



## Use of Drones for River Monitoring

iWaGSS – Status Workshop 2019  
05.11.-06.11.2019  
Sefapane Lodge, Phalaborwa

Dipl.-Geogr. Ingo Nienhaus



DIE **GEWÄSSER**-EXPERTEN!

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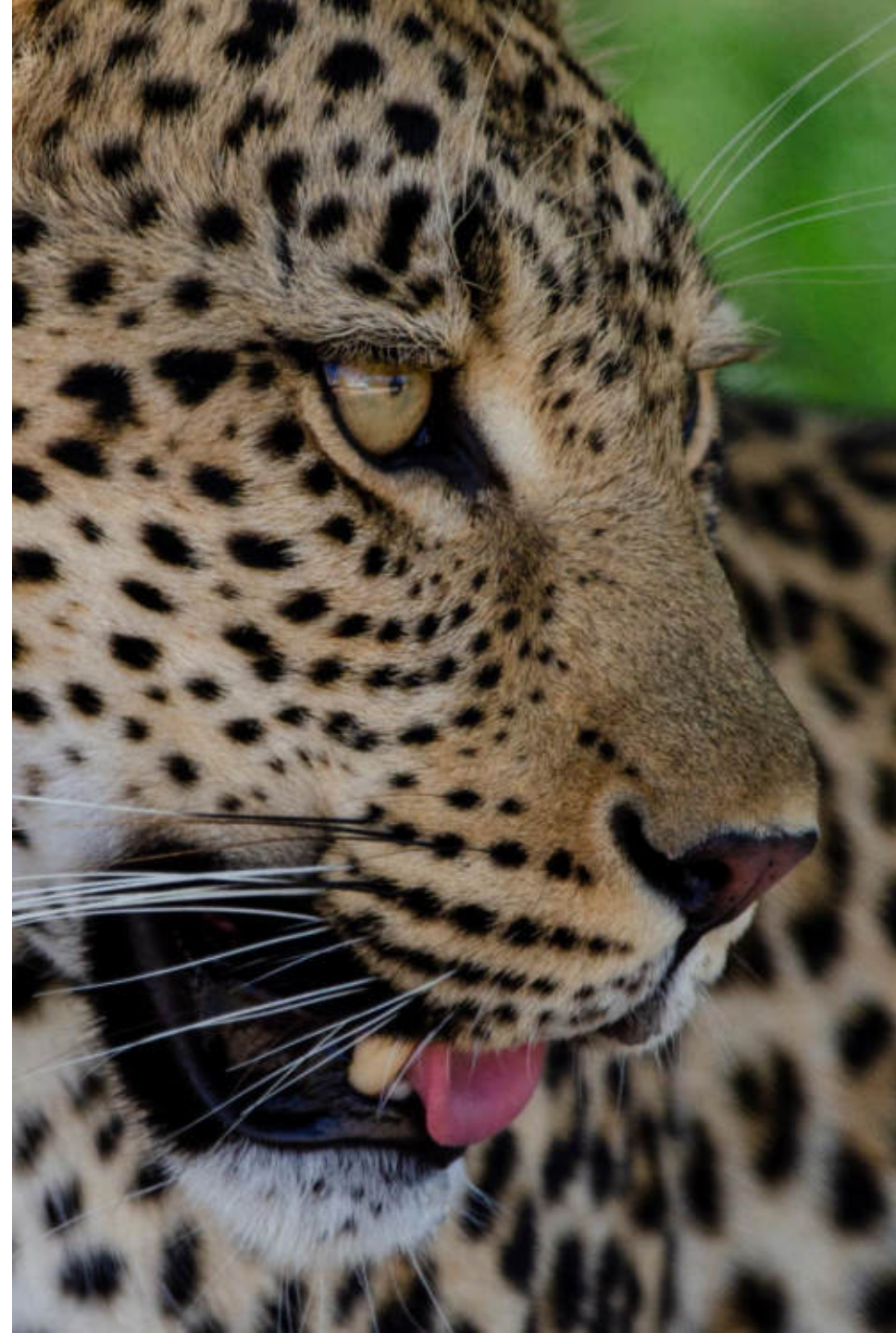


