UAV: Overview of systems, applications and processing

Kris Nackaerts, Peter Strigencz

Introduction

- Systems
- Applications
  - Non-imaging
  - Imaging
- Processing, focus on photogrammetry
- Use case

Systems

- Limited to ready to fly COTS solutions
- Characteristics
  - Fixed wing <-> multi rotor
  - Endurance / study area
  - Robustness
  - Flightplanning software
  - Autopilot capabilities
    - Automatic takeoff / landing?
    - Safety measures
  - Sensitivity to weather conditions
  - Payload capabilities
  - Logistics?

C-ASTRAL
AEROSPACE Ltd.

gatewing
A TRIMBLE COMPANY

senseFly

SmartPlanes

MAVINCI
UNMANNED AERIAL SYSTEMS

QUESTUAV

AIBOTIX

AERIALTRONICS
VISIT US ONLINE WWW.AERIALTRONICS.COM

ALTURA

microdrones.com

ASCENDING TECHNOLOGIES

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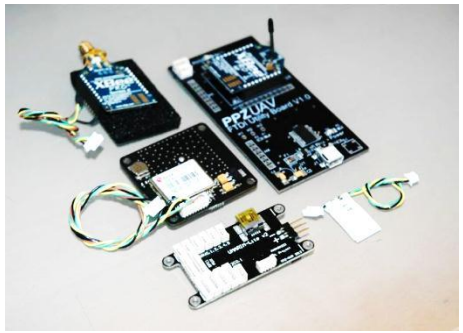
Systems – for the more adventurous

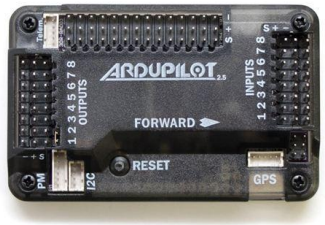
PAPARAZZI
The Free Autopilot



MikroKopter.de

ARDUCOPTER
MULTIROTOR UAV

ARDUPILOT
MEGA



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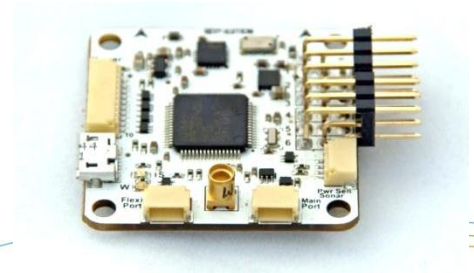
openpilot



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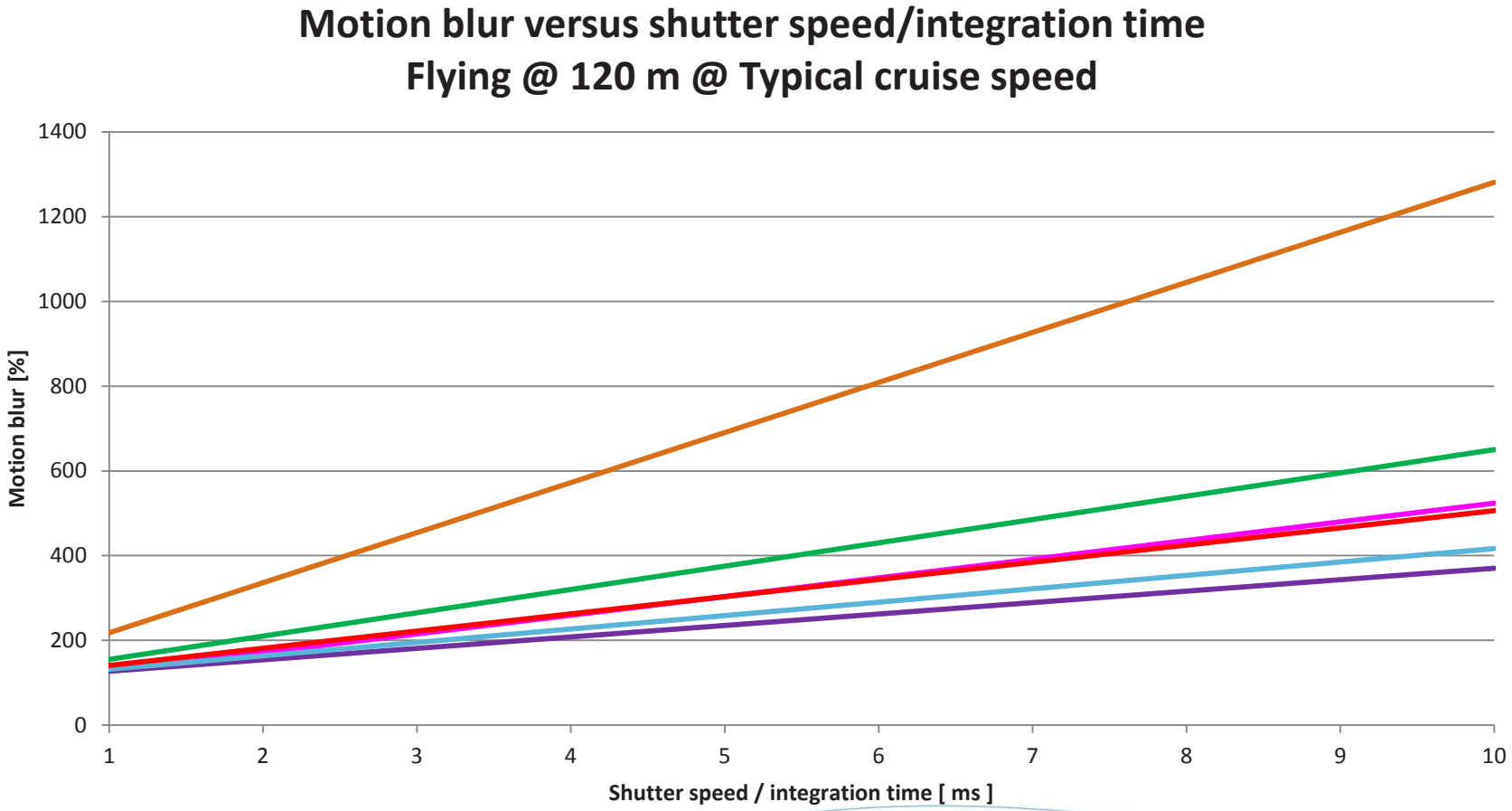
Systems – don’t forget …

Platform selection process: one example



Platforms: summary

- Platforms are available
- Ready to use with/without experience
- Challenges:
  - Technology is young, still needs to prove itself
  - Safety
  - Legislation: everyone wants to fly & communicate safely
  - TTM of ew technology is (extremely) short
  - Data is abundant but not always of best quality
    - Sensors & platform stability
  - Many possibilities, focus is needed

