

# COMPARISON OF TERRAIN MODELS BASED ON UAS IMAGES

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# Purpose of 3D modeling based on UAS imagery

- The main tasks are:
  - Taking aerial photos at three different times
  - Block adjustment
  - Generate pointclouds
  - Producing orthophotos
  - Producing point cloud differences
  - Mapping of erosion areas
  - Calculation of volumes to determine the amount of corn
- In order to have exact 3D models, we need enough number of high-precision, well-arranged control points.

# Sample area

- Hungary, corn field near Pusztaszentlászló



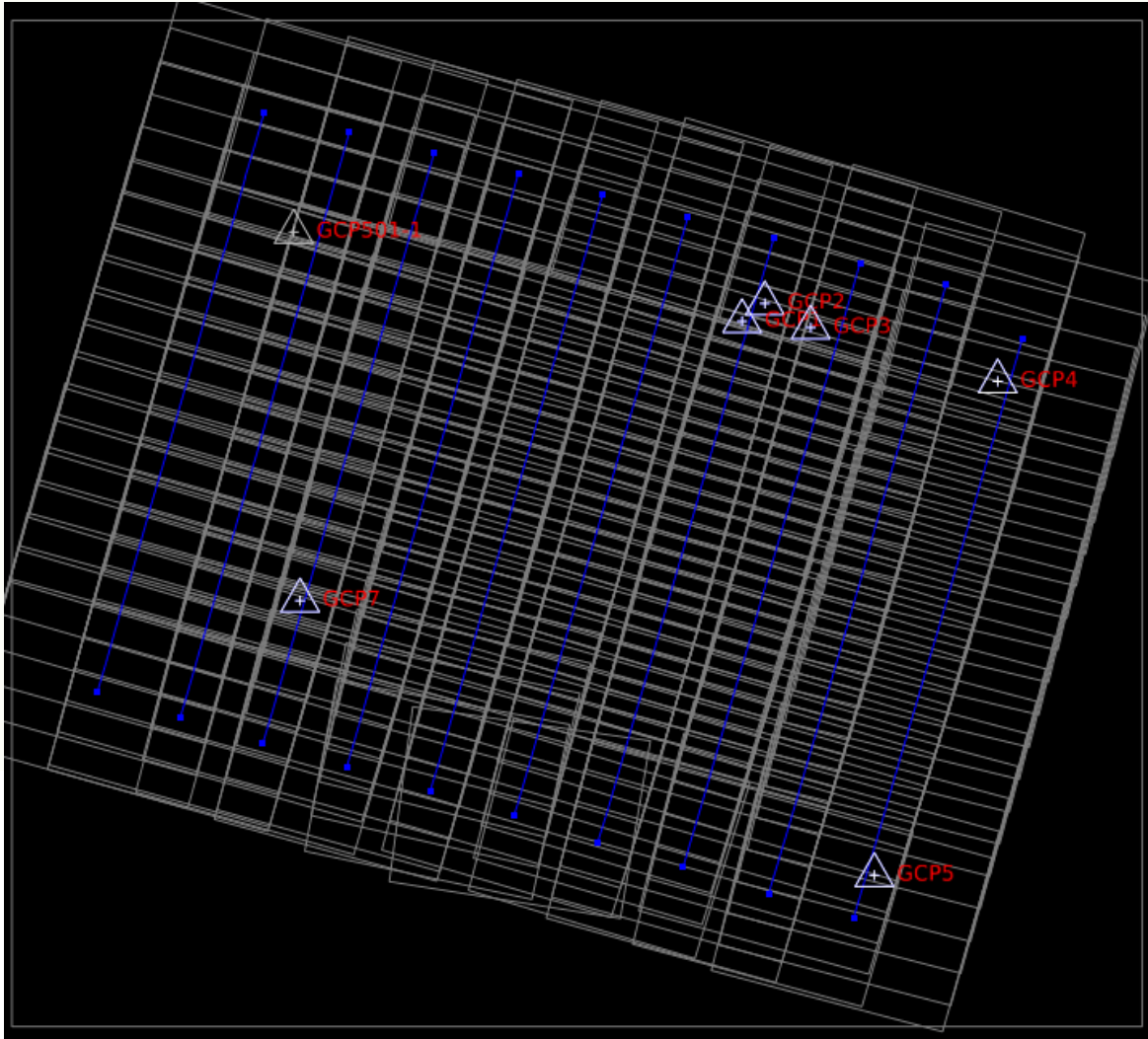
Date	NUMBER OF PHOTOS	AVG. FLIGH HEIGHT [M]	GROUND RESOLUTION [CM]
2003.05.01.	134	304.1	3.58
2023.06.17.	199	292.9	3.08
2023.08.15.	95	287.8	3.34



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# GCP points



- We needed control points in the corners of the block.
- The points must be clearly visible.

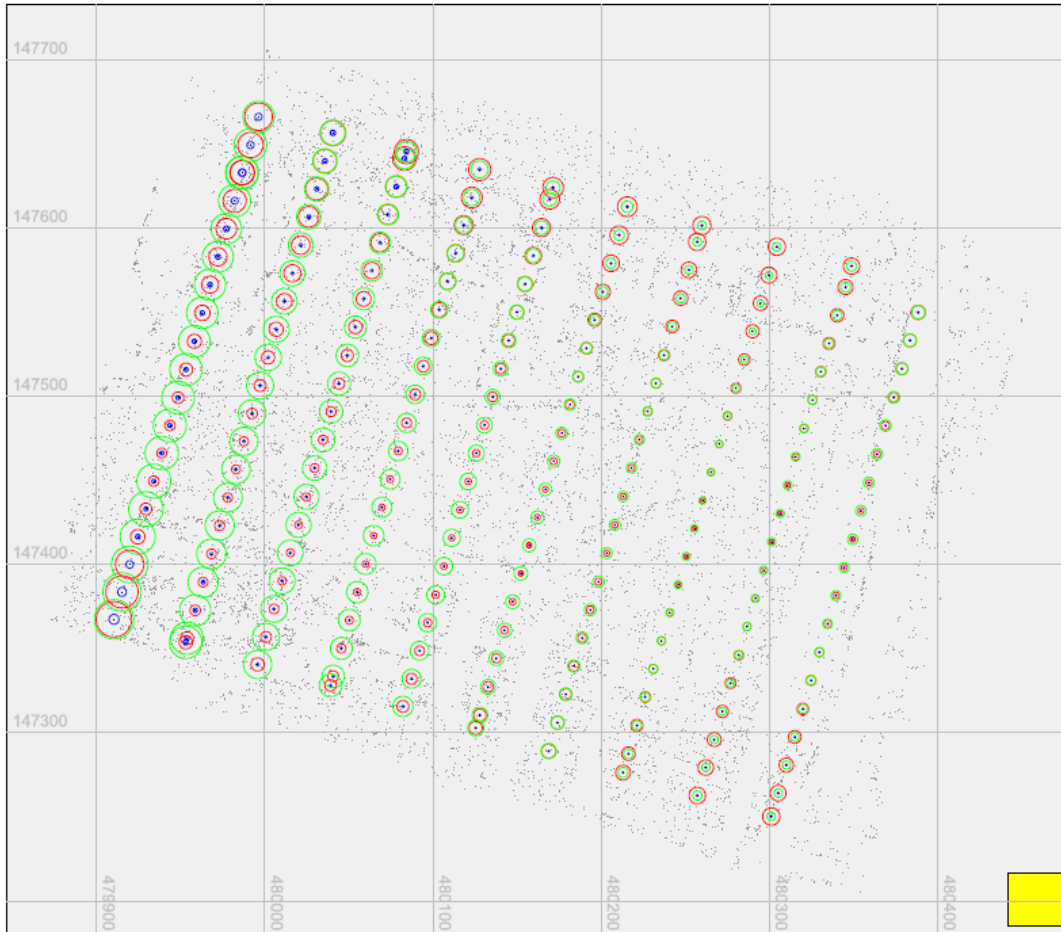


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# Block adjustment

Exterior orientation (Omega,Phi,Kappa) standard deviations  
(DJI\_FC220\_4.730000\_4000x3000)



Graphic with 199 photos from the project. The camera locations are shown with its standard deviations for omega,phi,kappa. The area has a planimetric extent of about: 634 x 554 [m].

