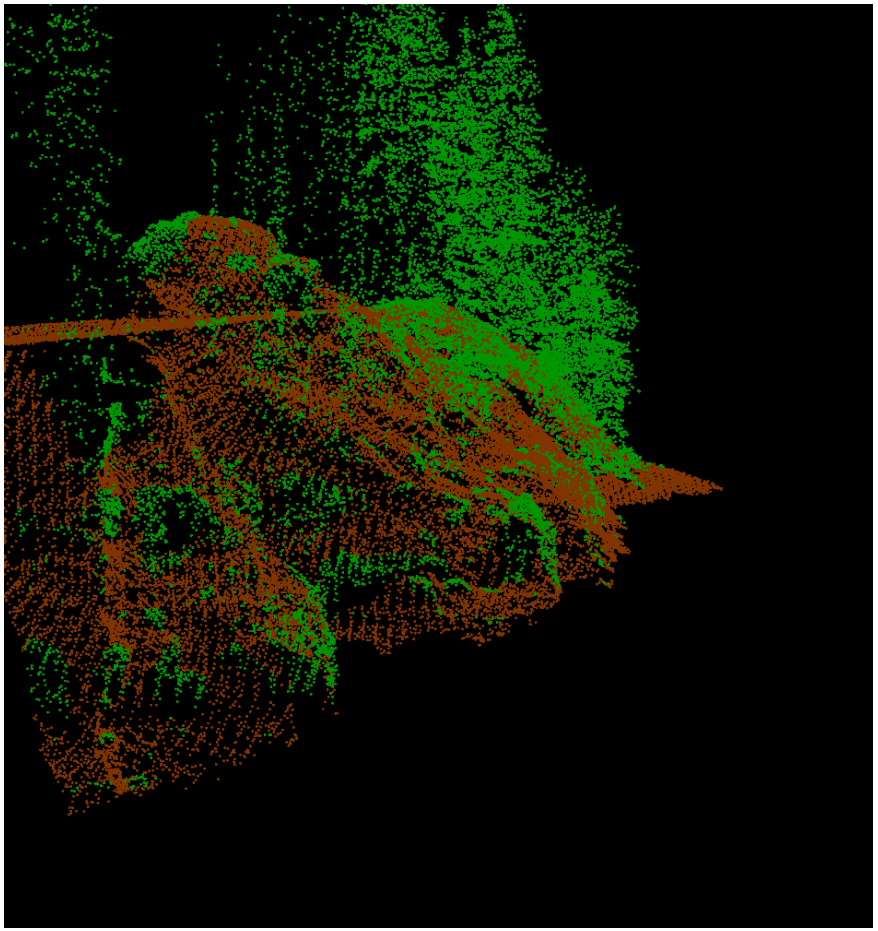
# DTM processing – Topographic Lidar



Topographic lidar

Only one transmission medium for all points: atmosphere

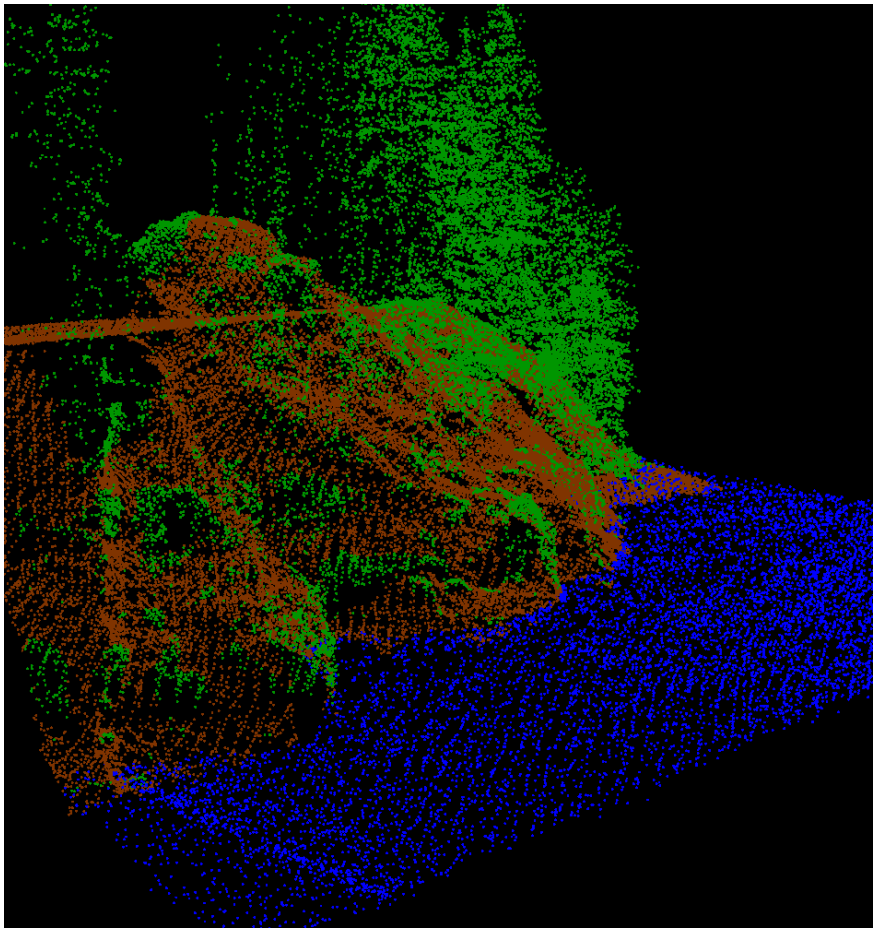
Ground coverage mainly depends on:

- Flight mission: # strips, height
- Instrument: PRR, opening angle
- Object: vegetation leaf on/off, absorption

Waterbodies cannot be measured.

DTM computation:
Classification into ground/off-terrain (vegetation, buildings)
Standard methods available

# DTM processing – Lidar Bathymetry



Transmission medium is changing for points in water

-> atmosphere

+ water

Ground coverage of water bodies depends on

-> water depth

-> water turbidity

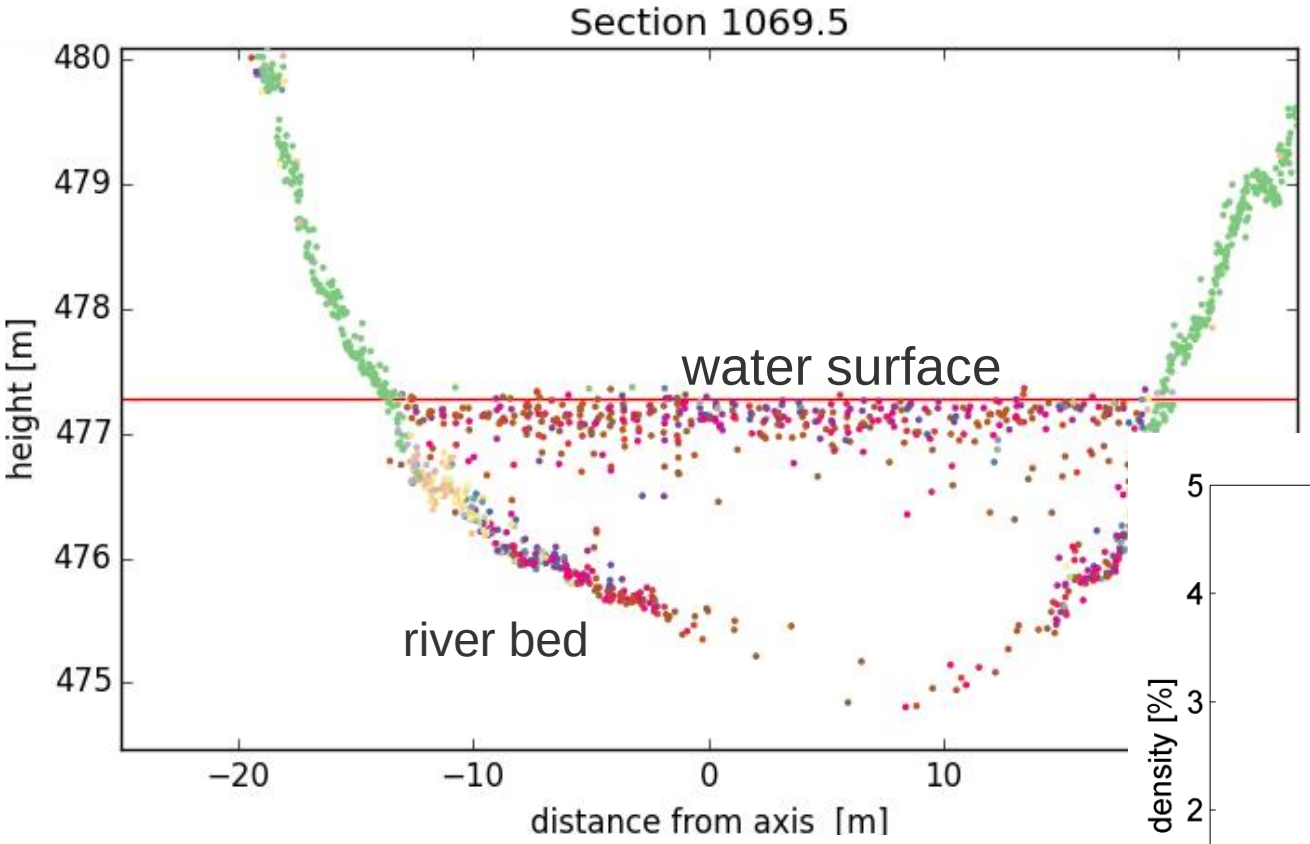
-> river bad ground cover (bright/dark)

