GNSS and photogrammetric surveying of Large Richňavská water reservoir bottom

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Goal of the paper

- Surveying of historical reservoir Veľká Richňavská

- RTK surveying

- Photogrammetric survey

- Surveyed data – use for the creation of reservoir bottom DTM and calculation of the accumulation capacity (usable volume of the water in reservoir)

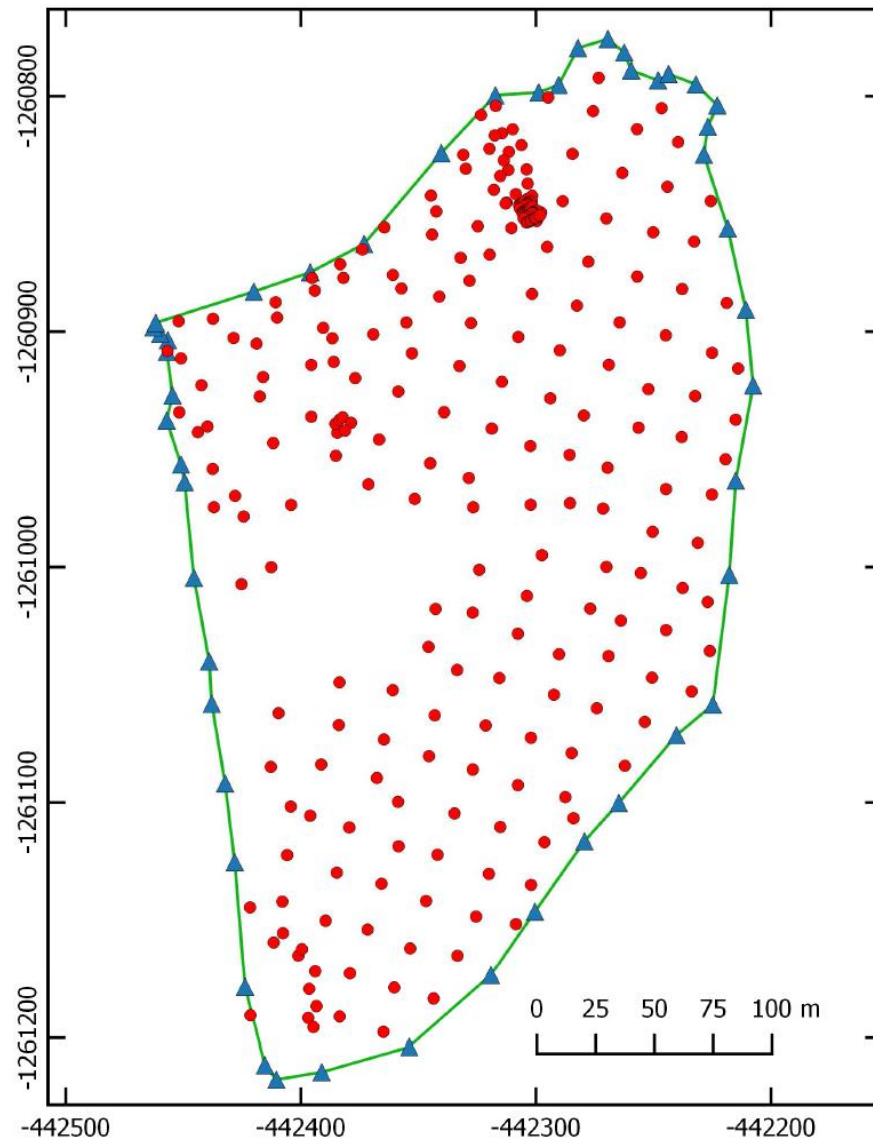# Study area – water reservoir Large Richňavská

- Start of construction: 1736

- Near town Banská Štiavnica

- UNESCO World Heritage

Data collection

- Date: 25.3.2015; Emptied reservoir

- RTK surveying with Leica GS 12 rover in approximate 30 x 30 m point distribution

- Points collected also for photogrammetric surveying

Data processing in QGIS

QGIS 2.6.1

- Shoreline – outlined from ortophotomap and vertices extracted as points (46 points)