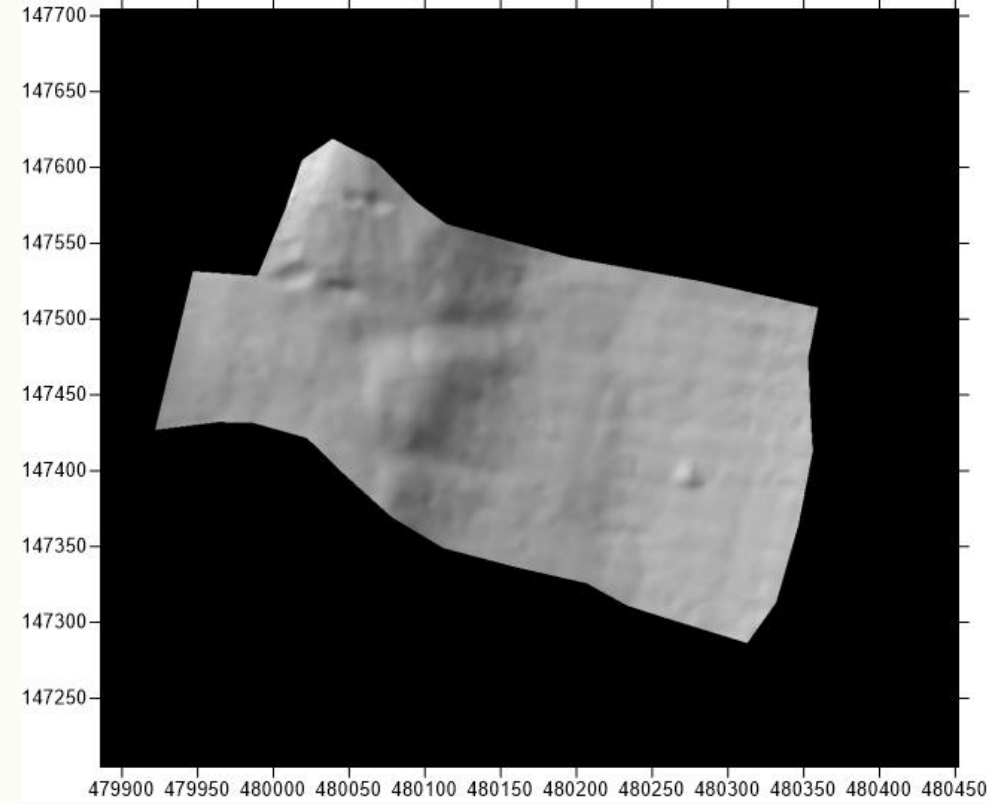
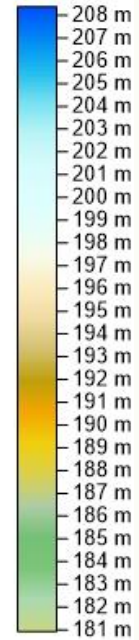
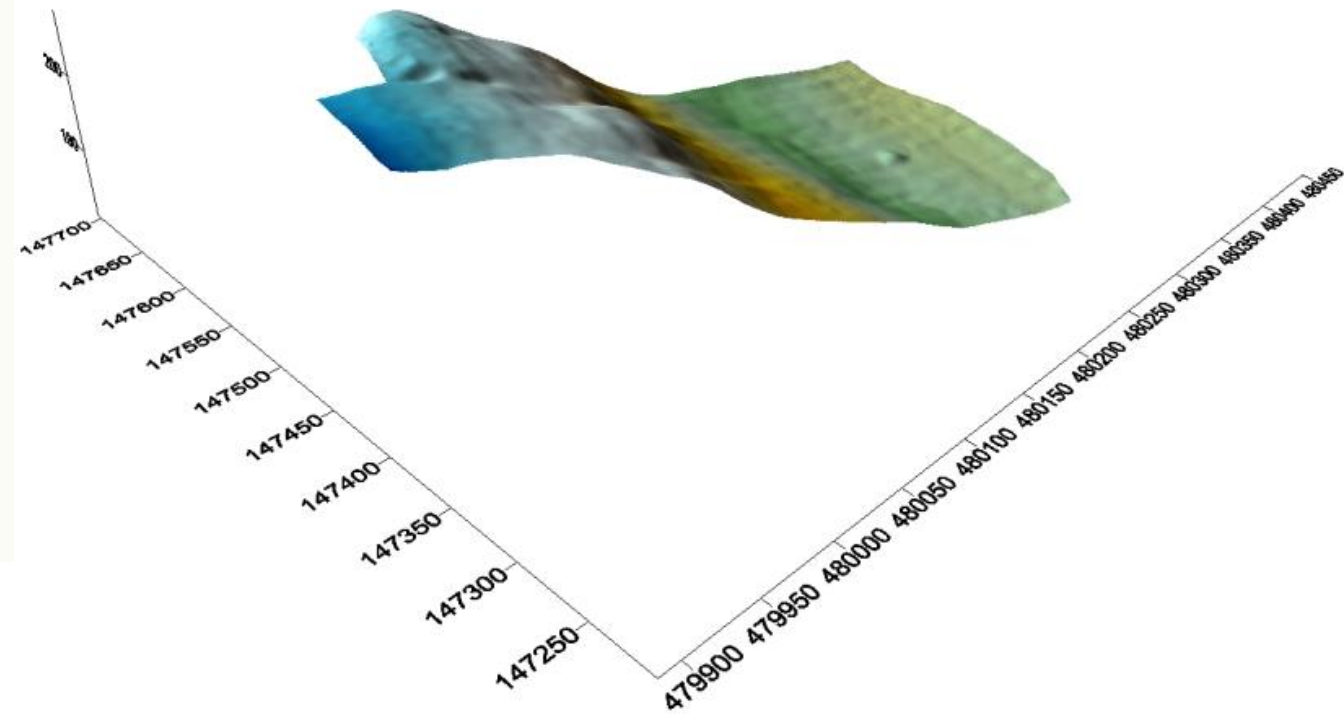
Date	SIGMA NAUGHT [PIXEL]	MEAN STANDARD DEVIATION OF HEIGHT [M]	GCP RMS ERROR [MM]
2003.05.01.	1.0521	0.2822	0.0040
2023.06.17.	1.1803	0.2964	0.0045
2023.08.15.	1.0828	0.4329	0.0016