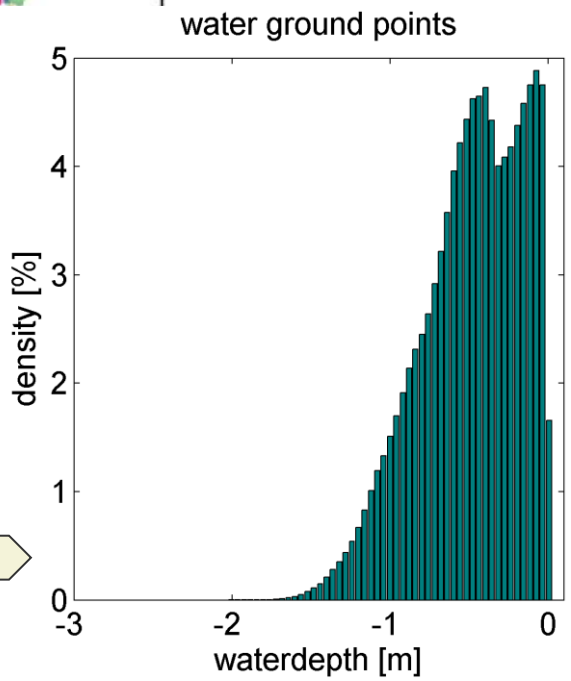
To calculate the DTM additional interim stages have to be worked out.

# Point cloud - Lidar Bathymetry

point cloud

DTM




water depth of all river bed points of profile point cloud
max. water depth ~2m

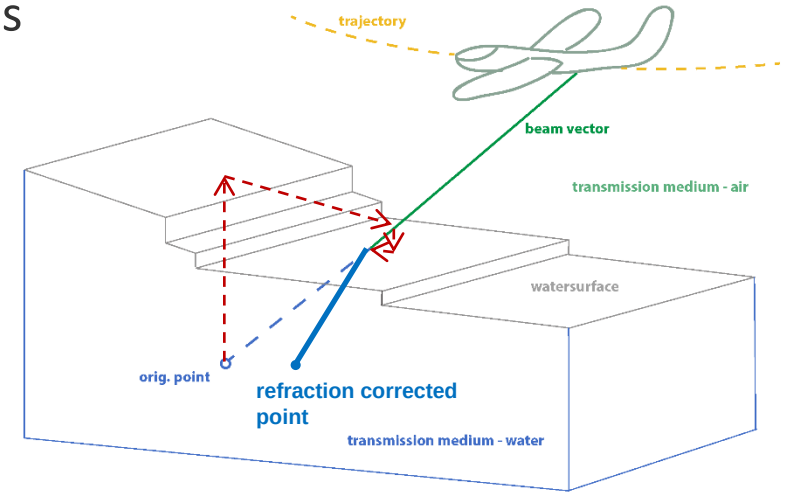
# Lidar bathymetry river bottom DTM

point cloud

DTM

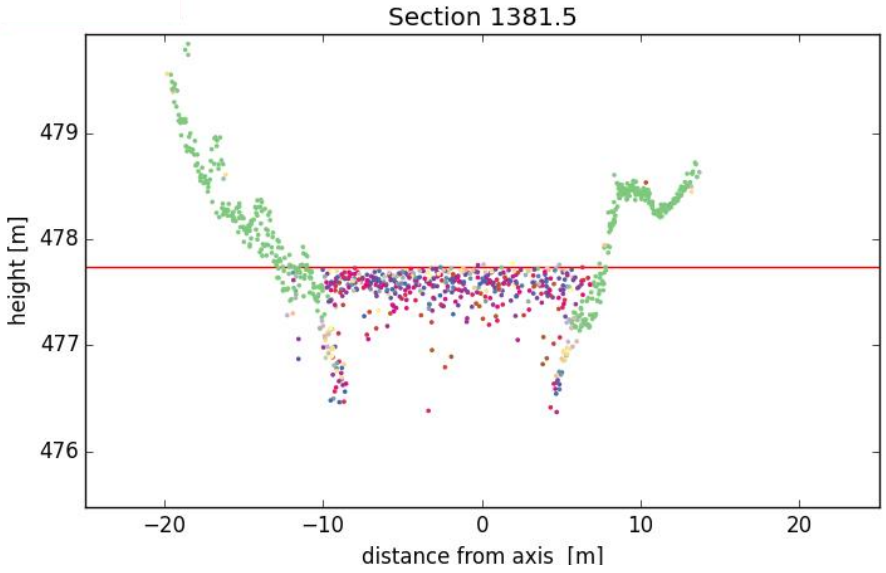
Differences to standard topographic cases

- Entire area
  → refraction correction
- Deep/special areas
  → very low ground echo density
  → partly no ground echoes
  → but water column echoes




Strategy

1. Detect water surface
2. Refraction correction
3. First classification of water points
4. Standard topographic filtering of foreland and water bottom candidates



# Water surface

point cloud

DTM

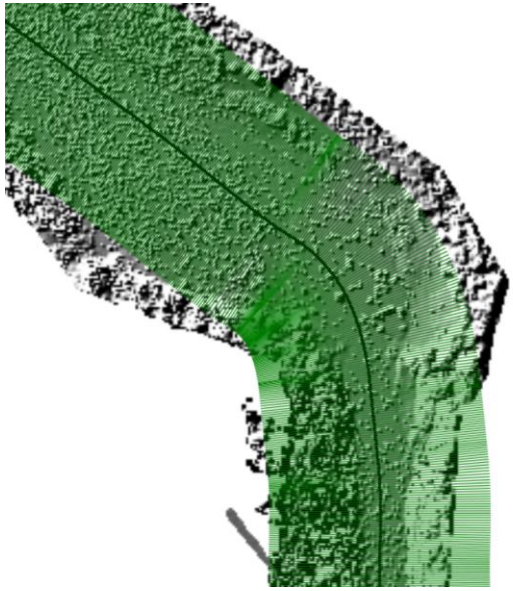
First implementation:
**semi-automatic tool**

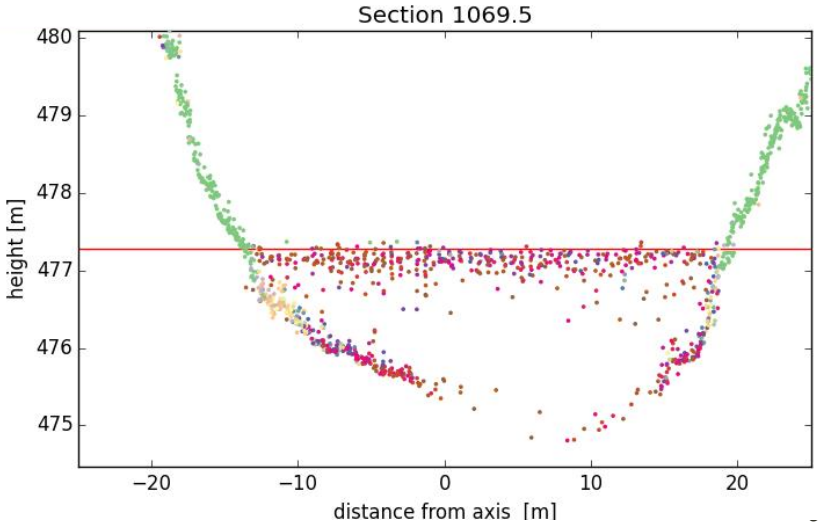
Cross sections along an axis computed an displayed.

User estimates water surface in cross sections.

Estimated water surface will be propagated continuously while moving through sections.

Currently working on water surface estimation using point attributes like amplitude, lowest points and pre classification.