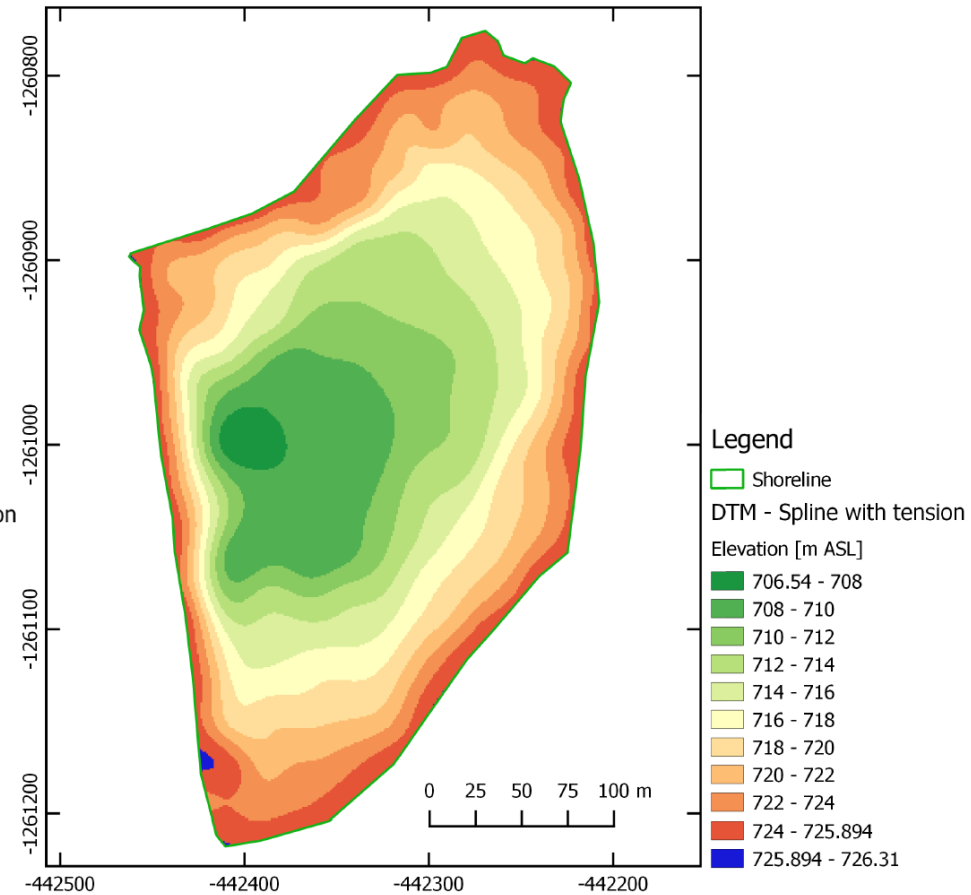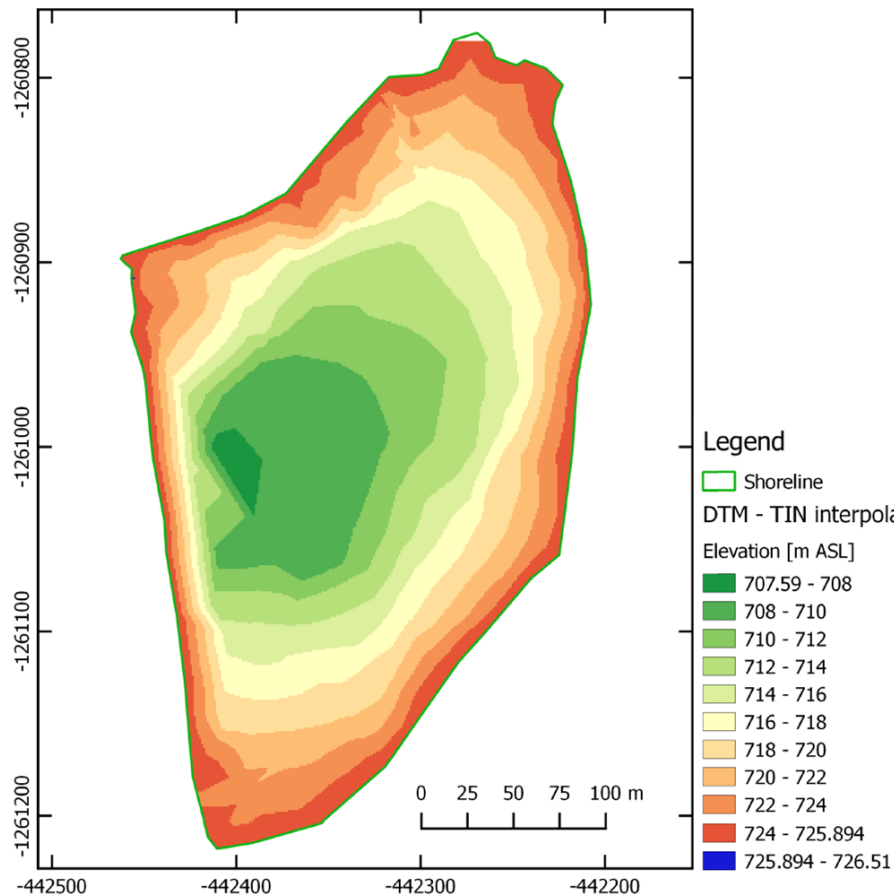- Points stored in ESRI shapefile format (267 points including the photogrammetry points)