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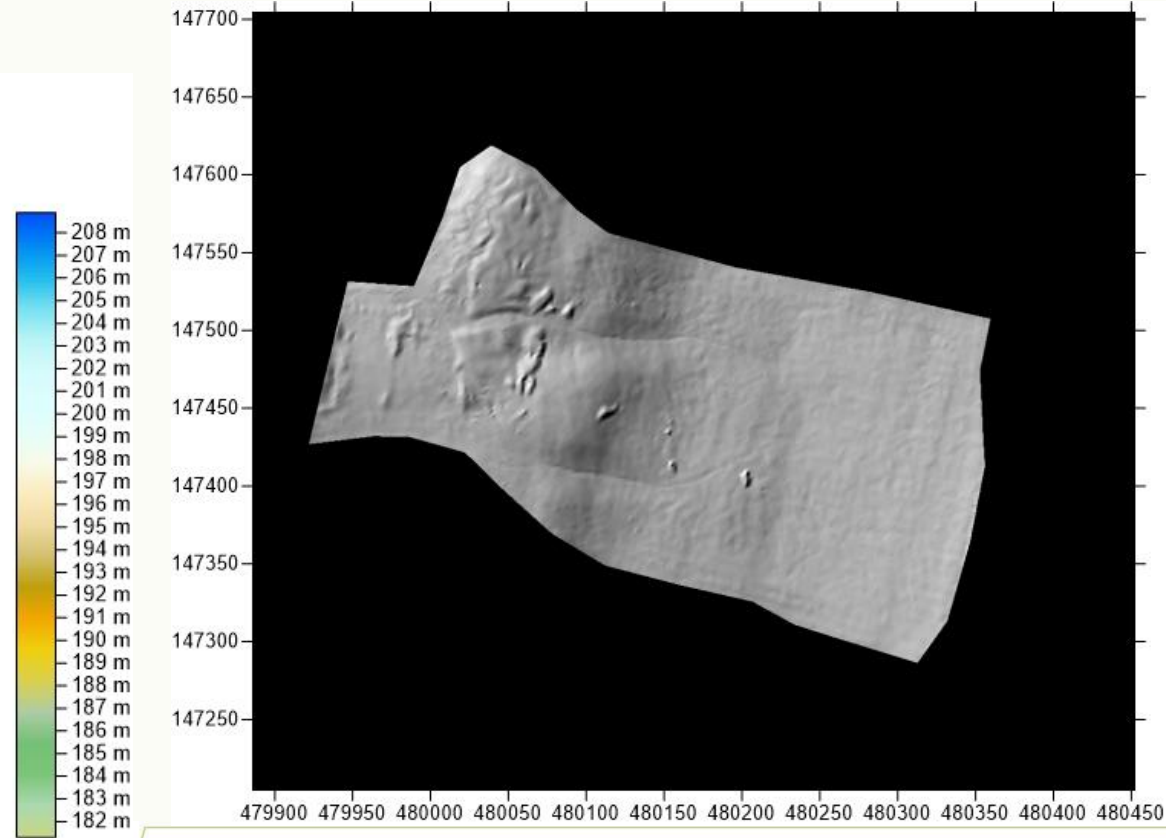
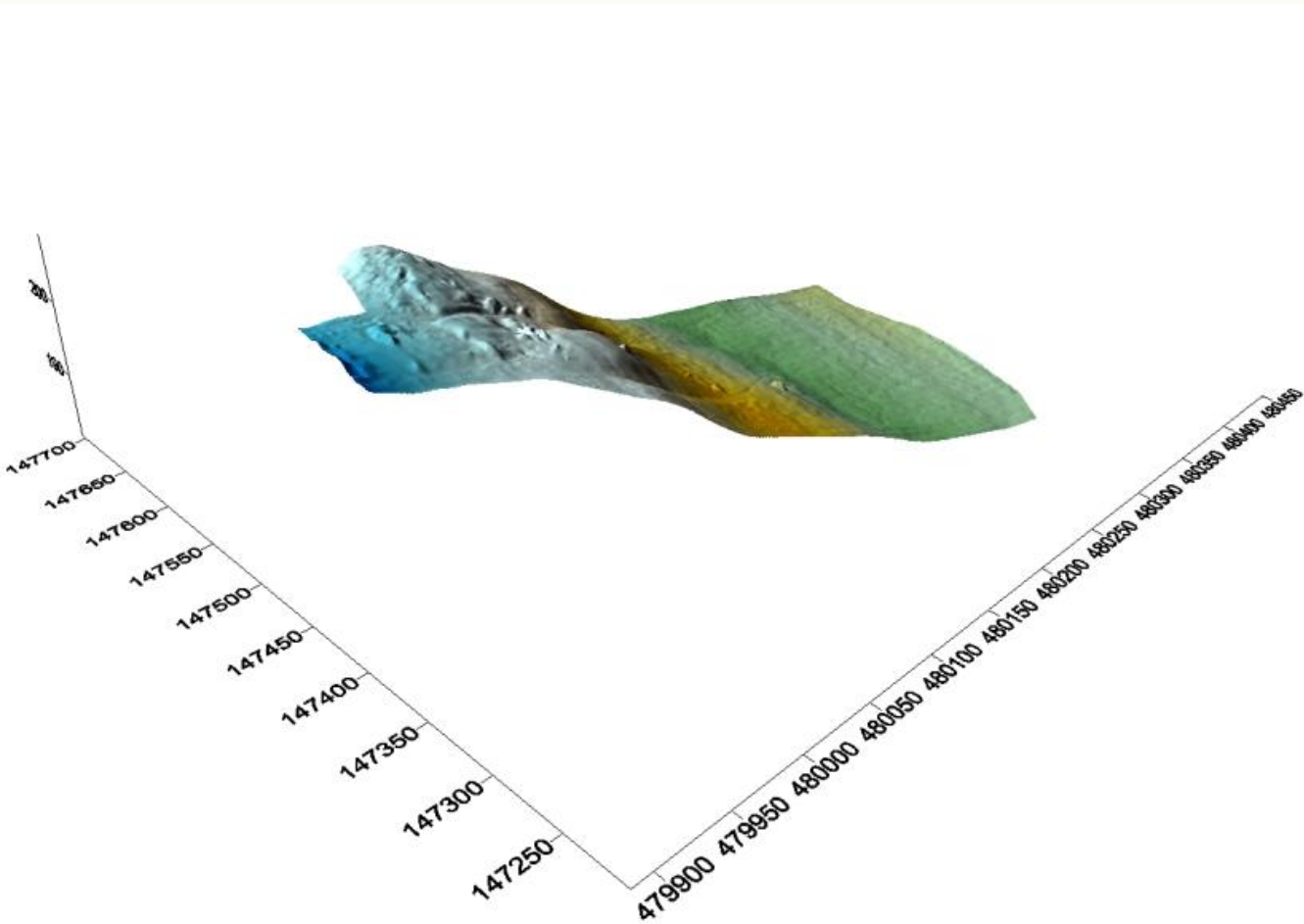
# Terrain model – 2023.05.01.