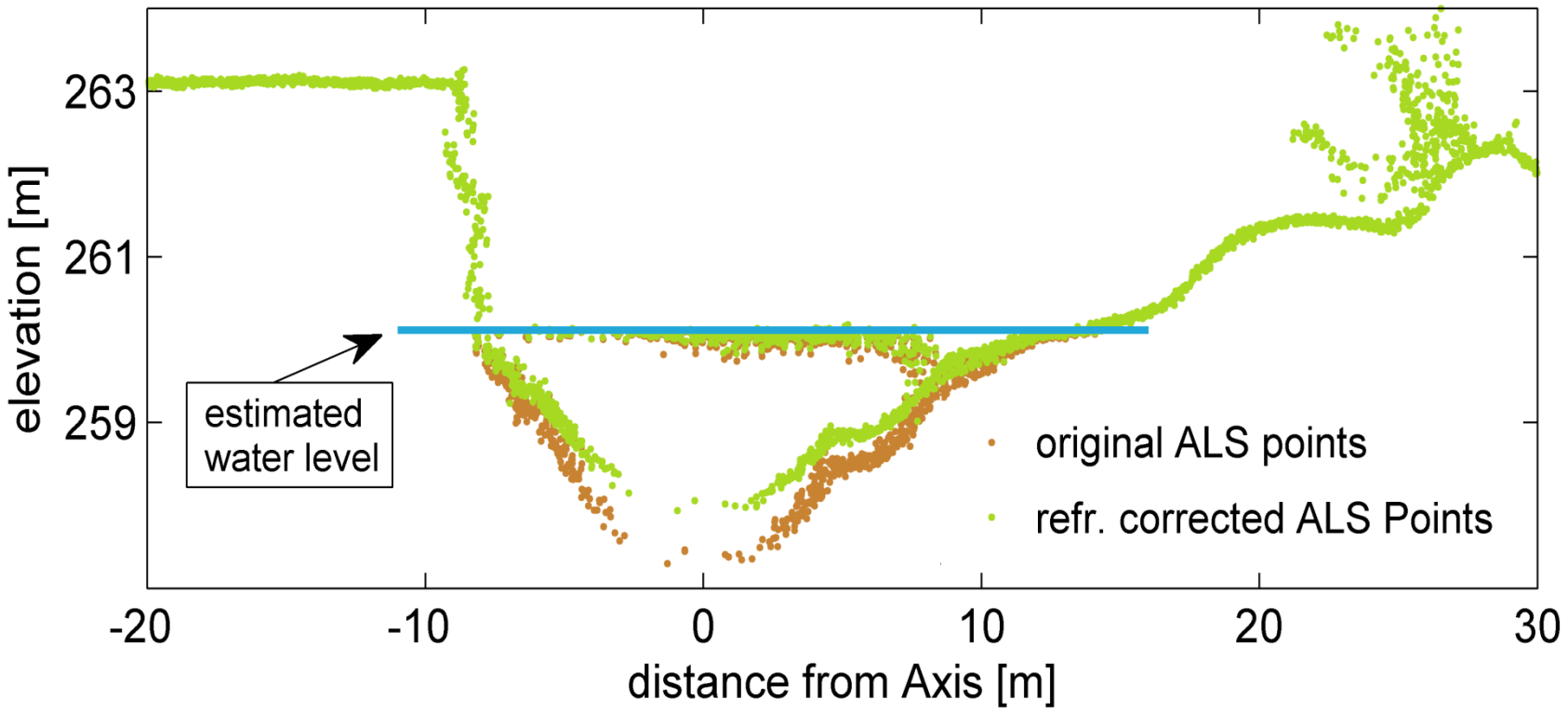




# Refraction Correction

point cloud

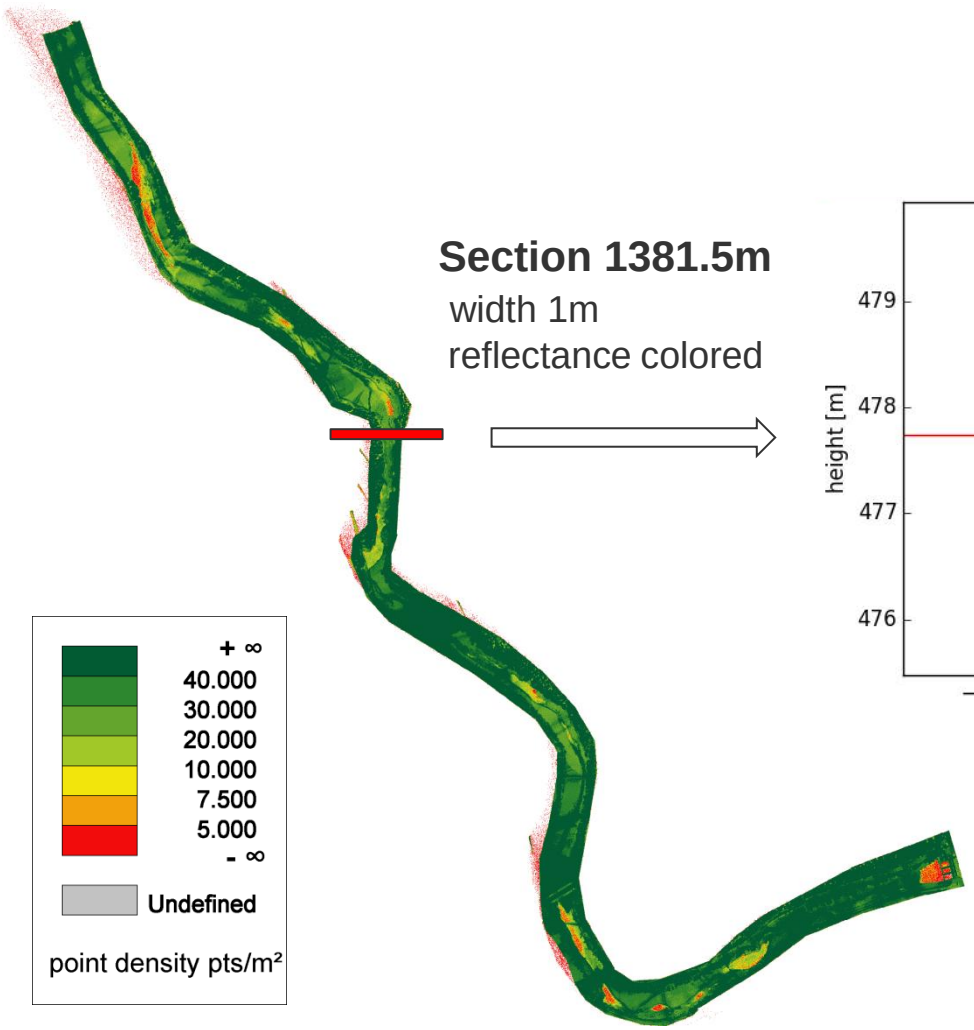
DTM



# Point Density

point cloud

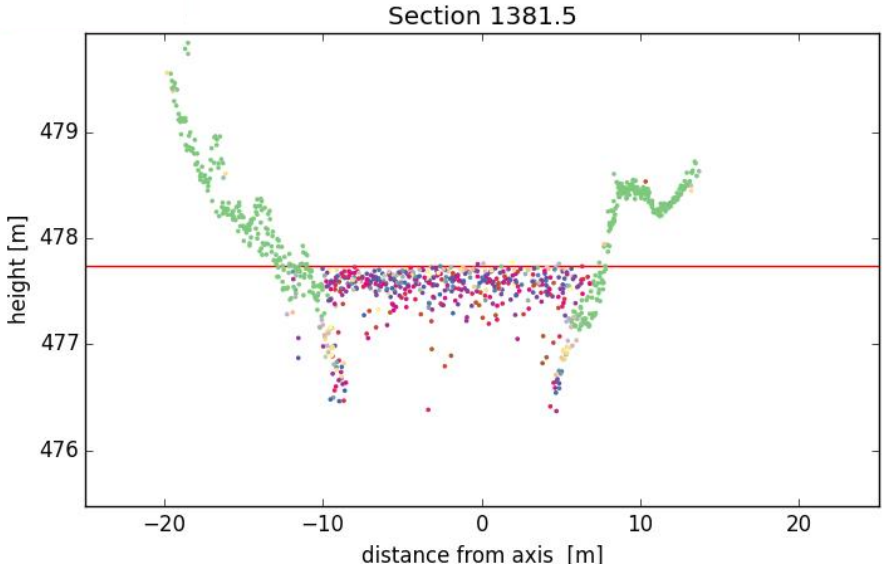
DTM




**Section 1381.5m**

width 1m

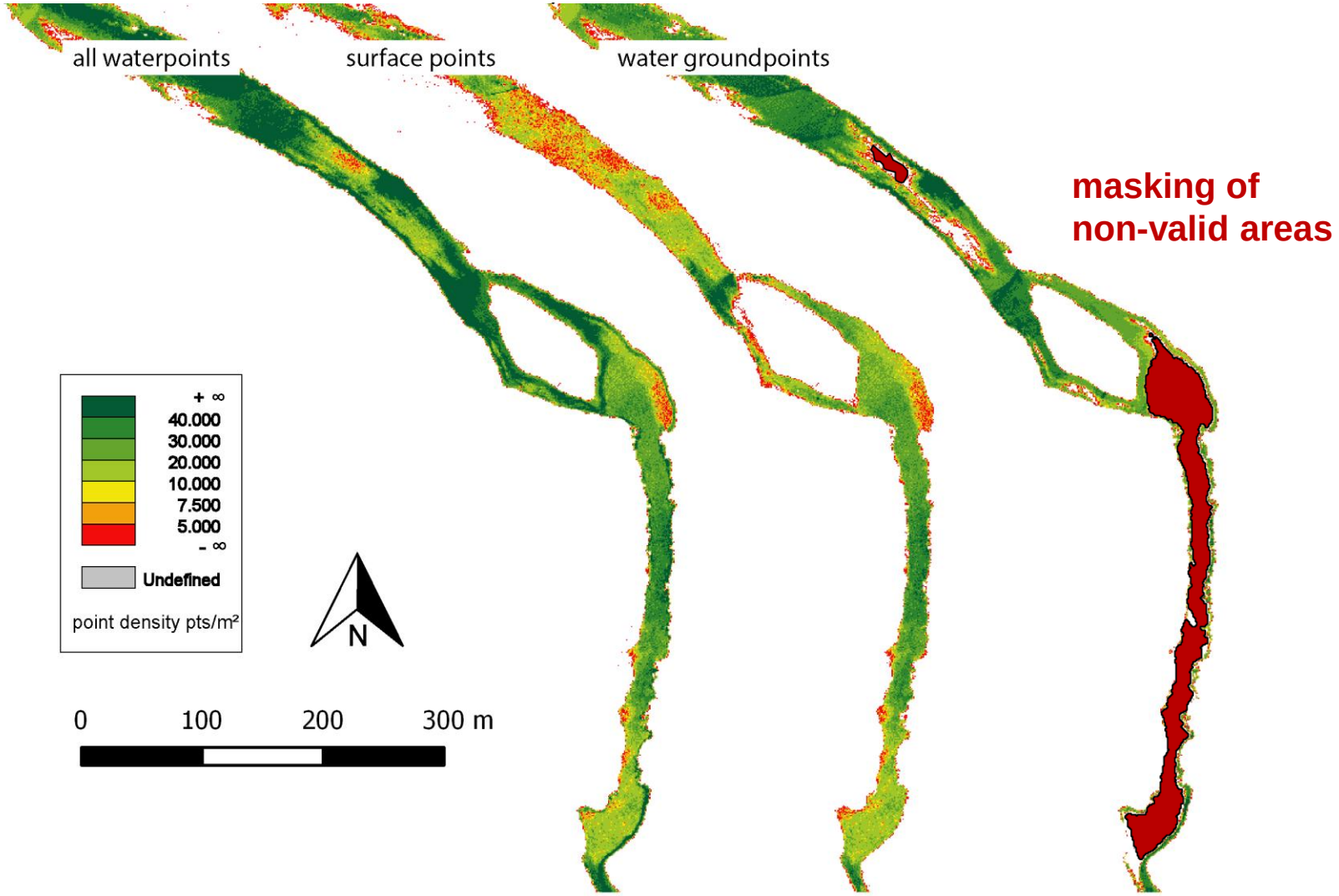
reflectance colored



# Point Density

point cloud

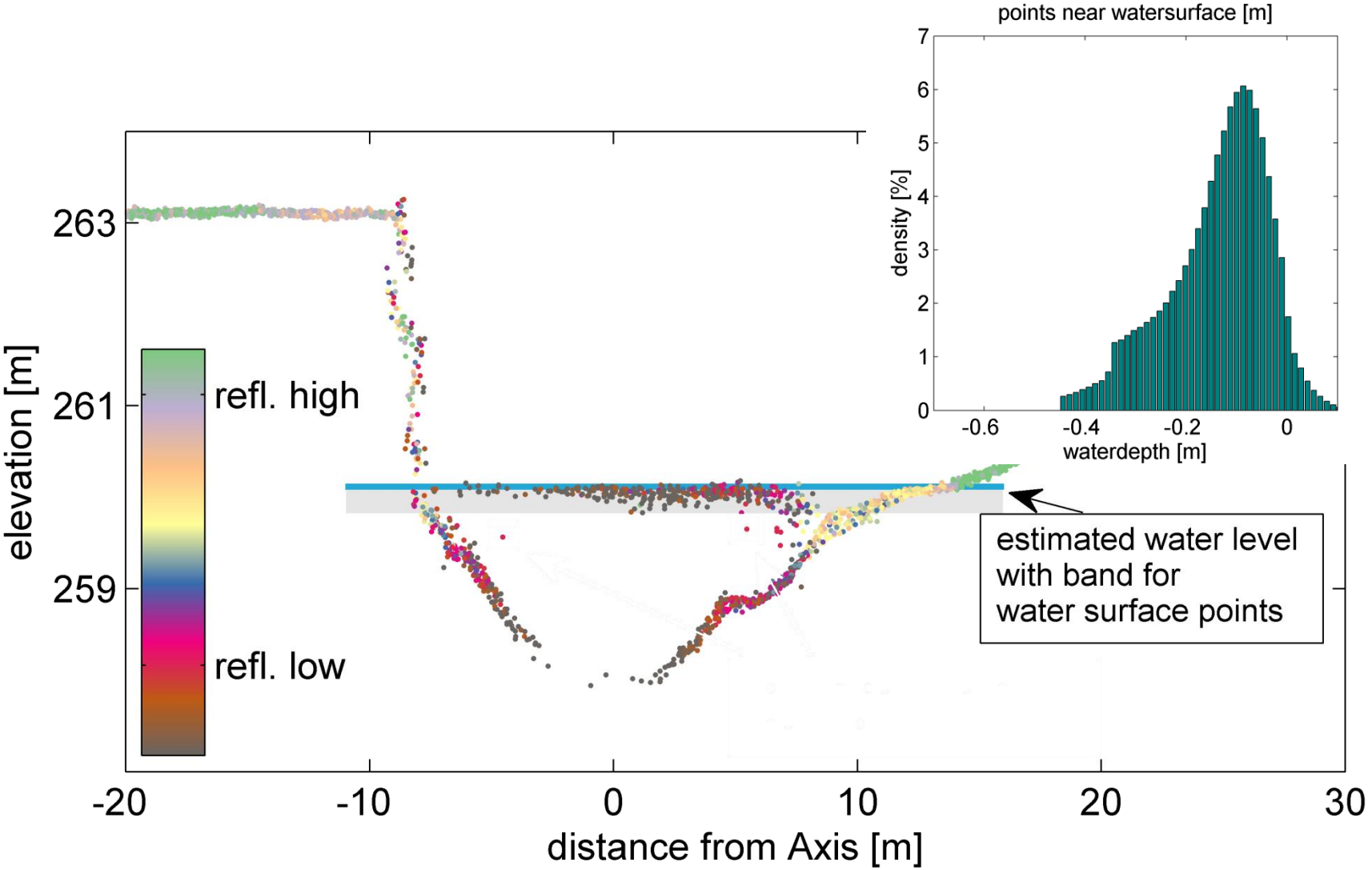
DTM