Legend
- GNSS points (red dot)
- Shoreline pounts (blue triangle)
- Shoreline (green outline)
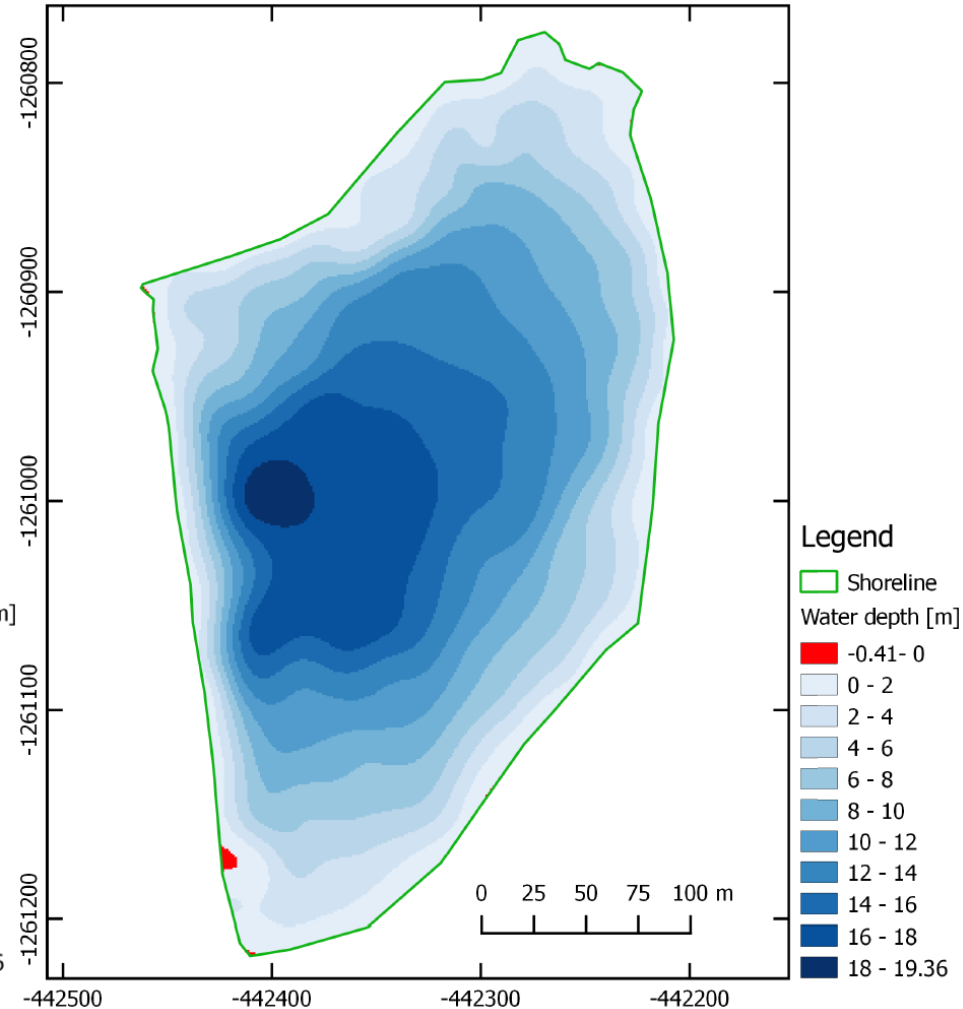
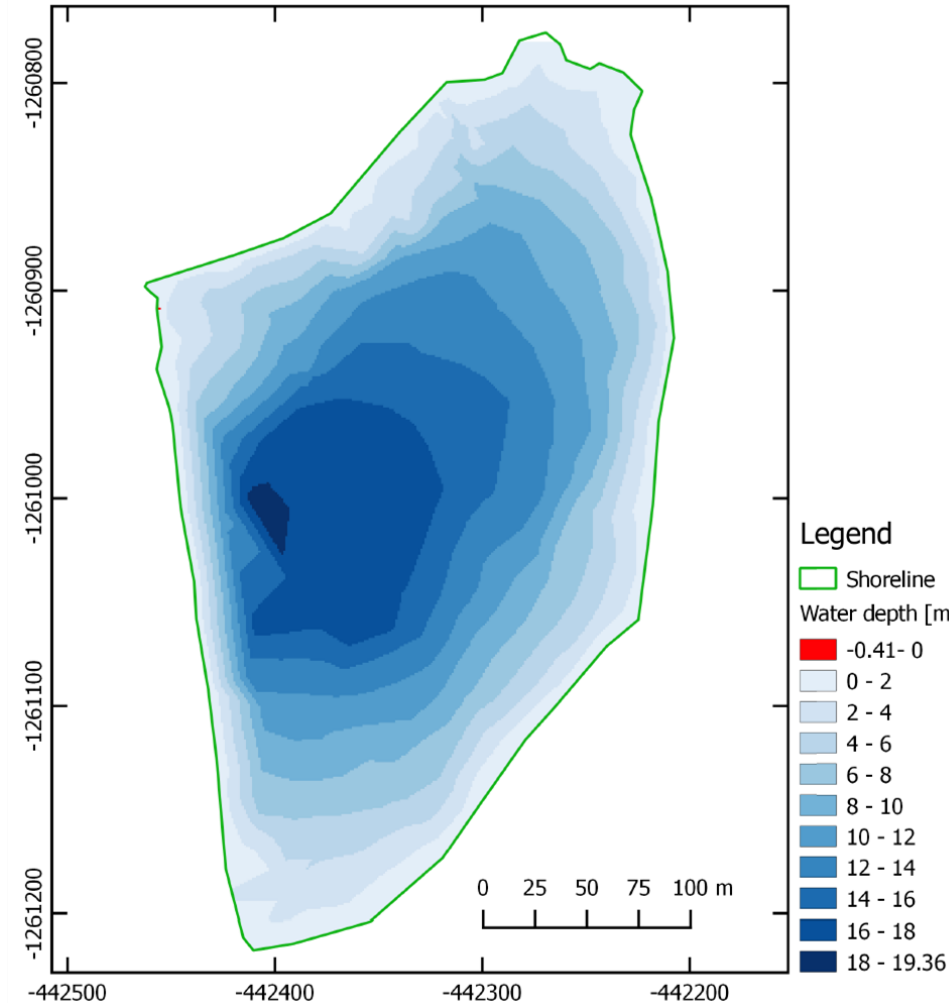# DEM creation – QGIS and GRASS GIS