Federal Ministry  
of Education  
and Research

# Agenda

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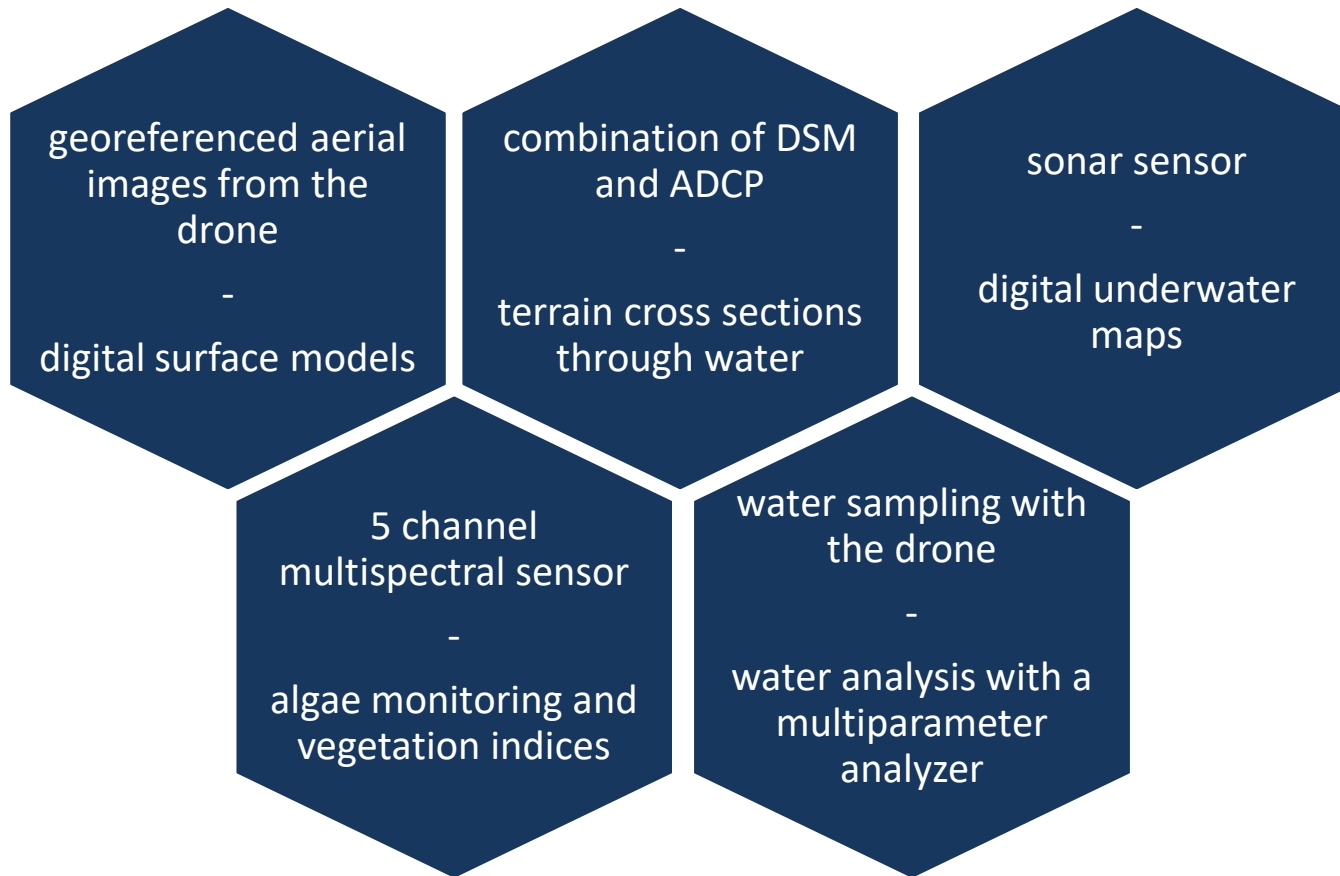
- 1 Introduction
- 2 Digital Surface Model
- 3 River Cross Sections by ADCP / DSM
- 4 Vegetation Indices und Algae Monitoring with a Multispectral 5-channel Sensor
- 5 Experimental Fieldwork: Water Sampling by Drone
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- 8 Outlook