Applications – non imaging

- Applications
  - Precision farming
  - Radio signal based search & rescue
- Atmospheric research & meteo
  - Pressure, temperature & relative humidity profiling
  - Wind profiling
  - Air quality parameters
  - COST action ES 0802
  - ISARRA: International Society for Atmospheric Research using Remotely piloted Aircraft
- Laserscanning
  - FARO, Riegl, Velodyne, Yellowscan

Applications – non imaging

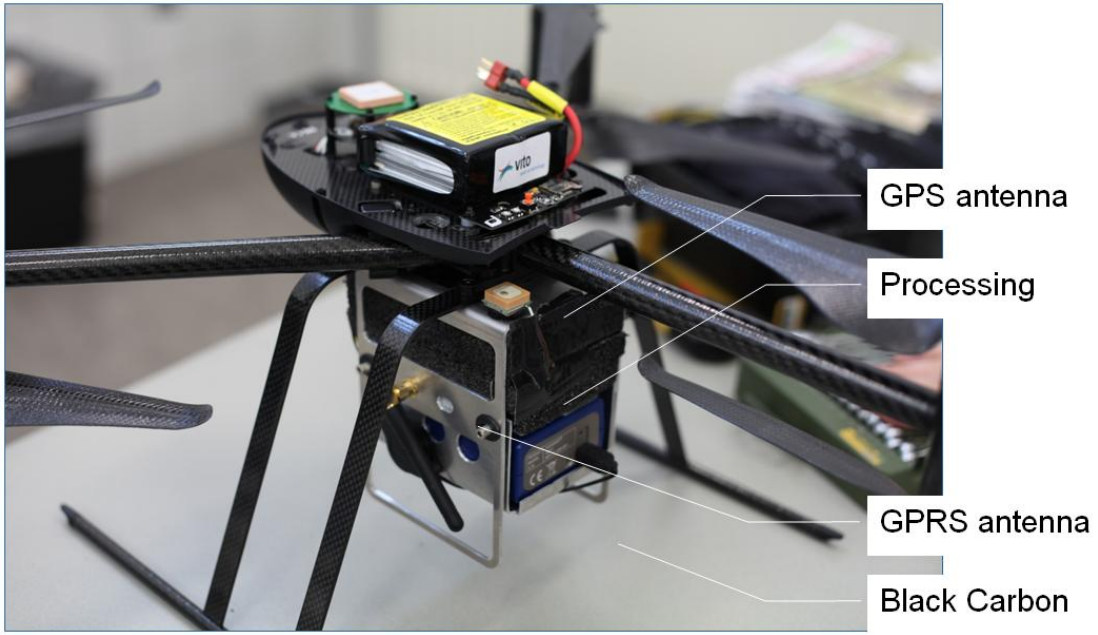
Source: http://www.sueddeutsche.de/wissen/schaedlingsbekaempfung-drohne-gegen-raupe-1.1500368

Source: Dyson Awards

Source: Aibotix

Applications – non imaging

- Example 1: SUMO UAV
  - Source: Reuder et al., 2009
- Example 2: Vito BlackCarbon Sensor



Applications - imaging

- Video
  - Object tracking, realtime imagery, realtime mosaicing,
- Photogrammetry
  - 2.5 & 3D extraction, orthophotographs
- Multi- / Hyperspectral imaging
  - Vegetation, air, water, soil quality monitoring
    - **Endless ?**
- Thermal imaging
  - Irrigation, energy budgets of houses/industrial areas, search & rescue, wildlife detection

← Hammerhead Demonstrator Completes Successful First Flight

Aibotix UAS Inspects Germany's Second Longest Bridge

Posted on November 20, 2013 by The Editor

The Aibot X6, developed by Aibotix in Kassel, Germany, and designed to carry out inspections or operations too dangerous for humans to carry out, can go to places conventional devices cannot go. This hexacopter was developed to meet the highest standards for industrial inspections and measurements and it has many applications, ranging from power lines, wind turbines and photovoltaic plants, to bridges and pipeline inspections.

The Aibot can record possible damage precisely and it will save pictures, positions and other flight data including geo-referential data. The material received can then be accurately analysed.

The Aibot X6 was recently able to utilise its unique features when it

Search

Categories
Select Category

Photogrammetry: some parameters

- Camera
  - Optics, mechanics, electronics
- Platform
  - Stability, speed
- GPS / IMU
  - Accuracy, synchronisation
- GCP
  - Accuracy (real world & image plane)
- Tiepoints
  - Detection & identification accuracy
- Bundle adjustment algorithm
  - Precision, robustness, performance, flexibility

Photogrammetric software – a short overview

- In situ check
  - Arrive at the office with usefull data
- Self calibration
  - During bundle adjustment camera parameters are optimized
- Focus on airborn or ground based photogrammetry
- Free net adjustment
  - Garbage in, beauty out ?
- Tiepoint extraction & coded GCP support
- Dense DSM
- Ortho generation
- GPU support (x 10 / 20 performance gain)
- Cloud services

Photogrammetric software – a short overview

		In situ check	Self calibration	Ground	Air	Free net	BA with support for GCP en EO	Gecoded GCPs	(True) Ortho	Dense DEM	Volume calculations	GPU support	Cloud processing
Pix4D		+	+	+	+	+	-	-	+	+	+		+
Photoscan		-	+	+	+	+	-	+	+	+	+	+	-
Erdas LPS		-	+	-	+	+	+		+	+	-		-
Menci		-	+	+	+	-	+		+	+			-
Ensomosaic		-	-	-	+	-	+	-	+	-	-	?	-
Pieneering		+	+	-	+	-	+	-	+	+		+	+
Photomodeler scanner		-	+	+	+	+	-	+	+/-	+	+	-	-
Autodesk ImageModeler		-	+	+	+	+	+/-	-	-	-	-		-

Photogrammetry - summary

- Software available in many varieties with varying complexity for novice and advanced users and price ranges
- Black box approach, focused on production
- Performance can vary widely in terms of robustness, accuracy and processing time

- Challenges:
  - Robustness: how sure are you as user that the images you took in the field will be processed correctly?
  - Flexibility towards researchers

Use case

- Mechelse heide / PS-Survey bvba
  - Can volumes be measured from gravel heaps with a UAV ?
  - How accurate is the end product, is it comparable to present measurement technique ?
  - What is the work effort ?