Spline with tension (tension factor set to 47) in GRASS GIS

TIN interpolation in QGIS

Water volume calculation in QGIS

- Water depth map from TIN and Spline with tension interpolation

Water volume

RESULTS

- Calculated as the sum of the depth values at each raster of water depth multiplied by cell area

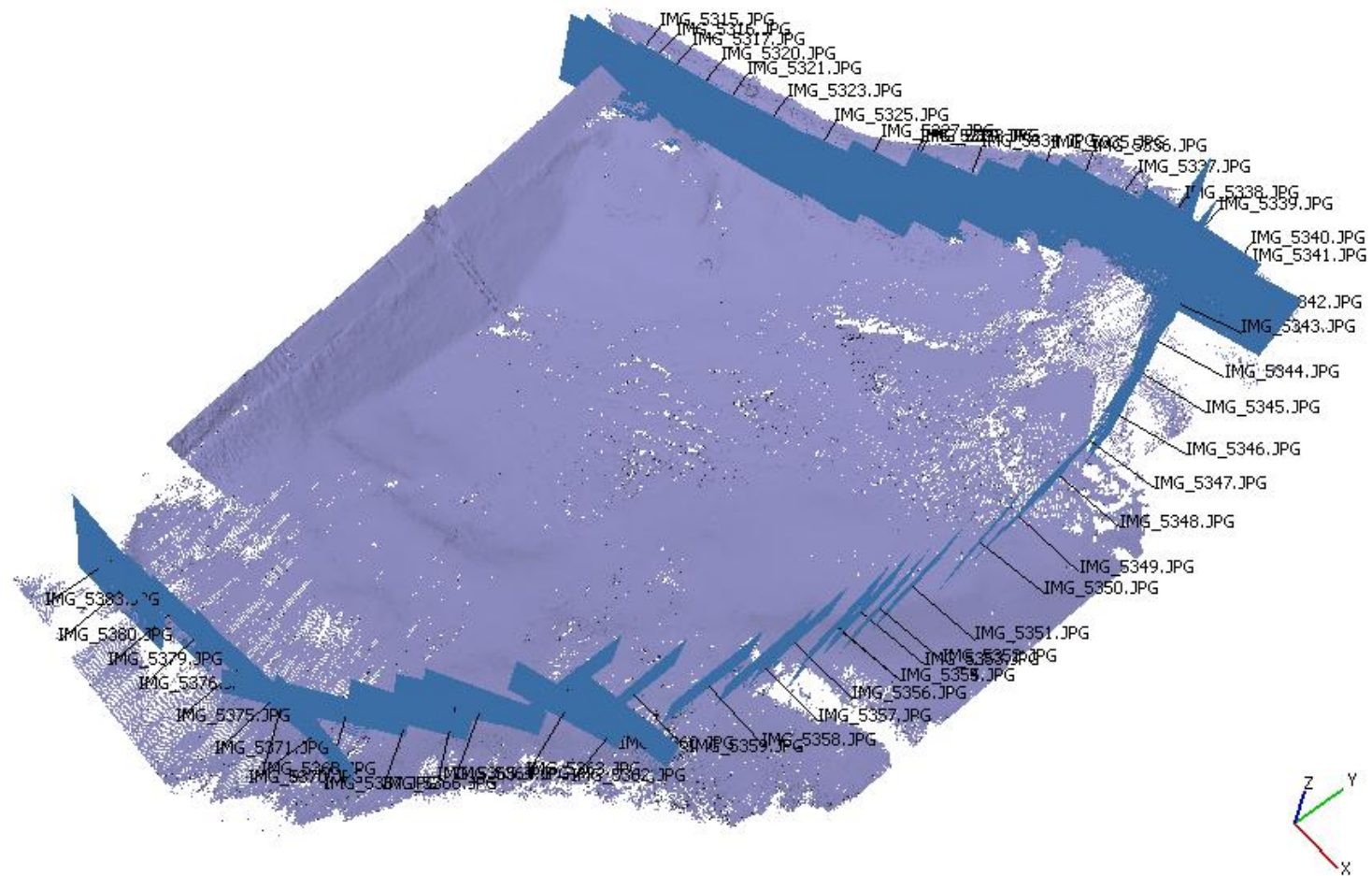- Calculation as zonal statistics of zone defined by polygon of shoreline

$$V_{water} = \sum_{n=1}^{i} Depth_{cell} \times Area_{cell}$$

TIN interpolation		Spline with tension	
Cell count	Water volume [m³]	Cell count	Water volume [m³]
73 669	**645 029**	73 701	**651 973**

Photogrammetric survey - Photoscan

Image capturing positions (51images for photogrammetric processing)