# 1. Introduction: Aim of Work Package 8 – Remote Sensing

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Development of a multiparameter drone with several sensors for a broad, efficient and safe data collection to support river research and monitoring:

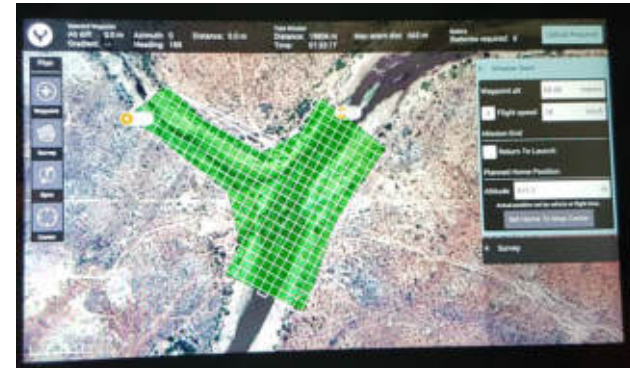


## 2. Digital Surface Model



### Yuneec Typhoon H520

- Camera E90: 20 MP, 23 mm focal distance
- Autonomous flying of planned missions
- Accurate overlap
- Double grid
- Takes georeferenced aerial pictures

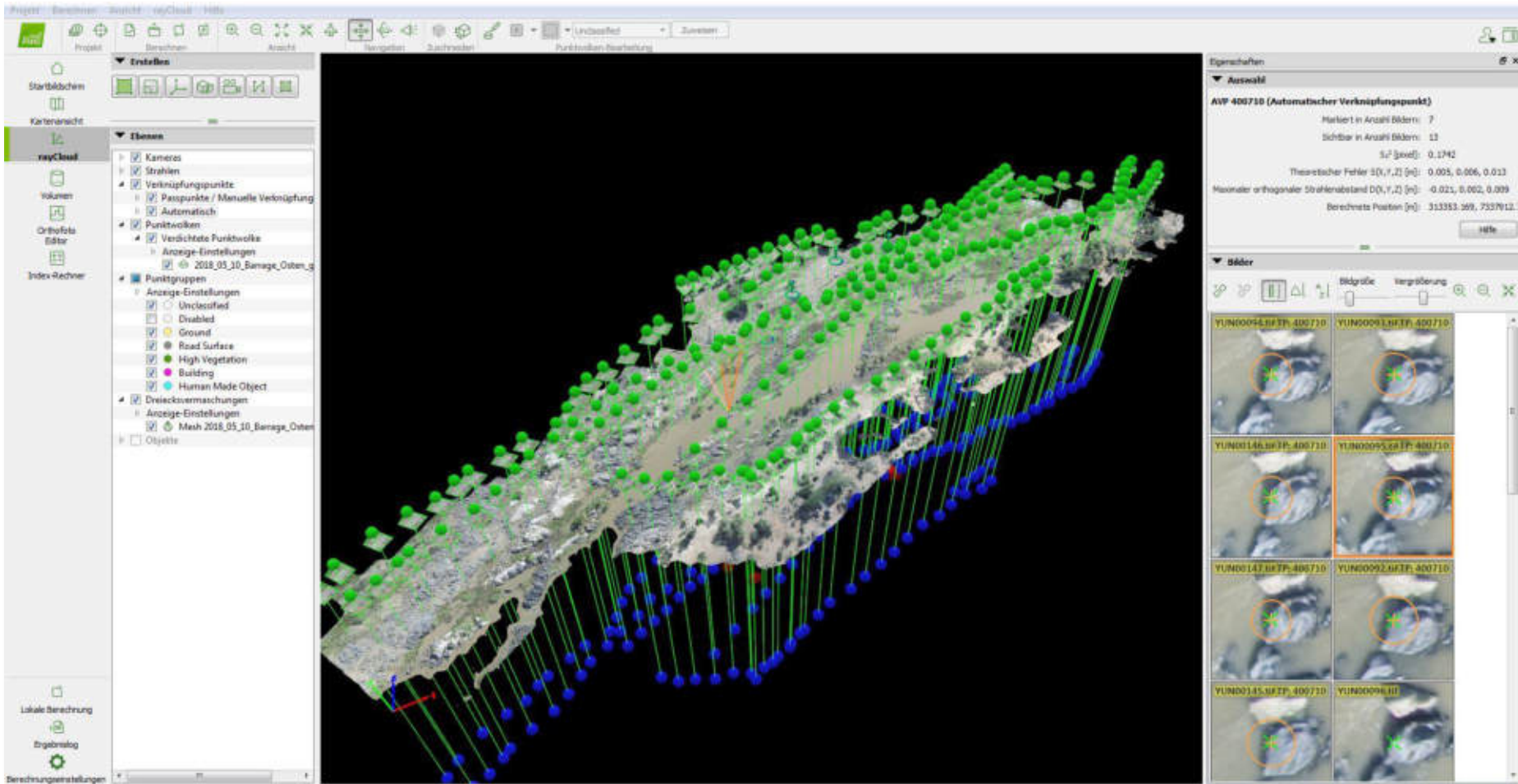


### MagicMapper DGPS

- Tough and light hardware
- GNSS receiver, GPS / GLONASS (u-blox neo-M8N)
- Precision of 0,3 - 1 m, even in altitude
- Takes GPS coordinates of Ground Control Points (GCPs)

# 2. Digital Surface Model

## Pix4D Mapper – Calculating DSM



## 2. Digital Surface Model

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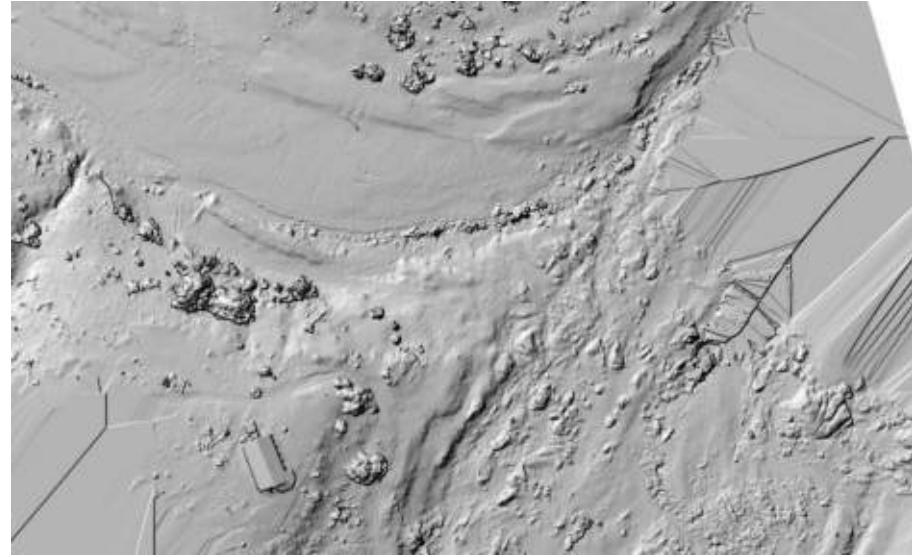
Pix4D Mapper – calculated 3D-model