Coordinaten = Lambert 72 / EPSG:31370
Eenheden = meter

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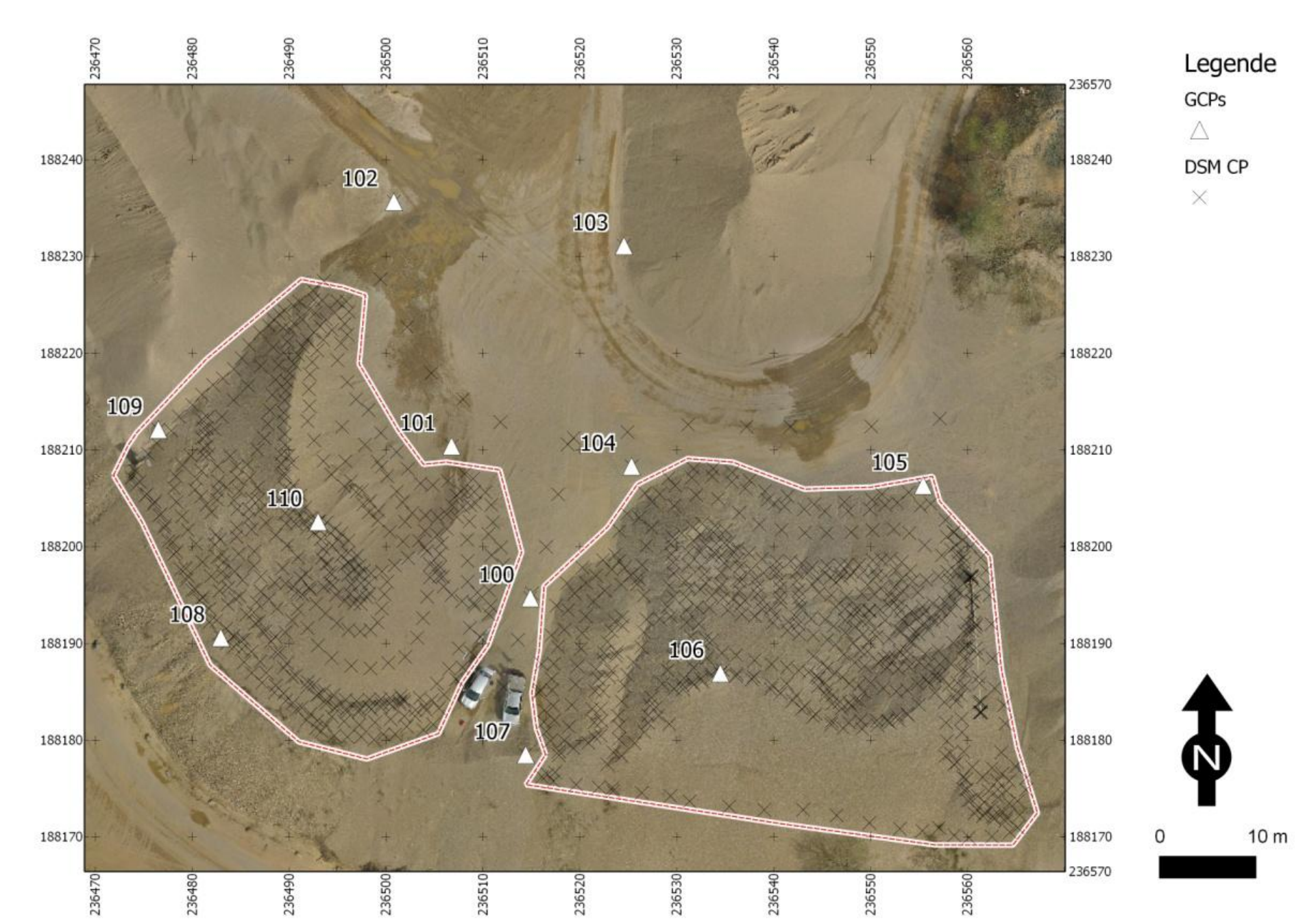
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