# First classification of water points

point cloud

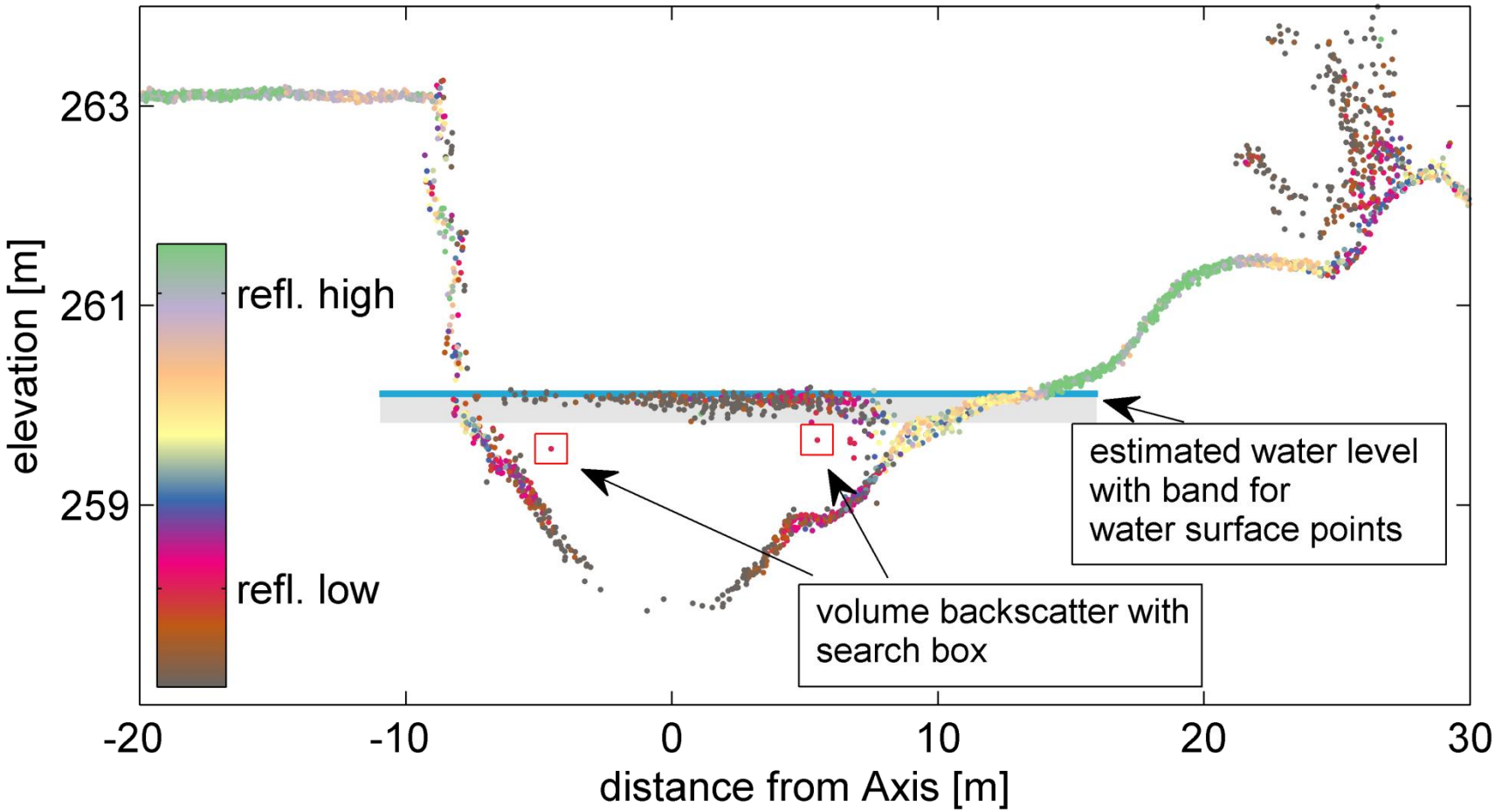
DTM



# First classification of water points

point cloud

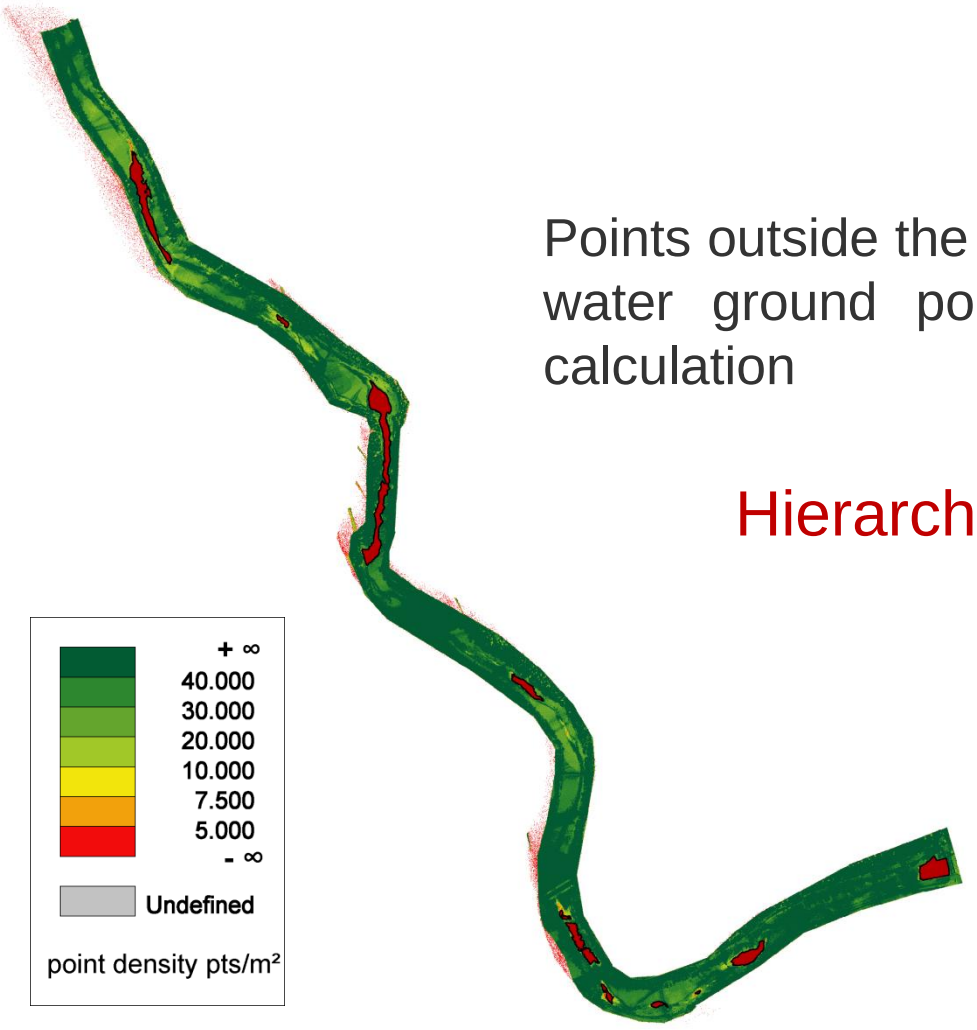
DTM



# Point Density

point cloud

DTM




Points outside the water body and the classified water ground points will be used for DTM calculation

Hierarchic Robust Interpolation