Photogrammetric survey

Photogrammetric survey - Photoscan

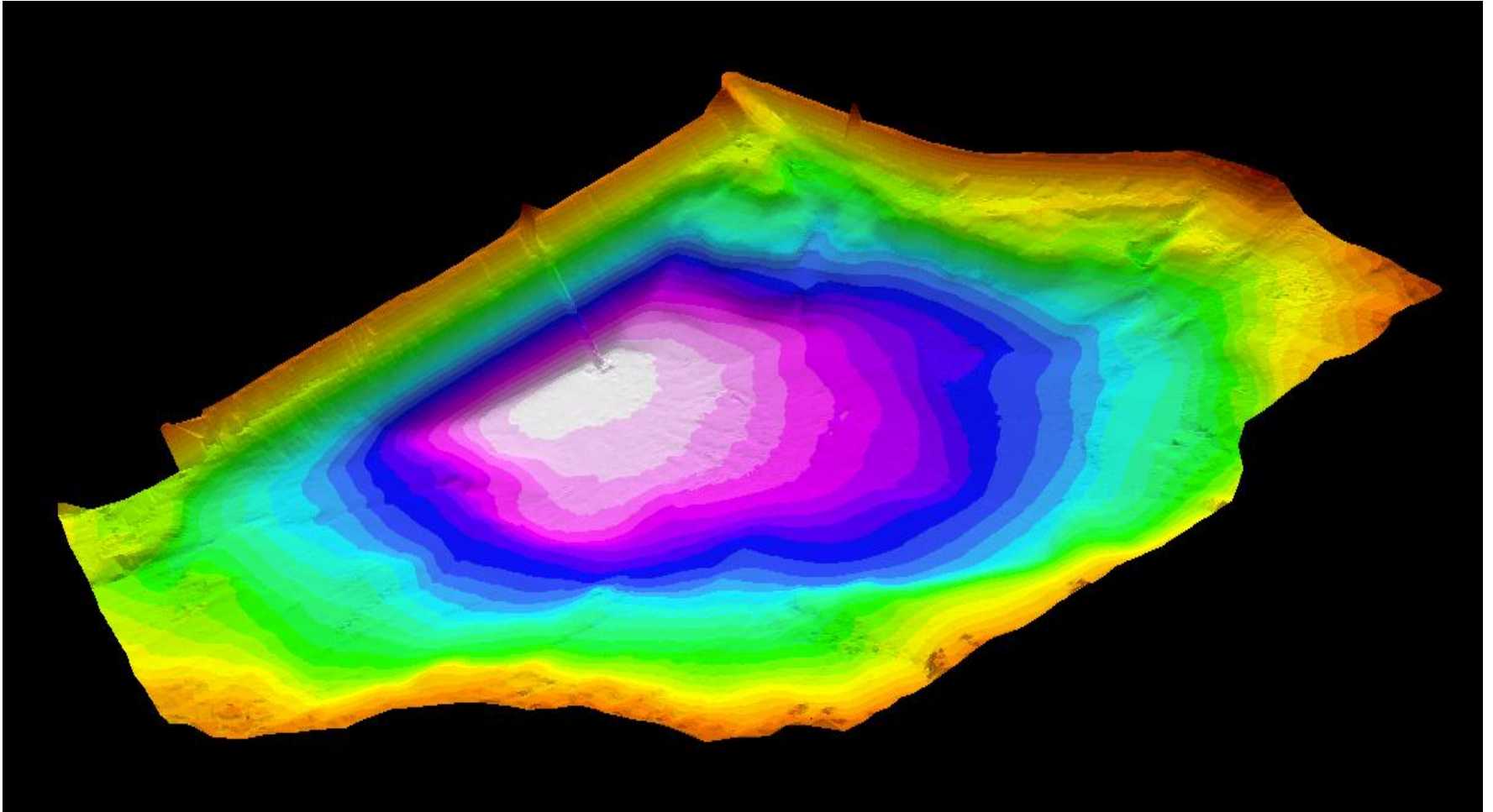**Dense point cloud** (429 050 points with RGB attribute)

Photogrammetric survey - DEM creation – ArcMap

Spline with tension (grid size 2 m, tension factor default)