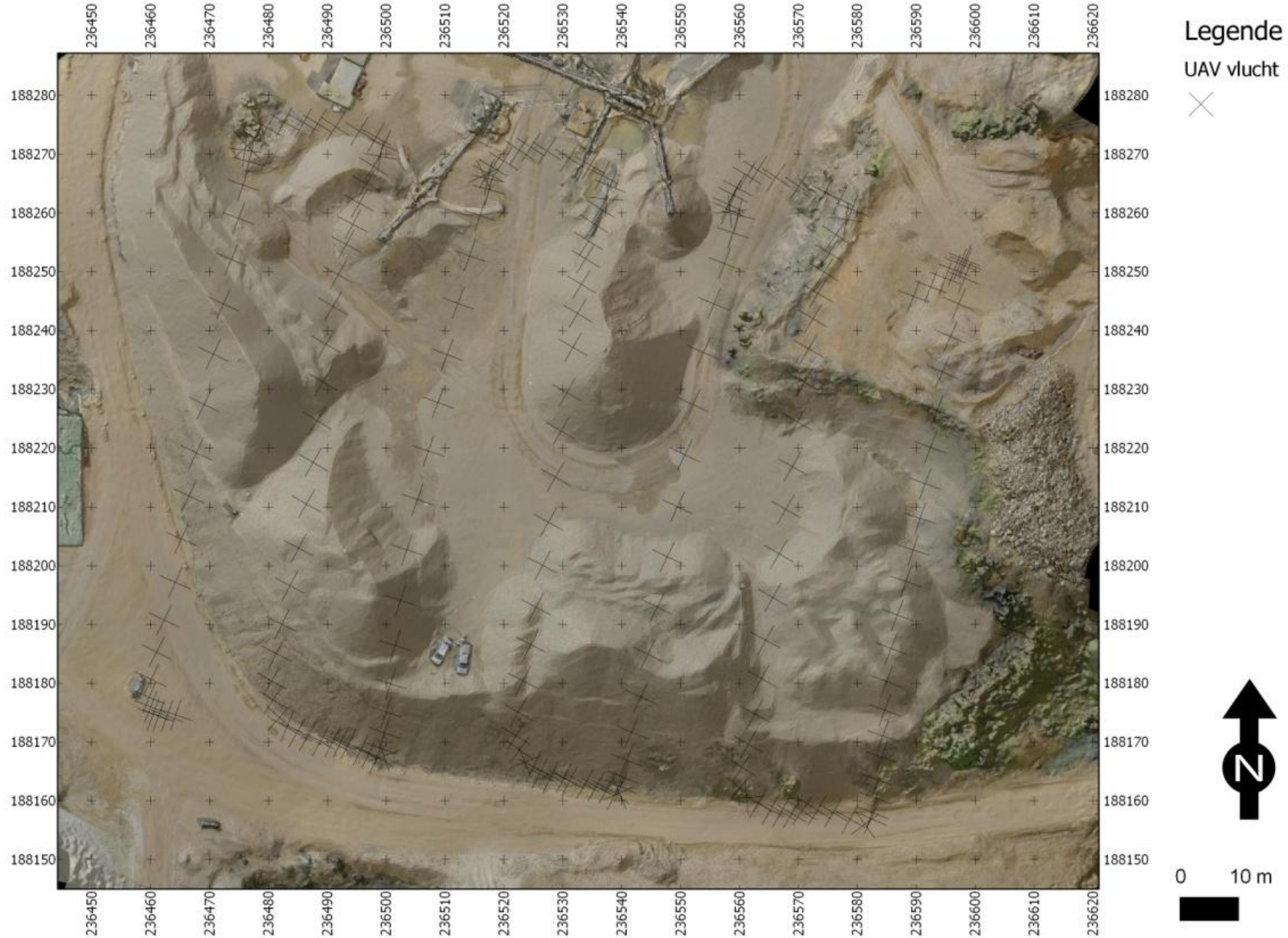
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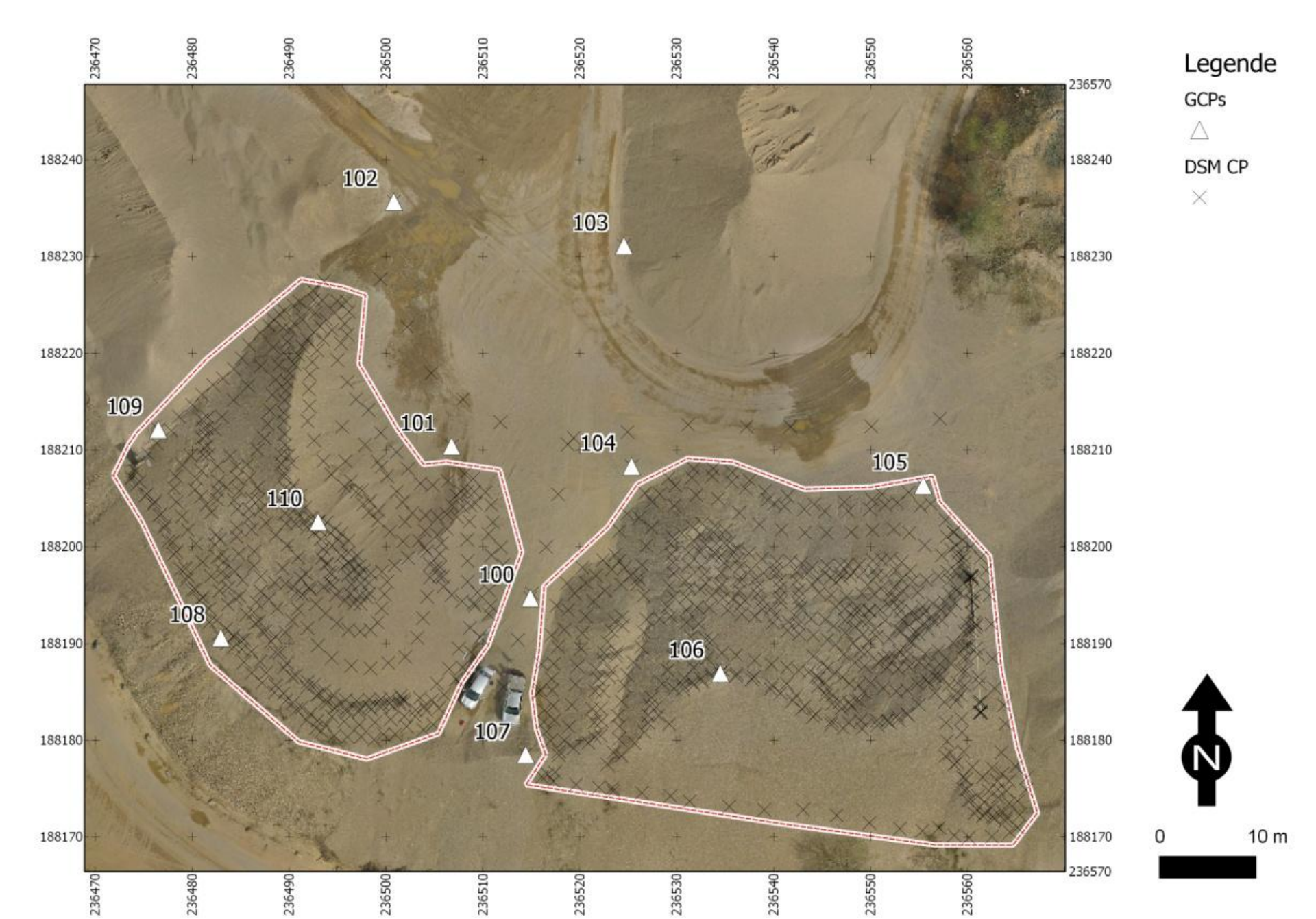
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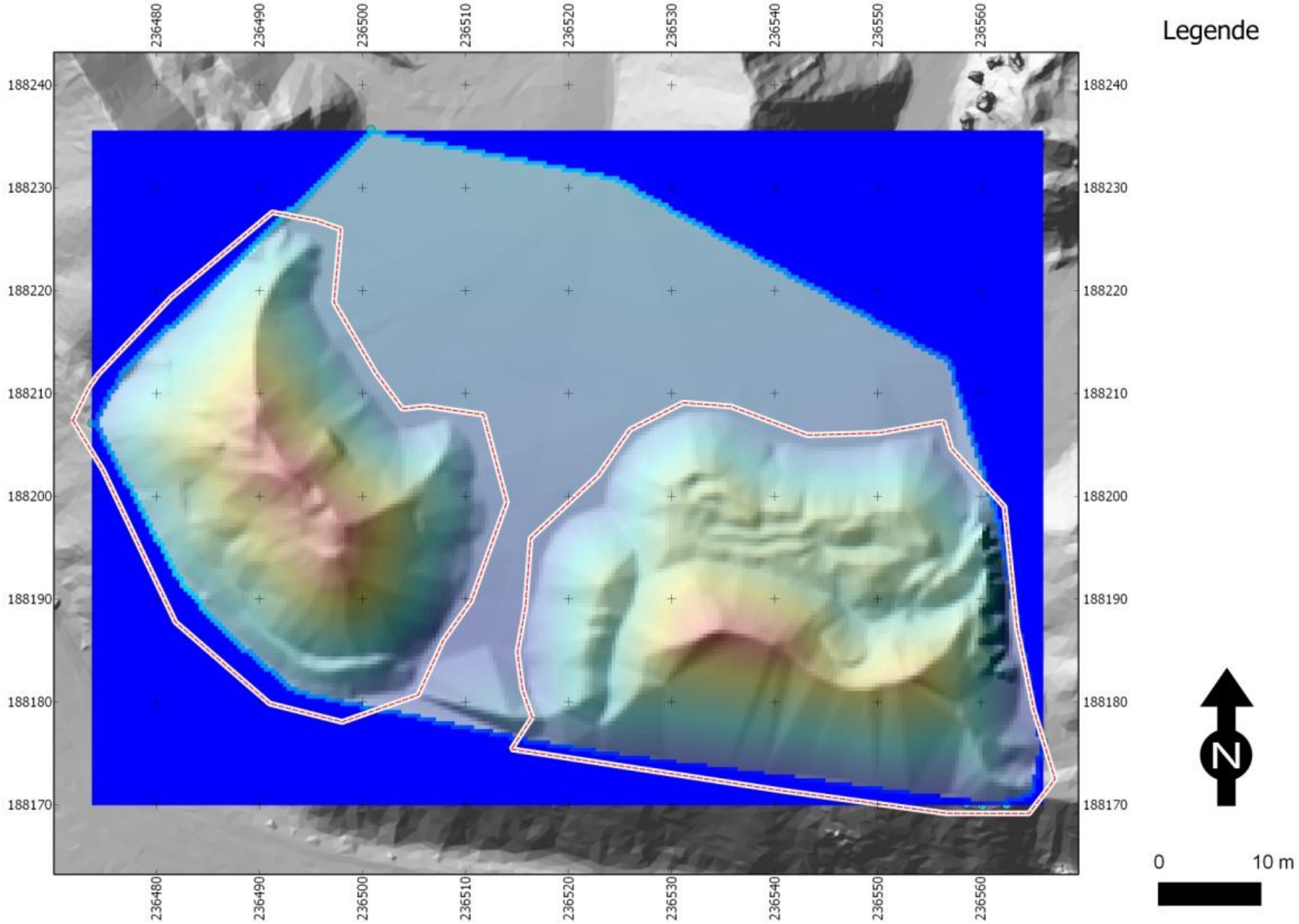