# Hierarchic Robust Interpolation I

point cloud

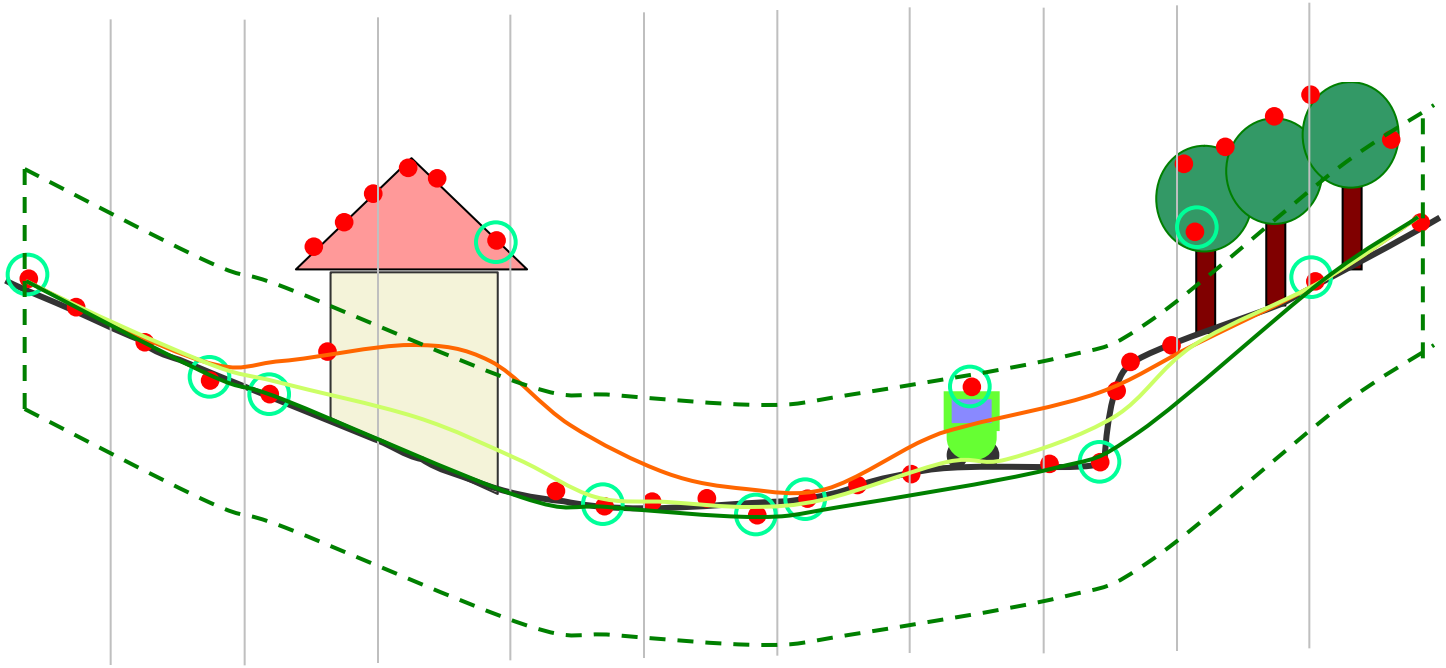
DTM

- Interpolation
  - Surface $s$ (x,y) through the points
  - Filtering of random measurement errors
- Robust
  - Height Residuals (surface – point)
  - Weight function for the points:
    Points above/below the surface get a lower/bigger weight
- Hierarchic
  - From rough to fine (e.g. 5m → 3m → 1m)
  - Data pyramides