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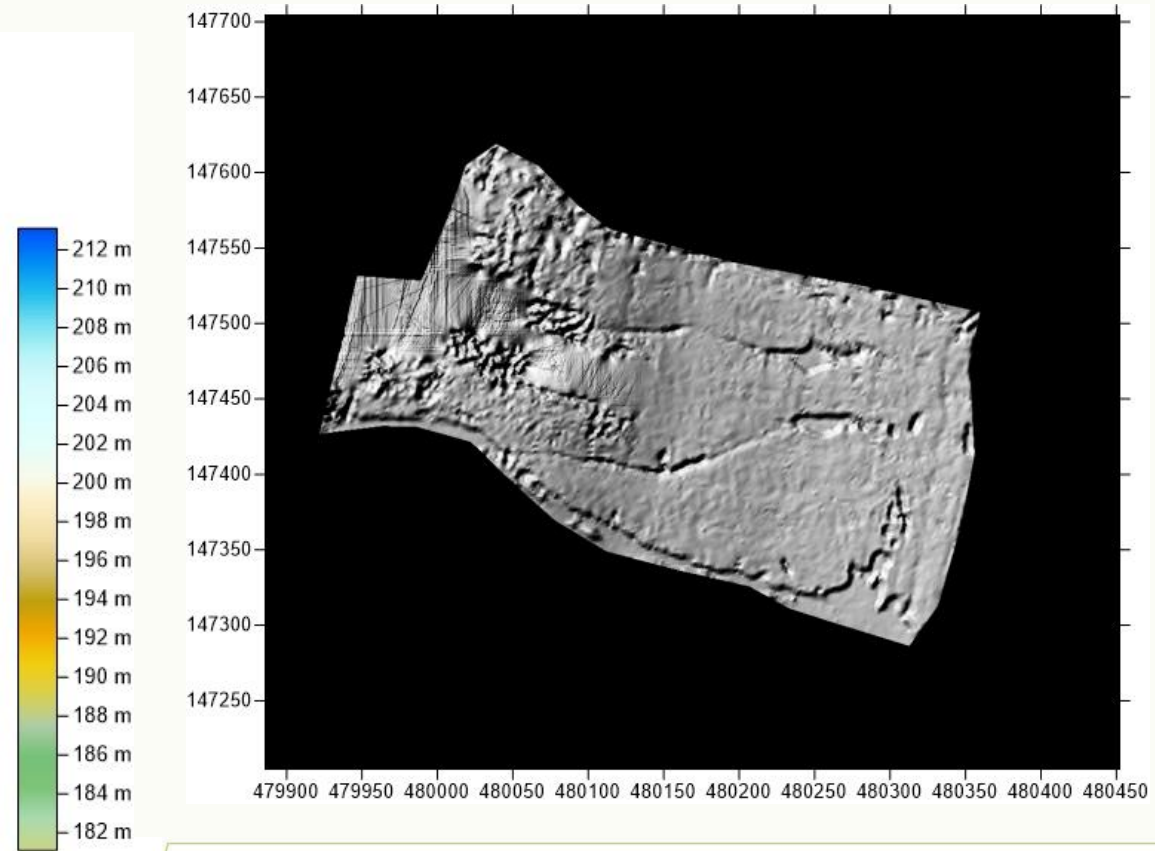
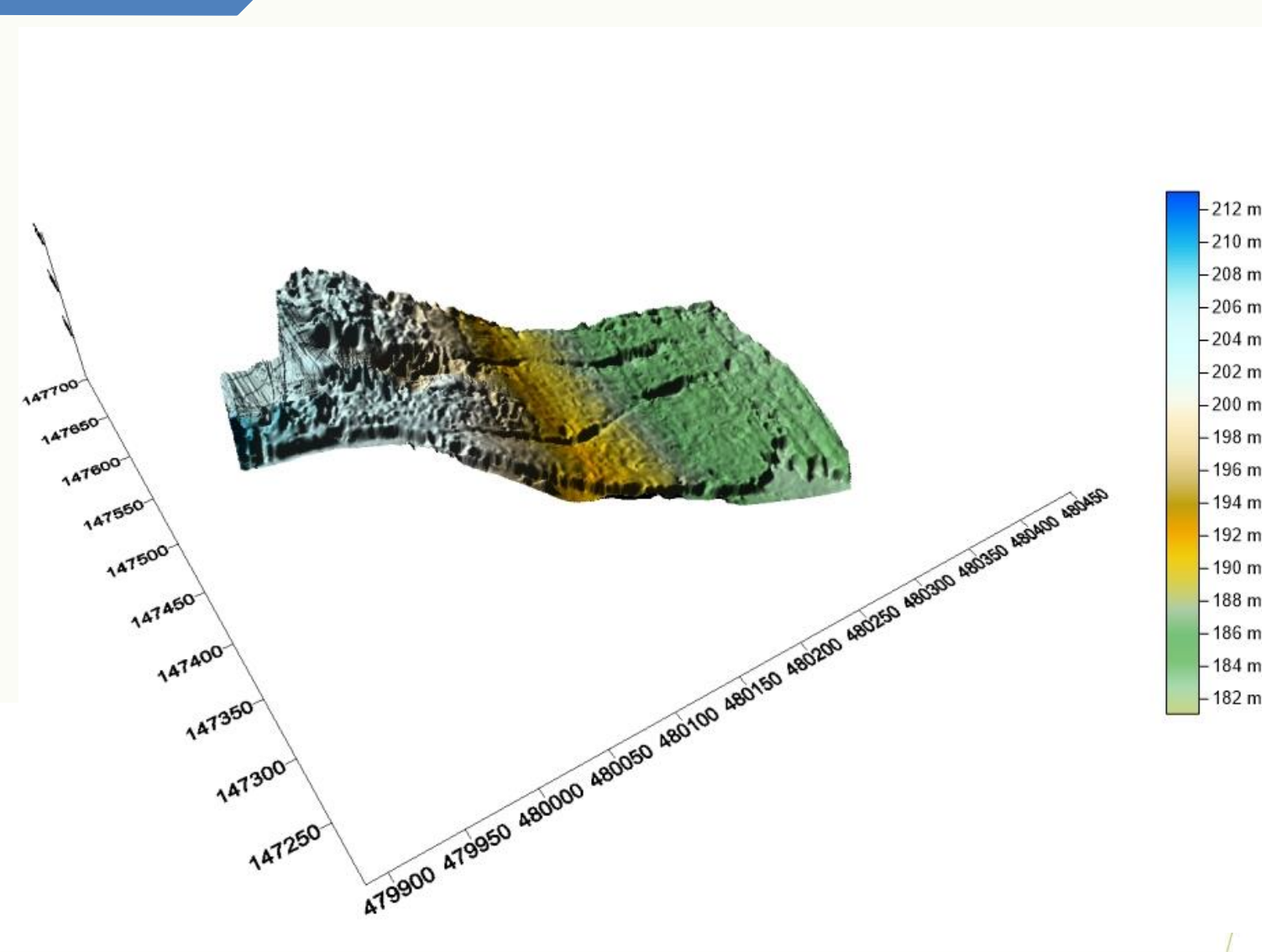
# Terrain model – 2023.06.17.



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# Terrain model – 2023.08.15.