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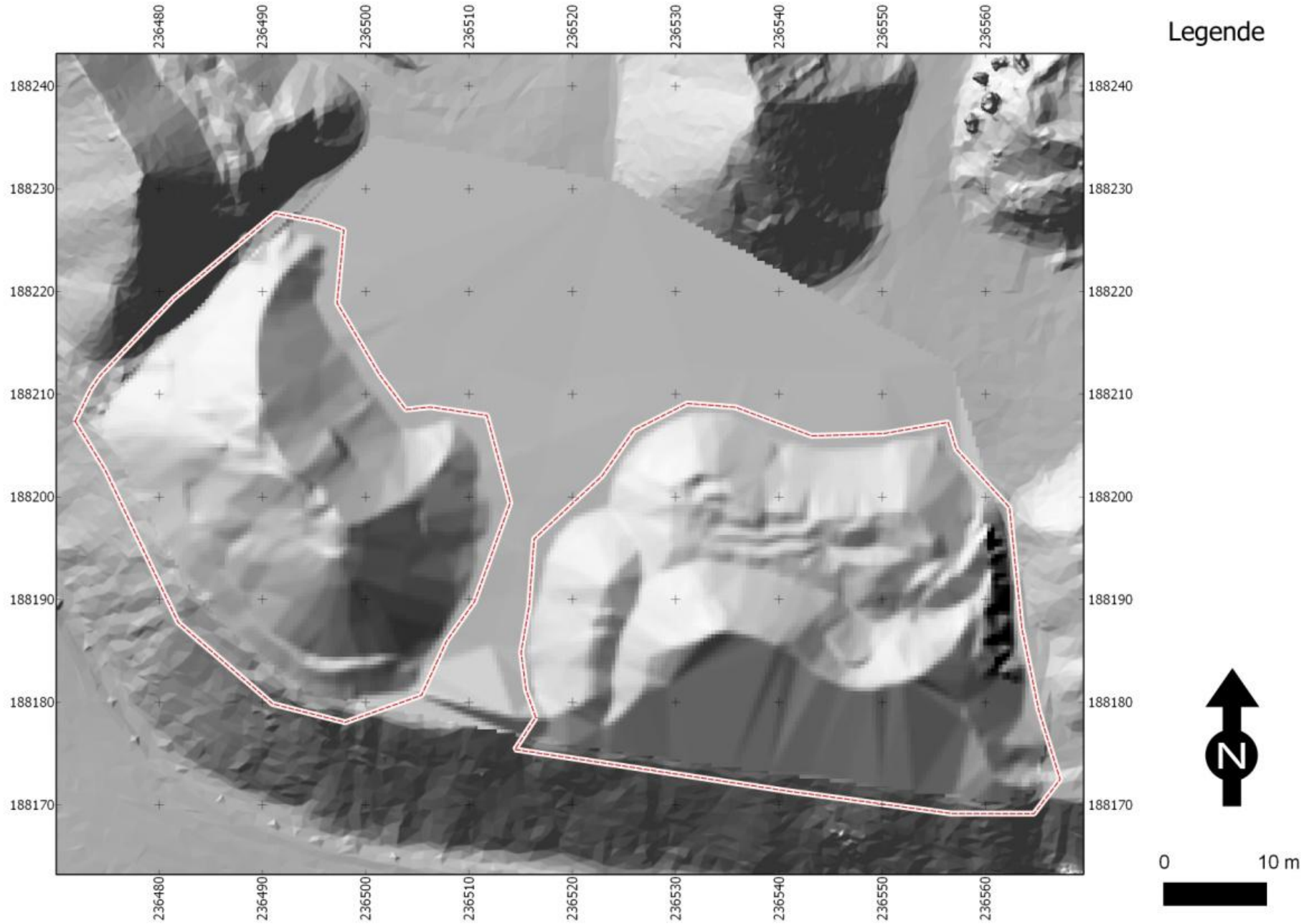
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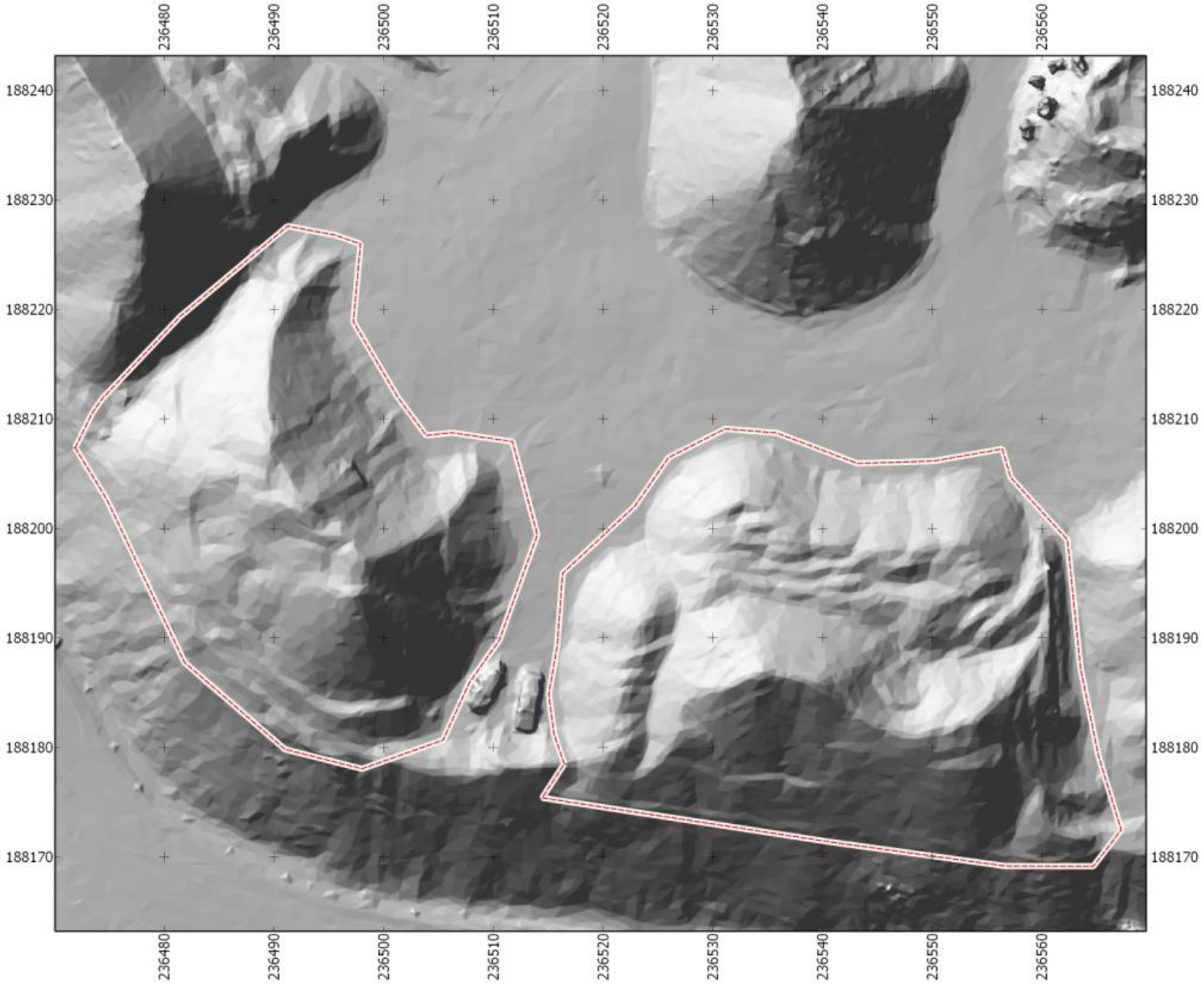