# Hierarchic Robust Interpolation II

point cloud

DTM

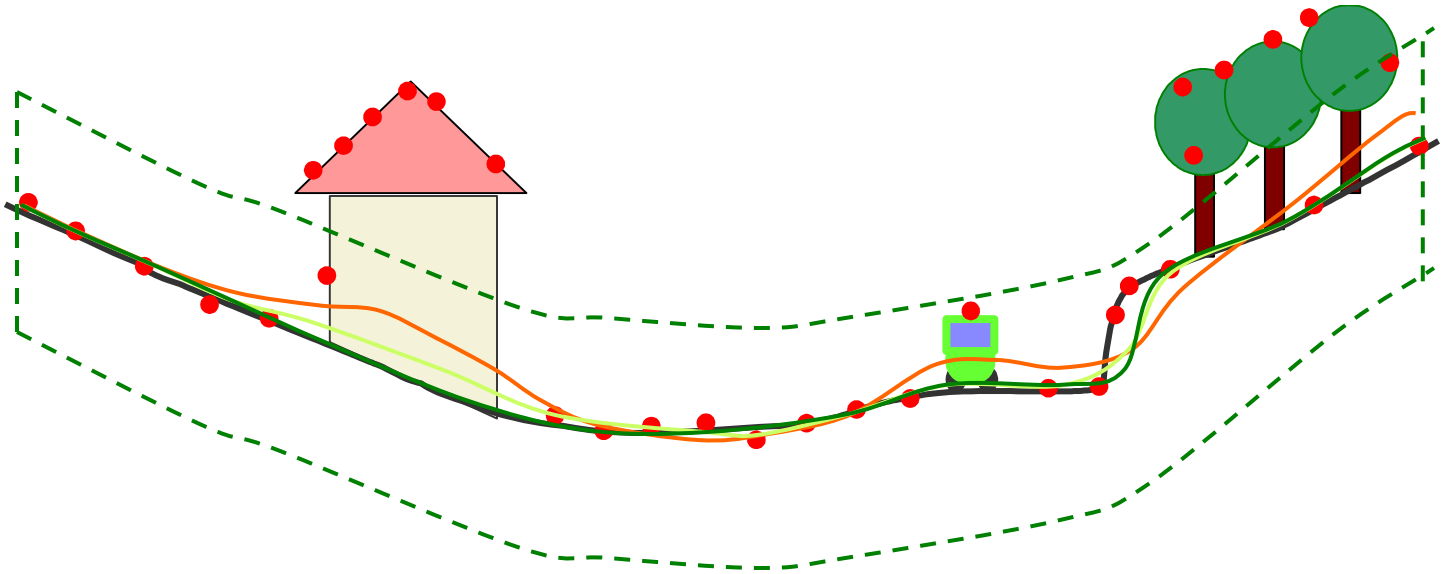


*Level 1 – initial data pyramid*
*choose k-lowest point in cell*

# Hierarchic Robust Interpolation III

point cloud

DTM

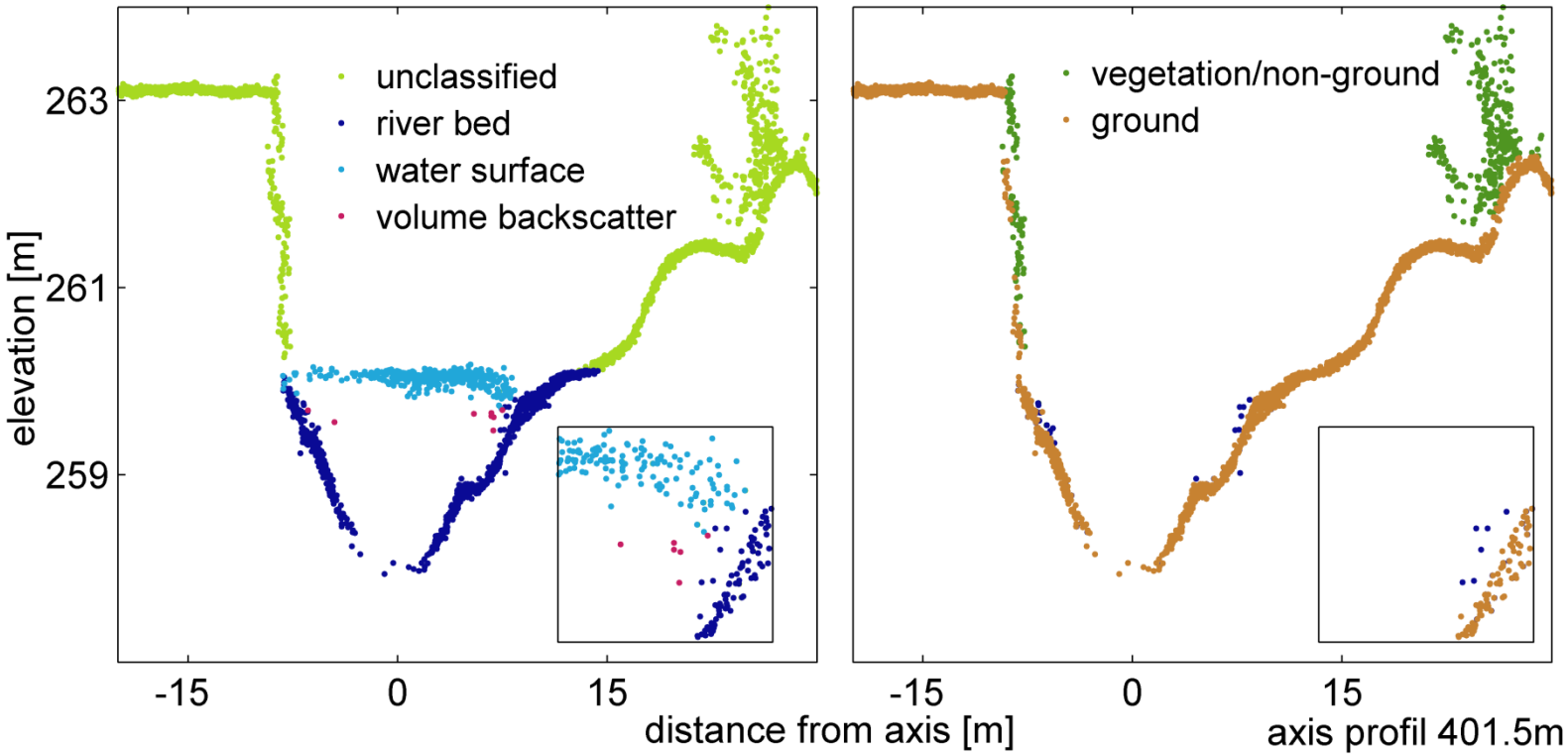


*Level 2 – Points outside a certain range to the previous interpolation will not be taken to the next level.*