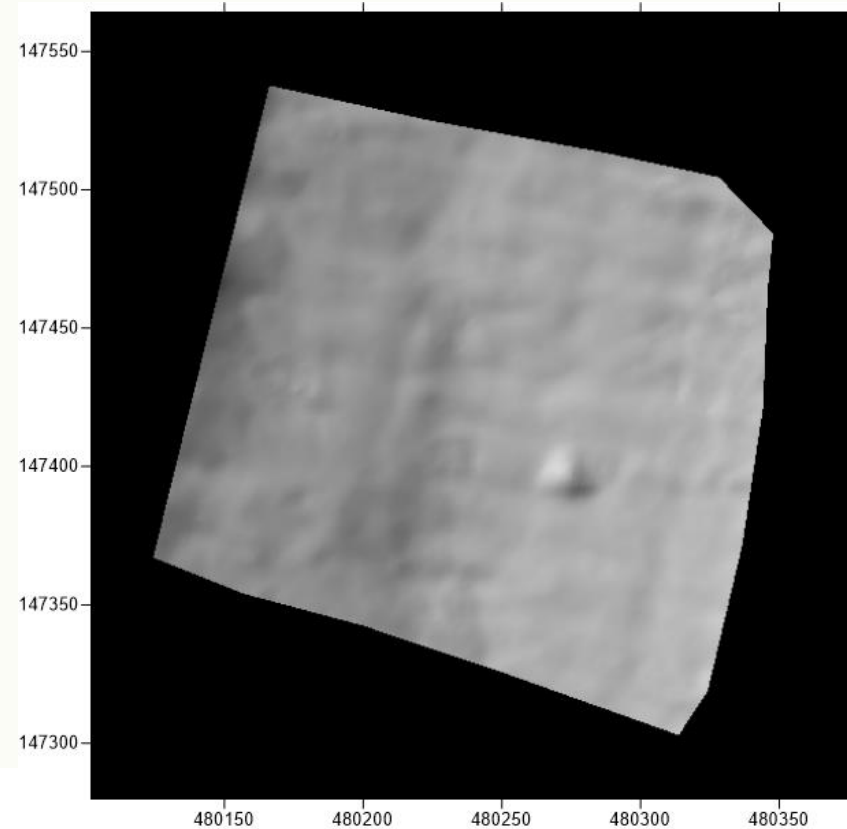
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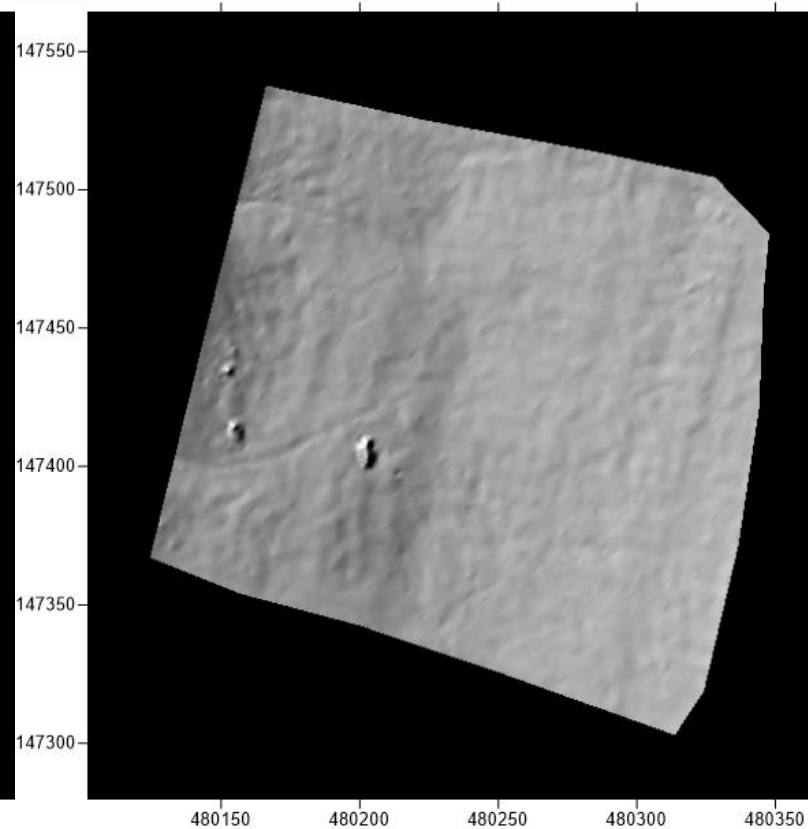


# Common area

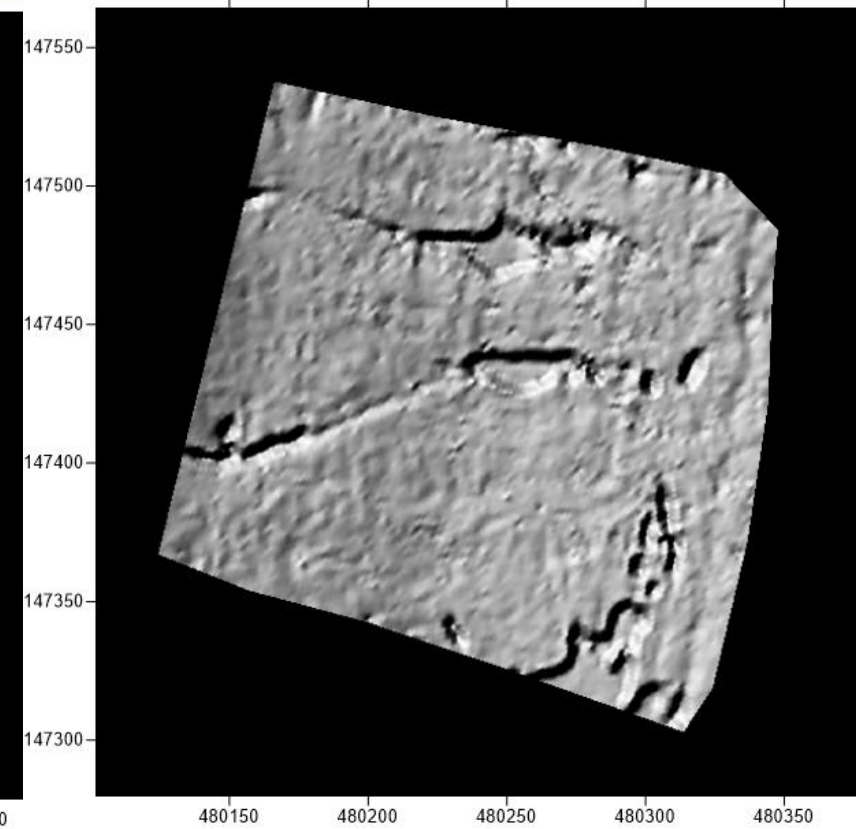
2023.08.15.



2023.05.01.