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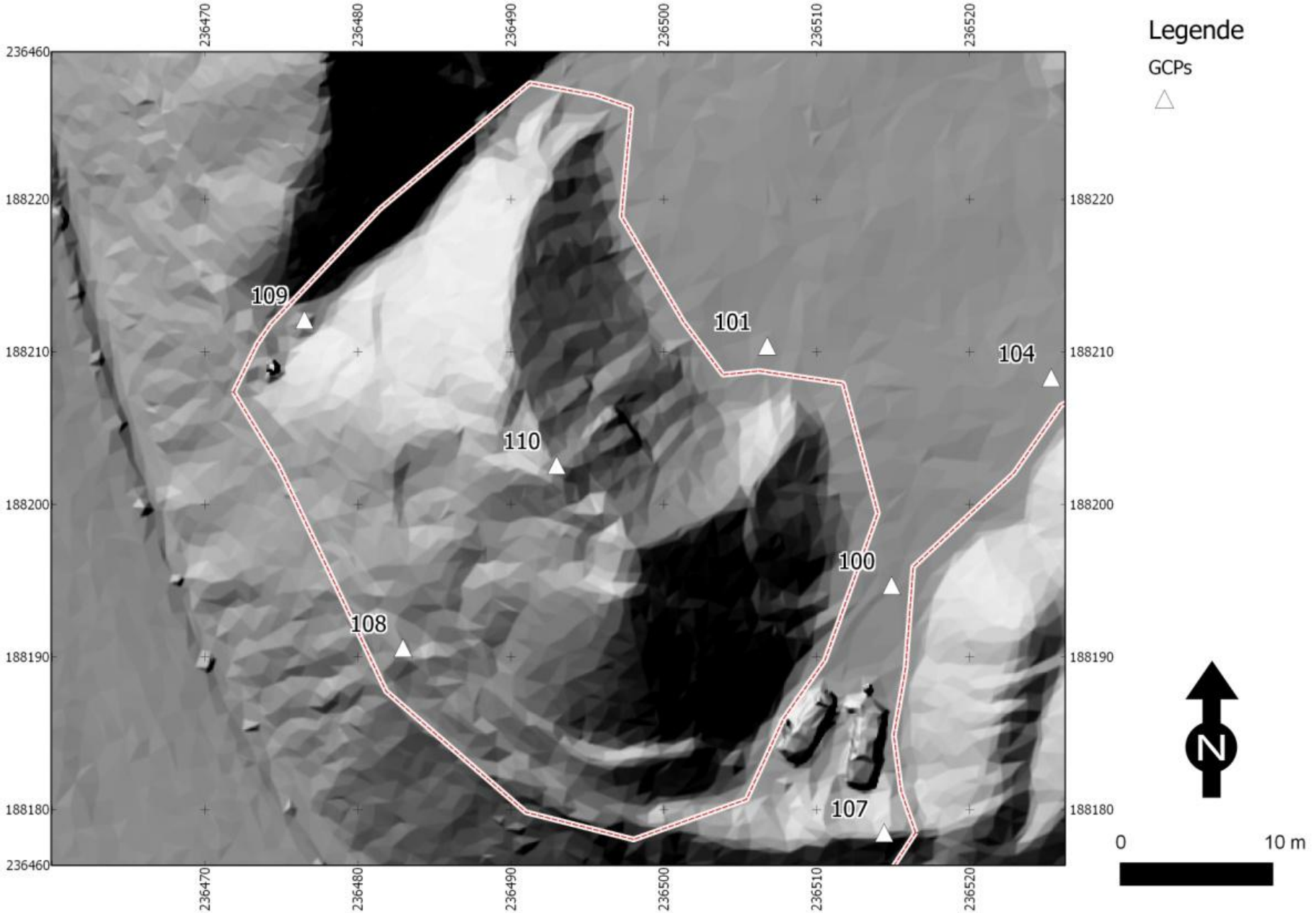
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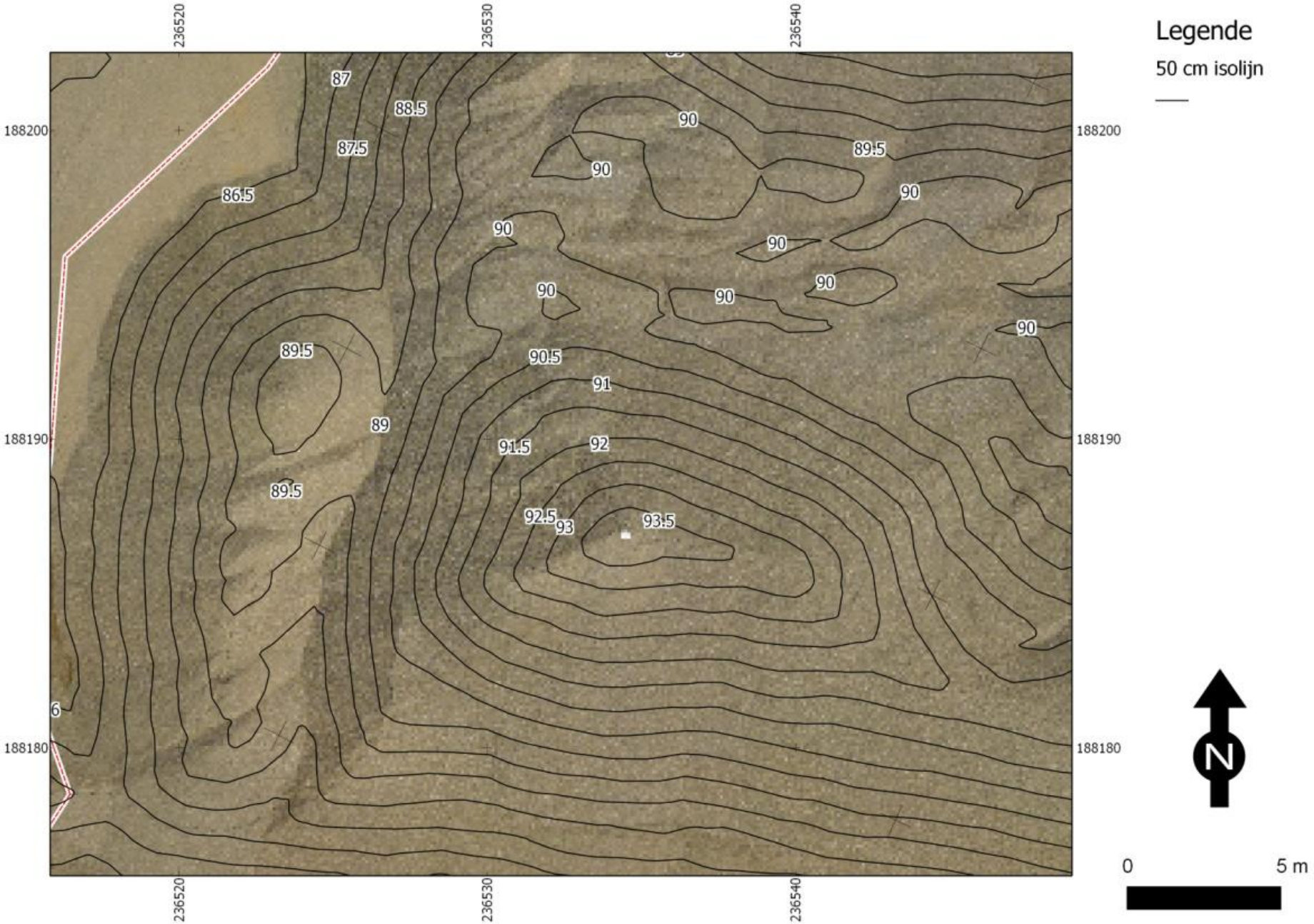