TIN interpolation (figure below)

Photogrammetric survey - Water volume

RESULTS

- Calculated as the sum of the depth values at each raster of water depth multiplied by cell area

- Calculation as zonal statistics in zone defined by the geodetic polygon of the shoreline

$$V_{water} = \sum_{n=1}^{i} Depth_{cell} \times Area_{cell}$$

TIN interpolation		Spline with tension	
Cell count	Water volume [m^3]	Cell count	Water volume [m^3]
17 014	**634 862**	17 035	**638 129**

Volume calculation Comparasion

RTK surveying ▼

TIN interpolation		Spline with tension	
Cell count	Water volume [m^3]	Cell count	Water volume [m^3]
73 669	**645 029**	73 701	**651 973**

Photogrammetric survey ▼

| TIN interpolation		Spline with tension	
Cell count	Water volume [m^3]	Cell count	Water volume [m^3]
17 014	**634 862**	17 035	**638 129**

Photogrammetric survey quality

Comparison

- zonal statistics of points to obtain Z-coordinate from DTM

- comparison done as subtraction of modelled elevation from the elevation surveyed by RTK

- Statistical evaluation and histograms

Value	Z,GNSS-Z,SPLINE [m]	Z,GNSS-Z,TIN [m]
Minimum	-4.886	-1.716
Maximum	2.025	1.467
Average	-0.279	-0.247
Absolute minimum	0.012	0.005
Standard deviation	0.681	0.355

Photogrammetric survey quality
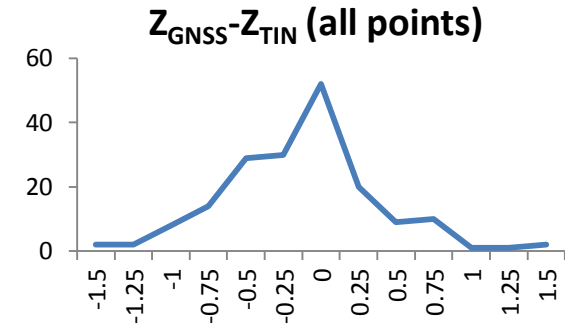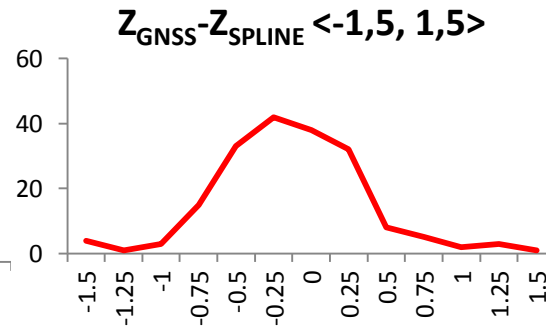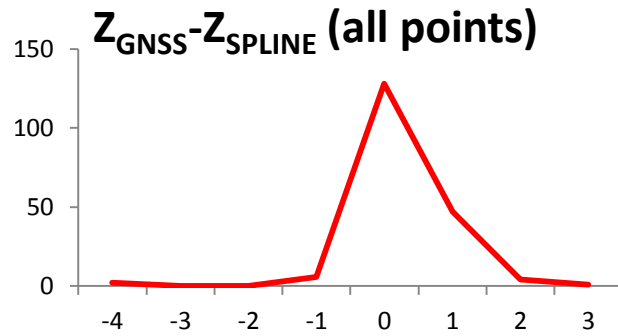
Z,GNSS-Z,SPLINE [m]	Point count
-4	2
-3	0
-2	0
-1	6
0	128
1	47
2	4
3	1

Z,GNSS-Z,SPLINE [m]	Point count
-1.5	4
-1.25	1
-1	3
-0.75	15
-0.5	33
-0.25	42
0	38
0.25	32
0.5	8
0.75	5
1	2
1.25	3
1.5	1

Z,GNSS-Z,TIN [m]	Point count
-1.5	2
-1.25	2
-1	8
-0.75	14
-0.5	29
-0.25	30
0	52
0.25	20
0.5	9
0.75	10
1	1
1.25	1
1.5	2

Thank you for your attention