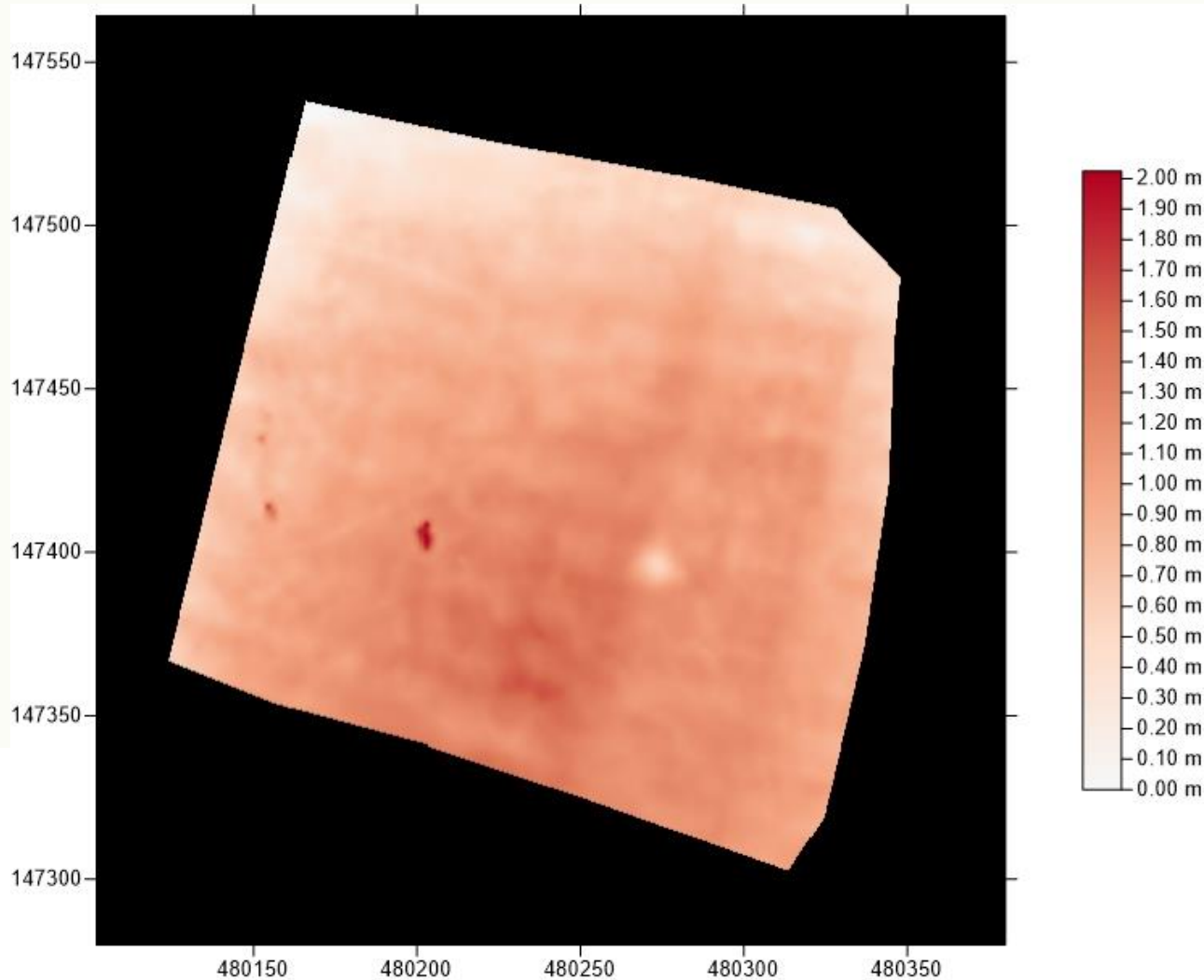
2023.06.17.



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# Volume calculation 2023.06.17.-05.01.



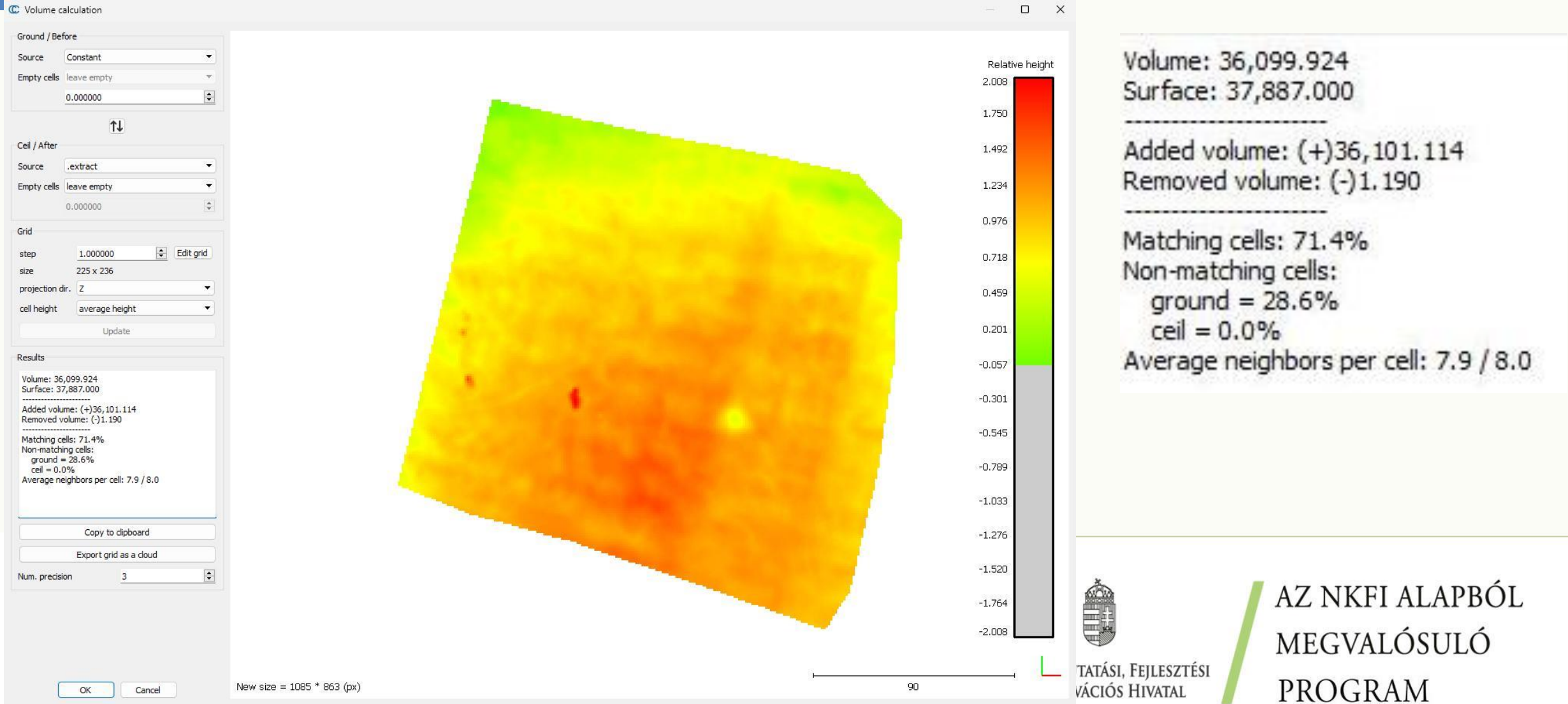
## Total Volumes by:

Trapezoidal Rule: 35929.066 m<sup>3</sup>  
Simpson's Rule: 35928.727 m<sup>3</sup>  
Simpson's 3/8 Rule: 35930.764 m<sup>3</sup>