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Photoscan t1
Pix4D t0
Pix4D t1
RTK GPS
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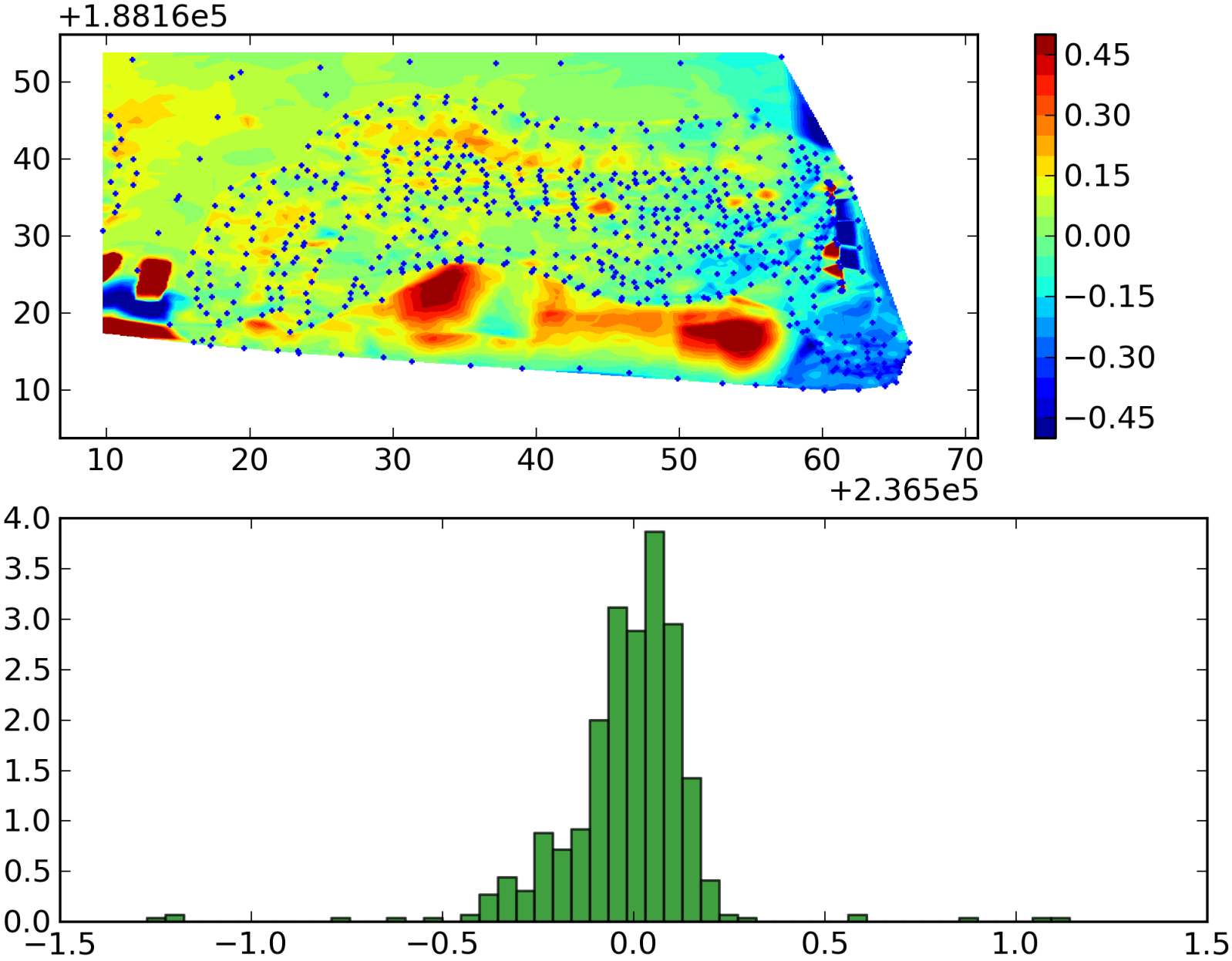
Results (10 cm resolution)