# Classification - Result

point cloud

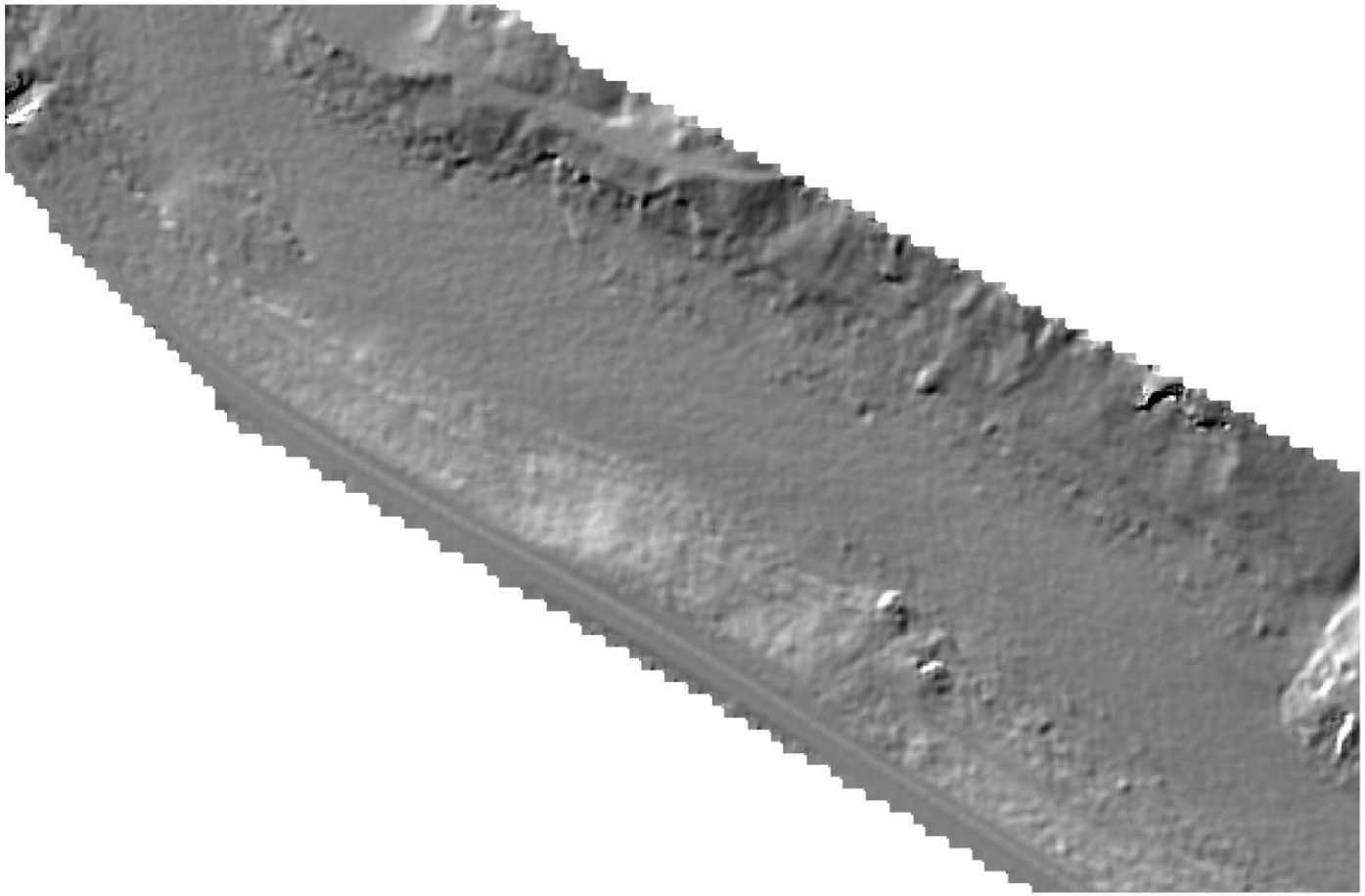
DTM



# DTM

point cloud

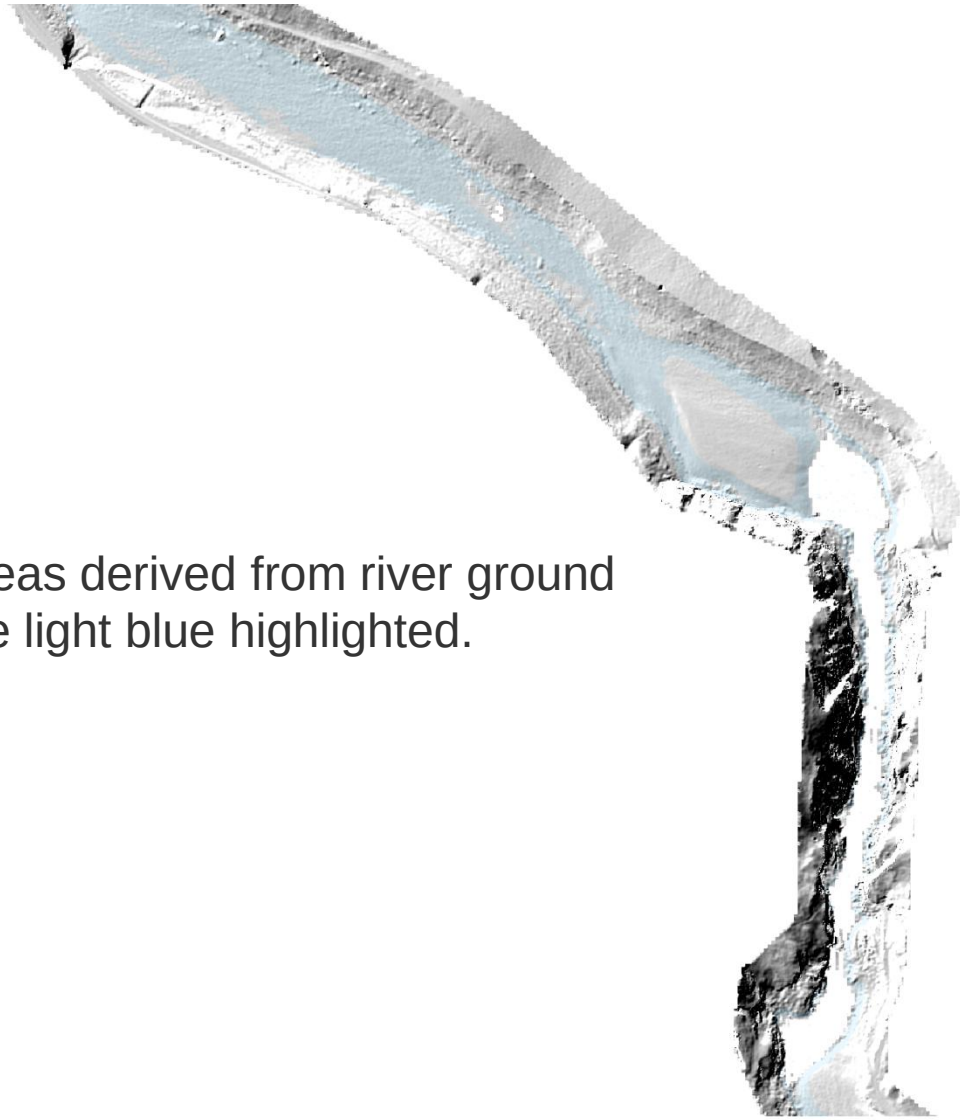
DTM



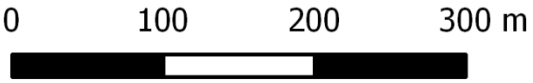
# DTM derived products - shading

point cloud

DTM



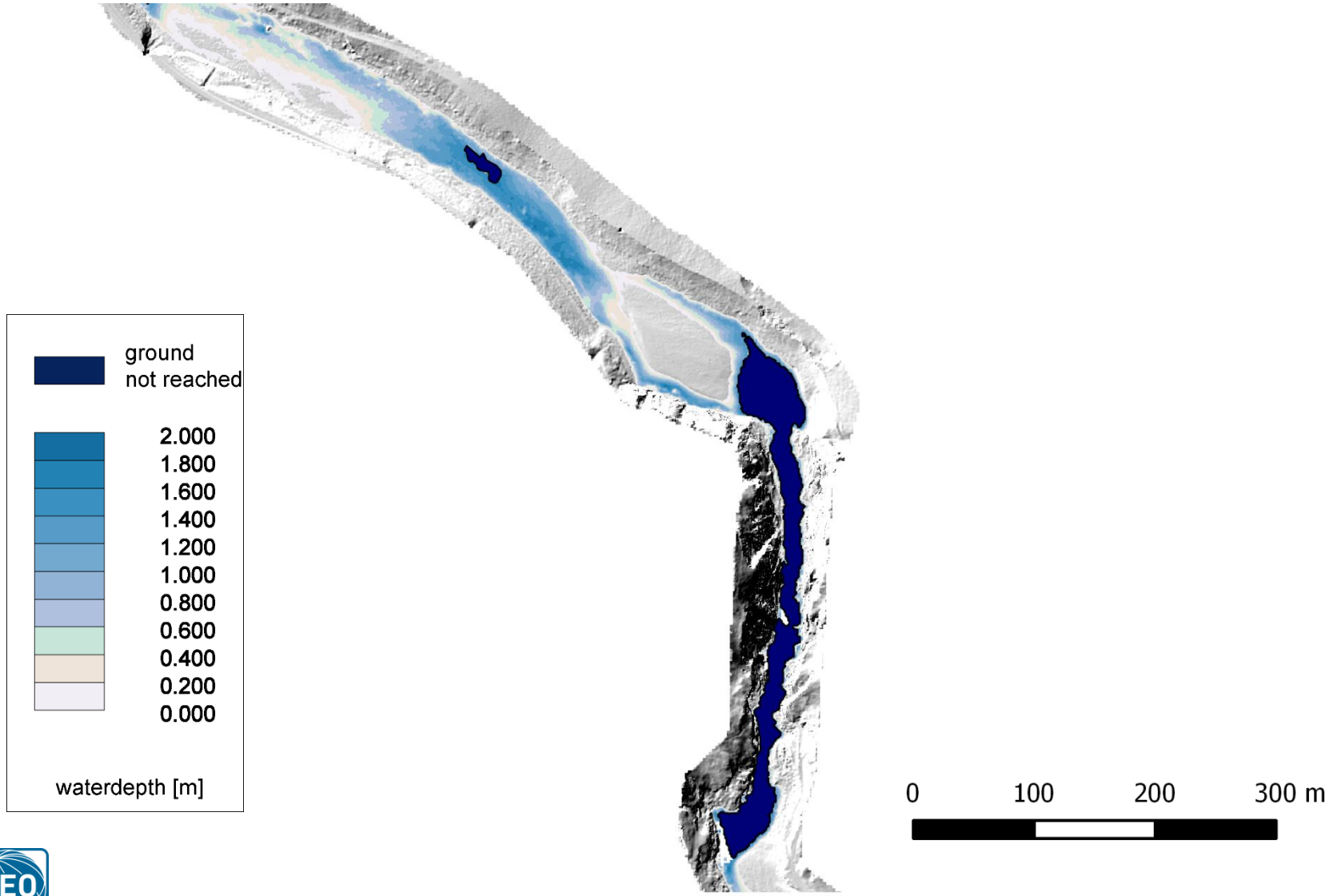
Areas derived from river ground are light blue highlighted.