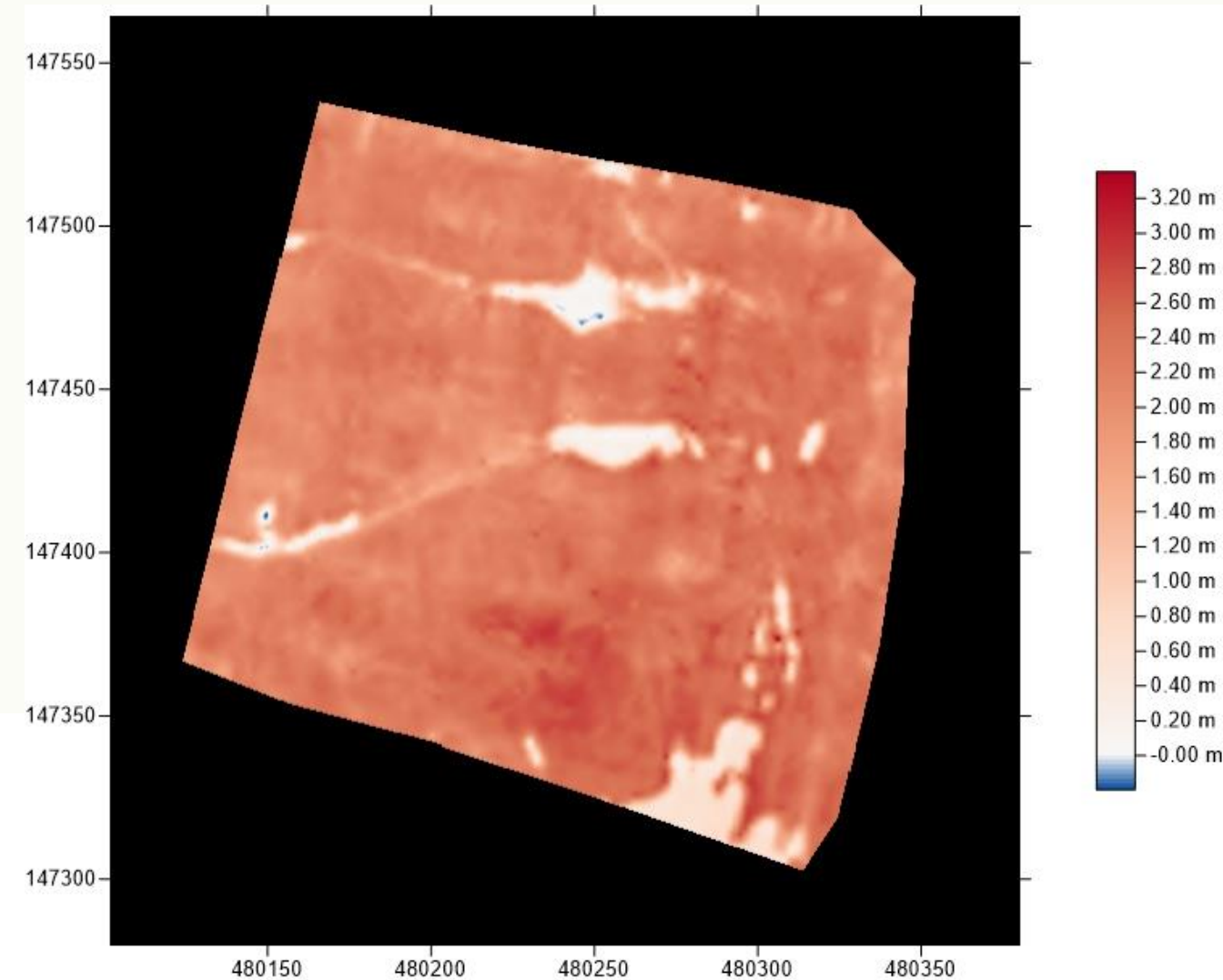
## Cut & Fill Volumes

Positive Volume [Cut]: 35930.082 m<sup>3</sup>  
Negative Volume [Fill]: 1.015 m<sup>3</sup>  
Net Volume [Cut-Fill]: 35929.066 m<sup>3</sup>

# Volume calculation 2023.06.17.-05.01.



# Volume calculation 2023.08.15.-05.01.



## Total Volumes by:

Trapezoidal Rule: 80624.613 m<sup>3</sup>

Simpson's Rule: 80623.654 m<sup>3</sup>

Simpson's 3/8 Rule: 80627.561 m<sup>3</sup>

## Cut & Fill Volumes

Positive Volume [Cut]: 80625.805 m<sup>3</sup>

Negative Volume [Fill]: 1.191 m<sup>3</sup>

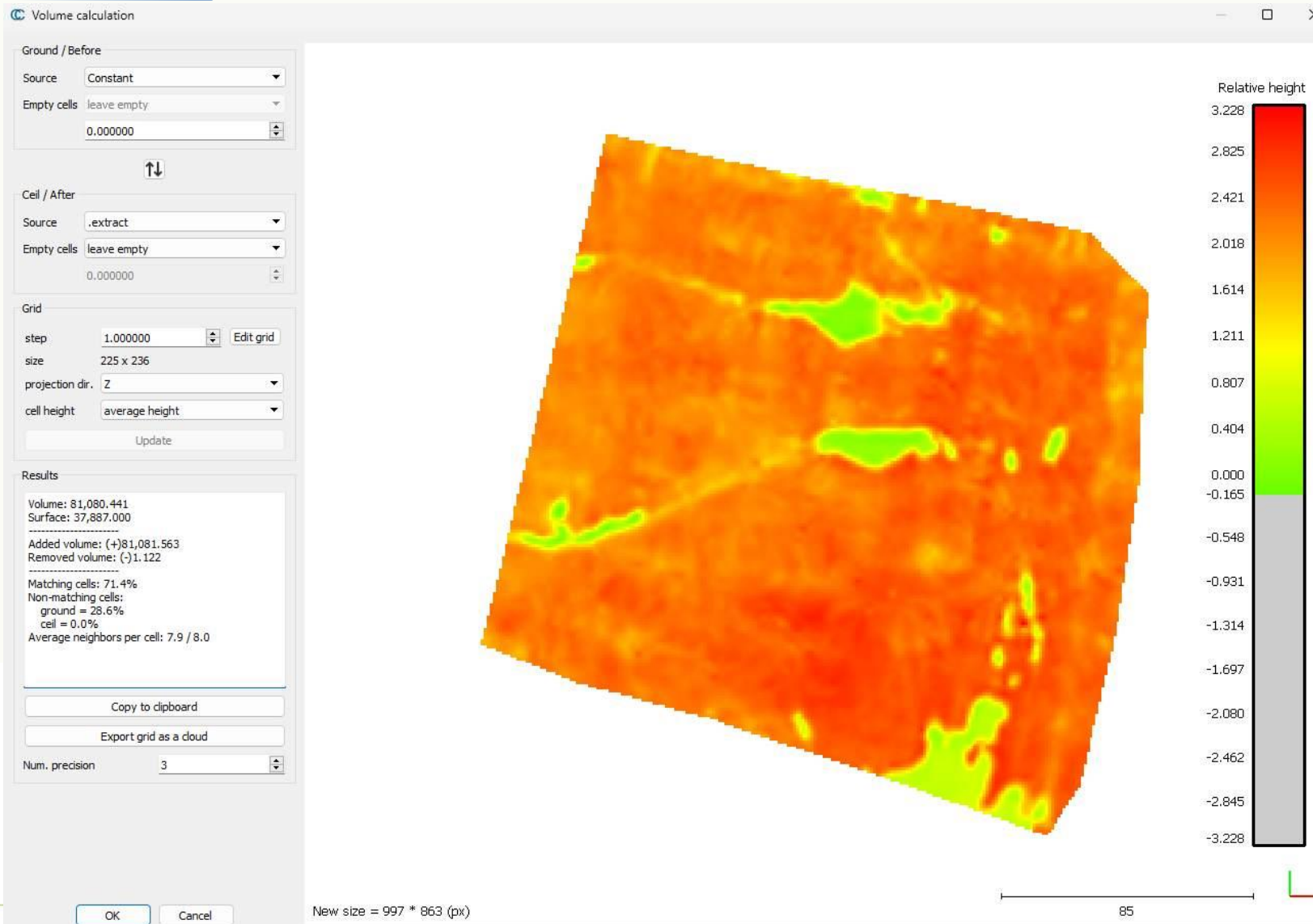
Net Volume [Cut-Fill]: 80624.613 m<sup>3</sup>



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# Volume calculation 2023.08.15.-05.01.