	Photoscan				Pix4D				
Zone	1		2		1		2		
Time	0	1	0	1	0	1	0	1	
Mean error on CP elevation	7,6	7,5	3,1	-1,6	3,3	3,9	-1,1	1,8	cm
StDev error on CP elevation	11	7	13,8	17,7	19,1	16,2	17,4	21,3	cm
Volume estimate	4783	4766	5823	5756	4708	4688	5784	5801	m3
RTK GPS volume	4654	4654	5689	5689	4654	4654	5689	5689	m3
Relative error	2,7	2,3	2,3	1,2	1,2	0,7	1,6	1,9	%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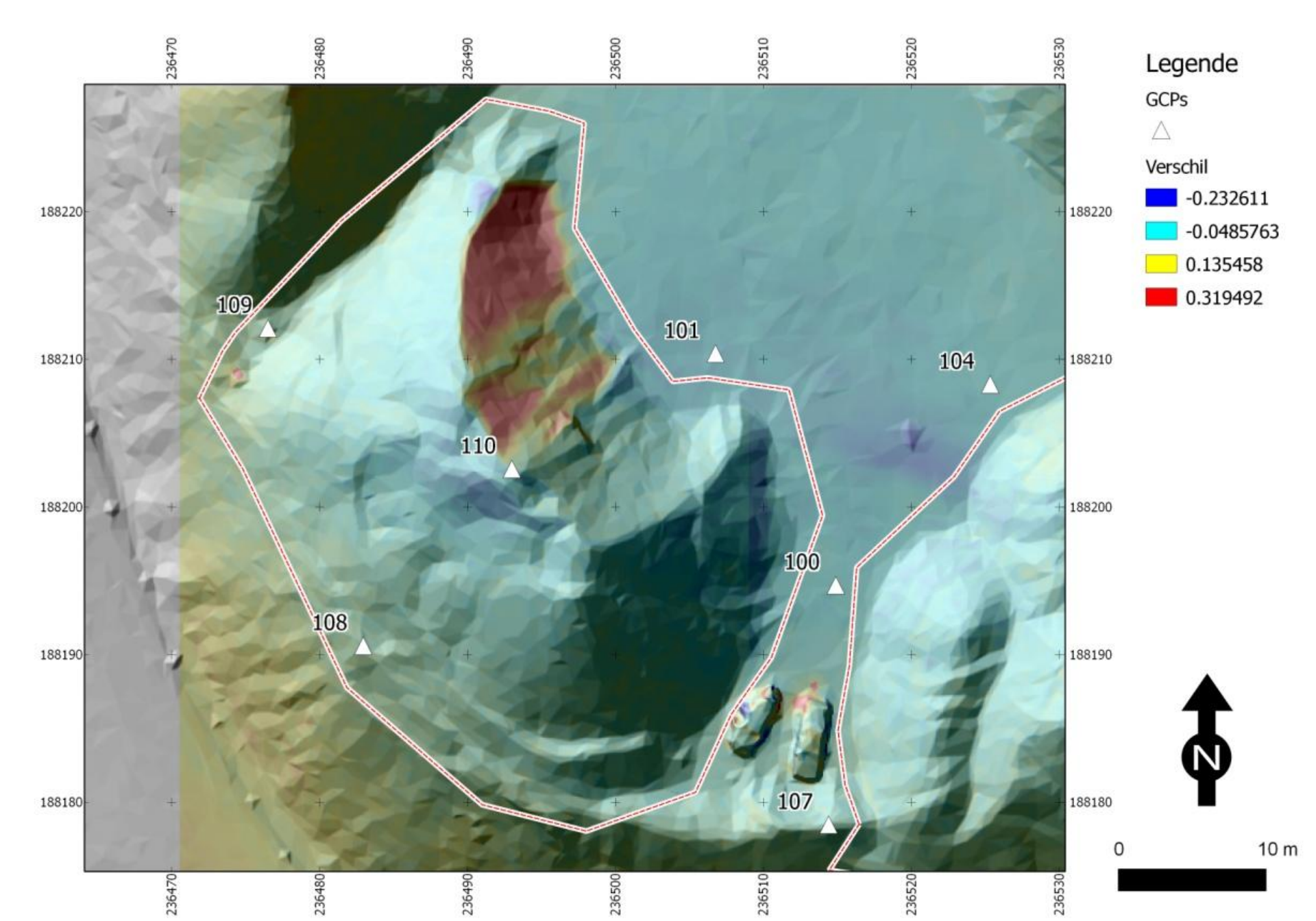
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Conclusions

- Platforms are ready
  - Improvements possible, especially multispectral sensors
- Software is ready
  - Improvements possible, especially in information extraction
- Legislation is … not ready, yet

- Real world applications are possible/feasible

- Great opportunity for the remote sensing community
  - Please focus on real world applications to make this technology a success

Conclusions

- It’s not about the platform, it’s about the solution(s)
- UAV technology is mainly complementary to other existing technologies