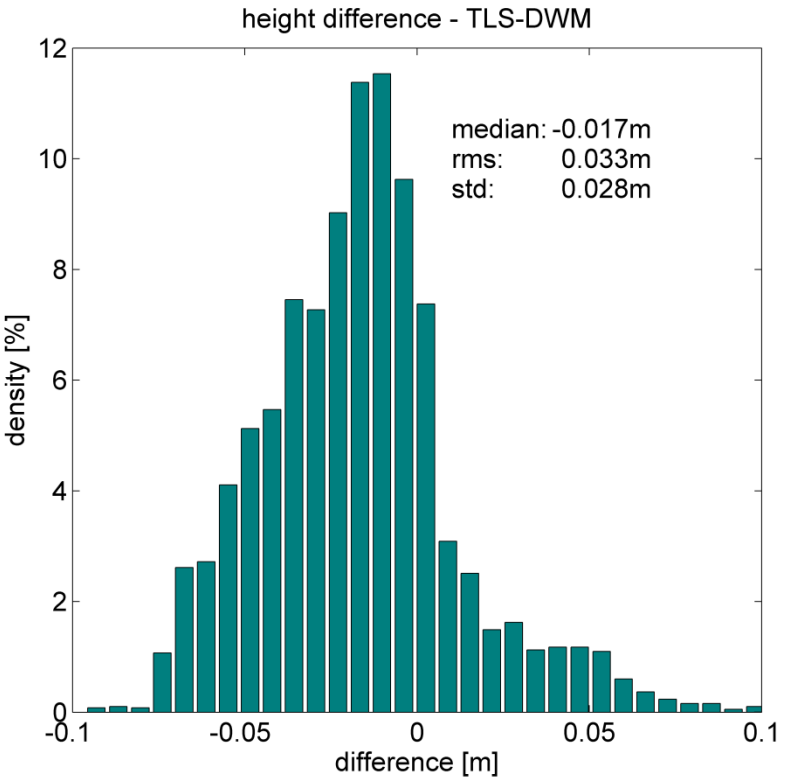
# DTM derived products – water depth

point cloud

DTM

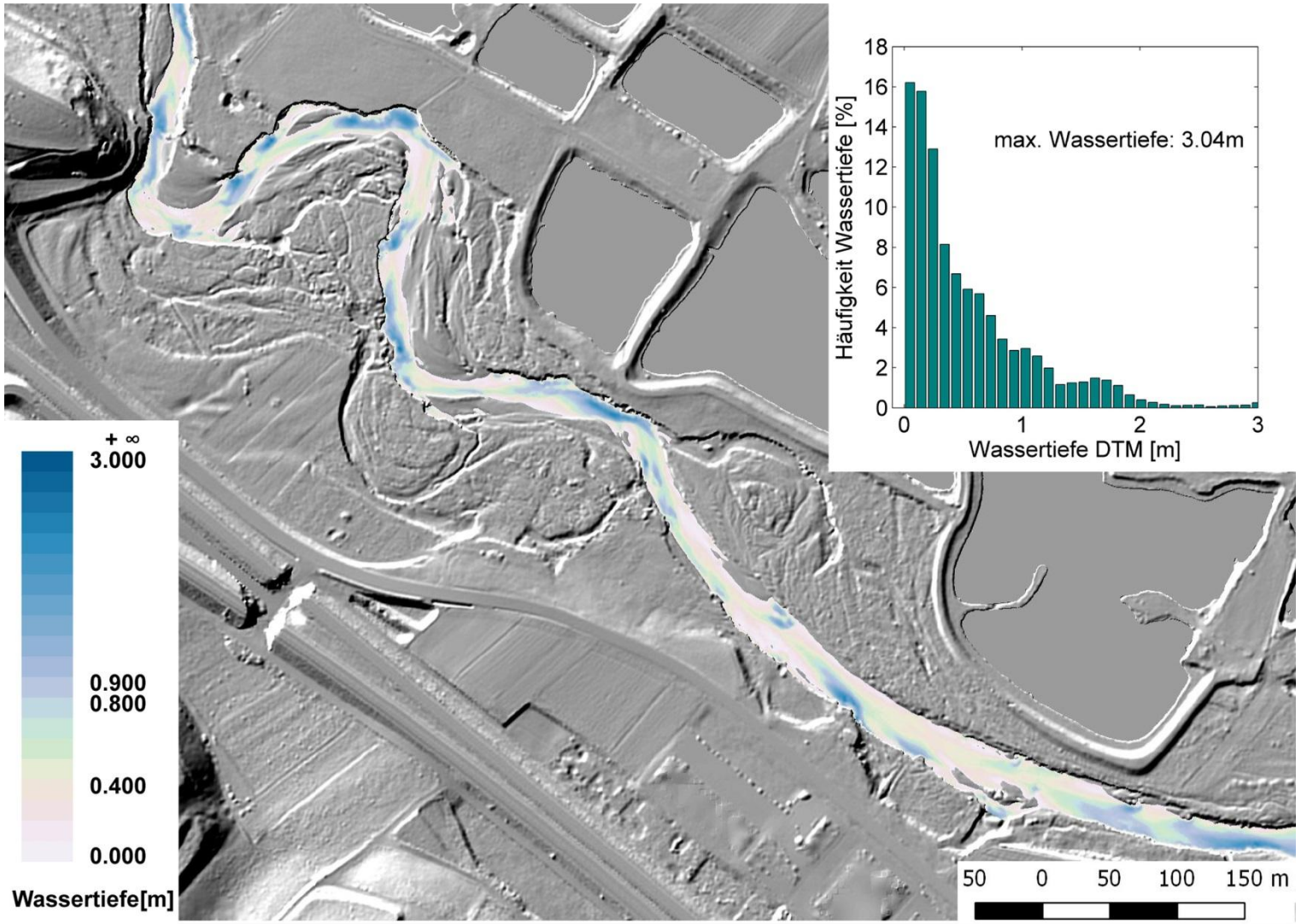


# Estimated water surface versus TLS derived

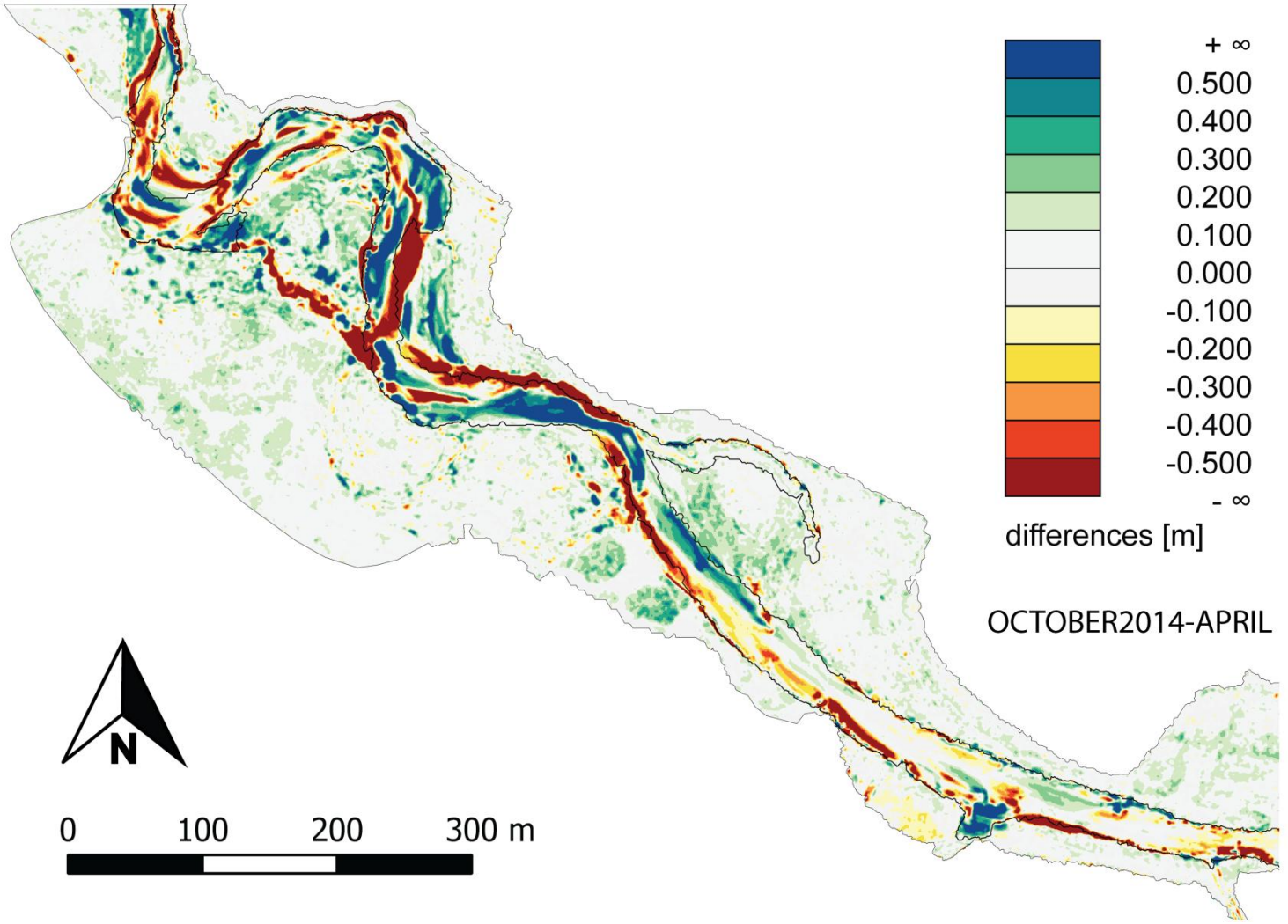



Water surface measured with TLS during the same time as the flight campaign took place. Surface points have been compared to the derived water surface

# Case Study – River Pielach



# Case Study – River Pielach
# DTM – Change Detection



# Summary

Strategy for DTM computation of lidar bathymetry point clouds

1. Detect water surface
2. Refraction correction
3. First classification of water points
4. Filtering of foreland and water bottom candidates