Volume: 81,080.441  
Surface: 37,887.000

Added volume: (+)81,081.563  
Removed volume: (-)1.122

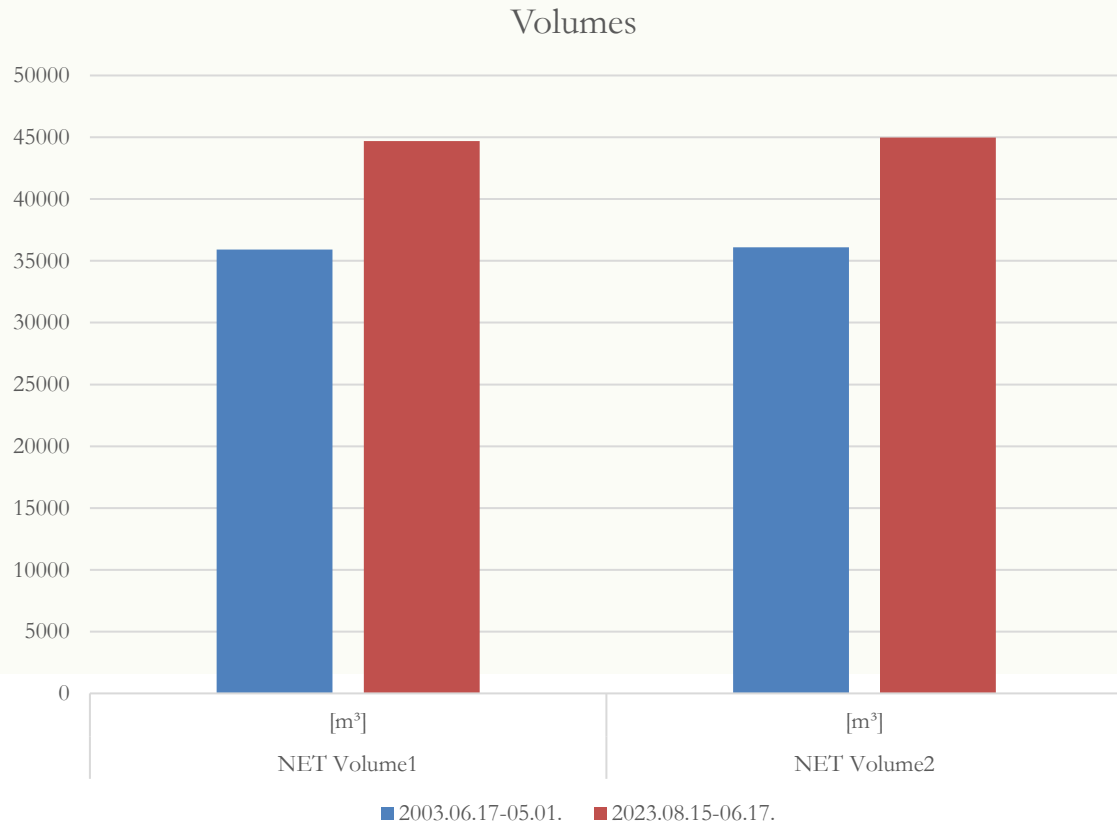
Matching cells: 71.4%  
Non-matching cells:  
ground = 28.6%  
ceil = 0.0%  
Average neighbors per cell: 7.9 / 8.0



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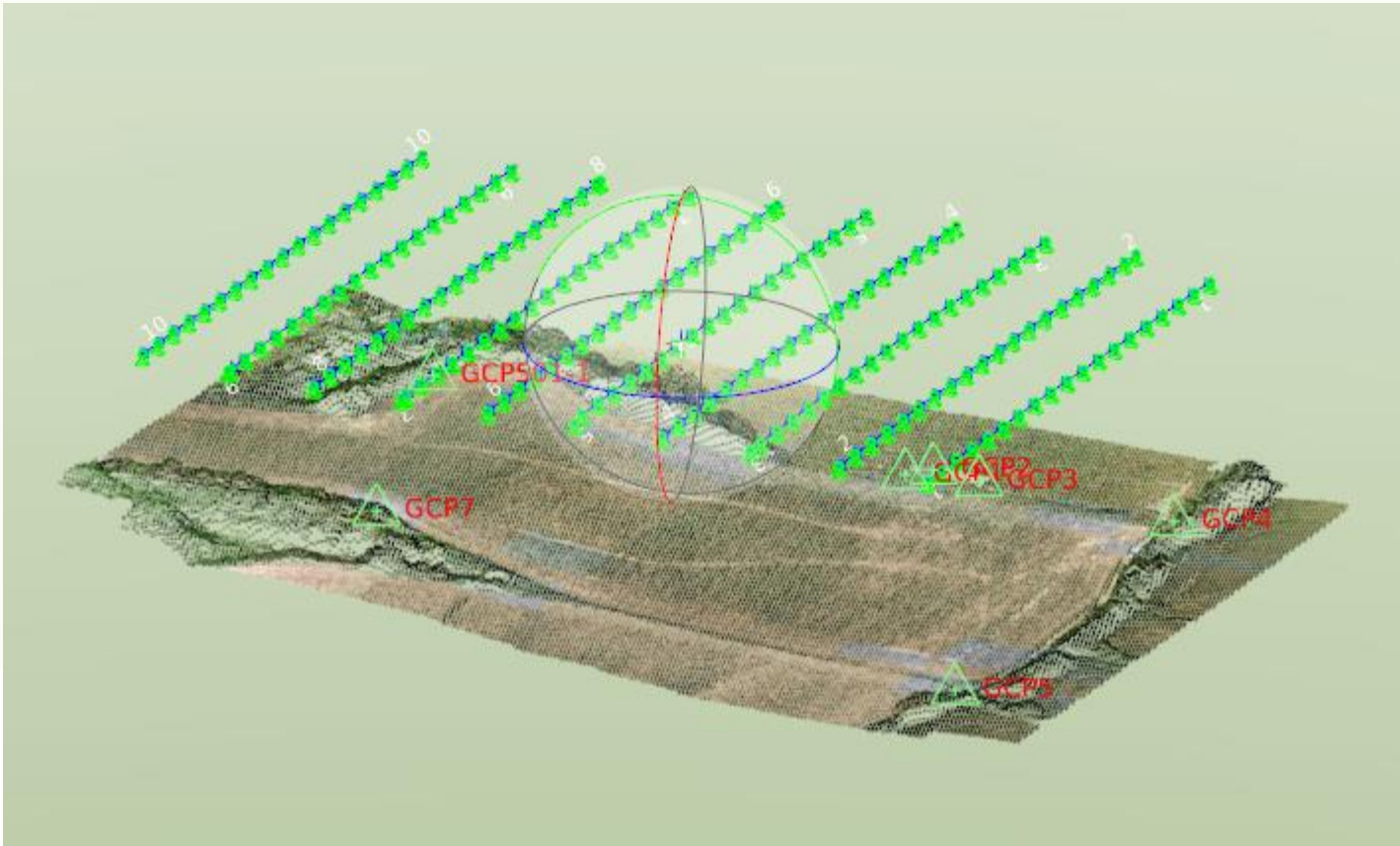
# Comparison of volumes



PERIOD	NET VOLUME SURFER [m³]	NET VOLUME CLOUD COMPARE [m³]	DIFFERENCE [m³]
2003.06.17-05.01.	35929.066	36099.924	170.858
2023.08.15-06.17.	44695.547	44980.533	284.986
2023.08.15-05.01.	80624.613	81080.441	455.828

Relative average error in volumes:  $\pm 0.5\%$

# Conclusions (advices)



- Control points are needed in the corners of the block and preferably in the middle as well.
- To achieve good results, the field resolution should be below 5 cm.
- Camera should be calibrated.



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# Acknowledgement

We express our acknowledgment to the Bilateral Chinese-Hungarian Project No. 2019-2.1.11-TÉT-2020-00171, the project title is “Investigation of the characteristics of surface shapes in rural environment based on point clouds and remote sensing data”.



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**THANK YOU FOR YOUR ATTENTION!**

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