## 2. Digital Surface Model

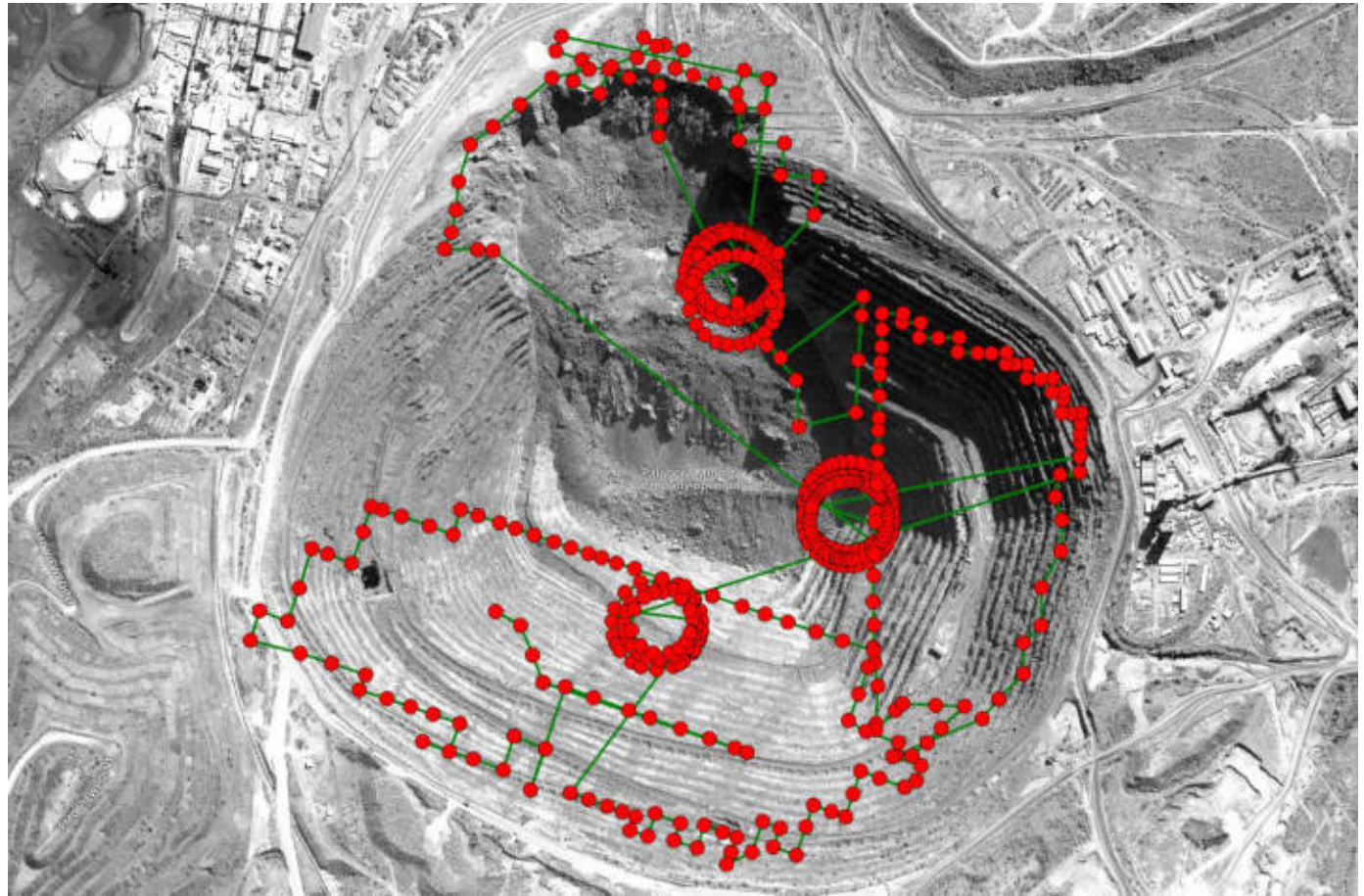
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Post processing in GIS:



## 2. Digital Surface Model – Example: Openpit Mine

Capture Photo Points:



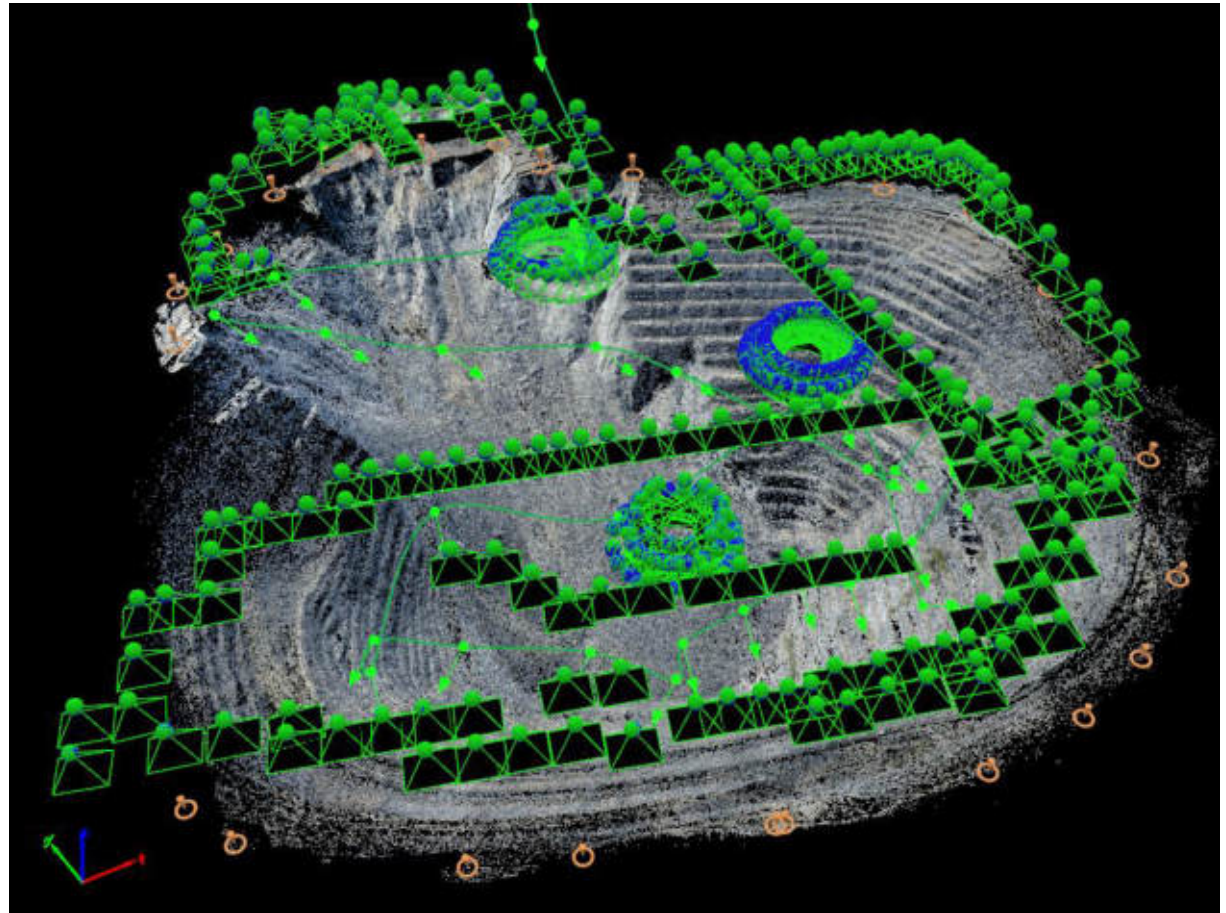


## 2. Digital Surface Model – Example: Openpit Mine

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### Capture Points

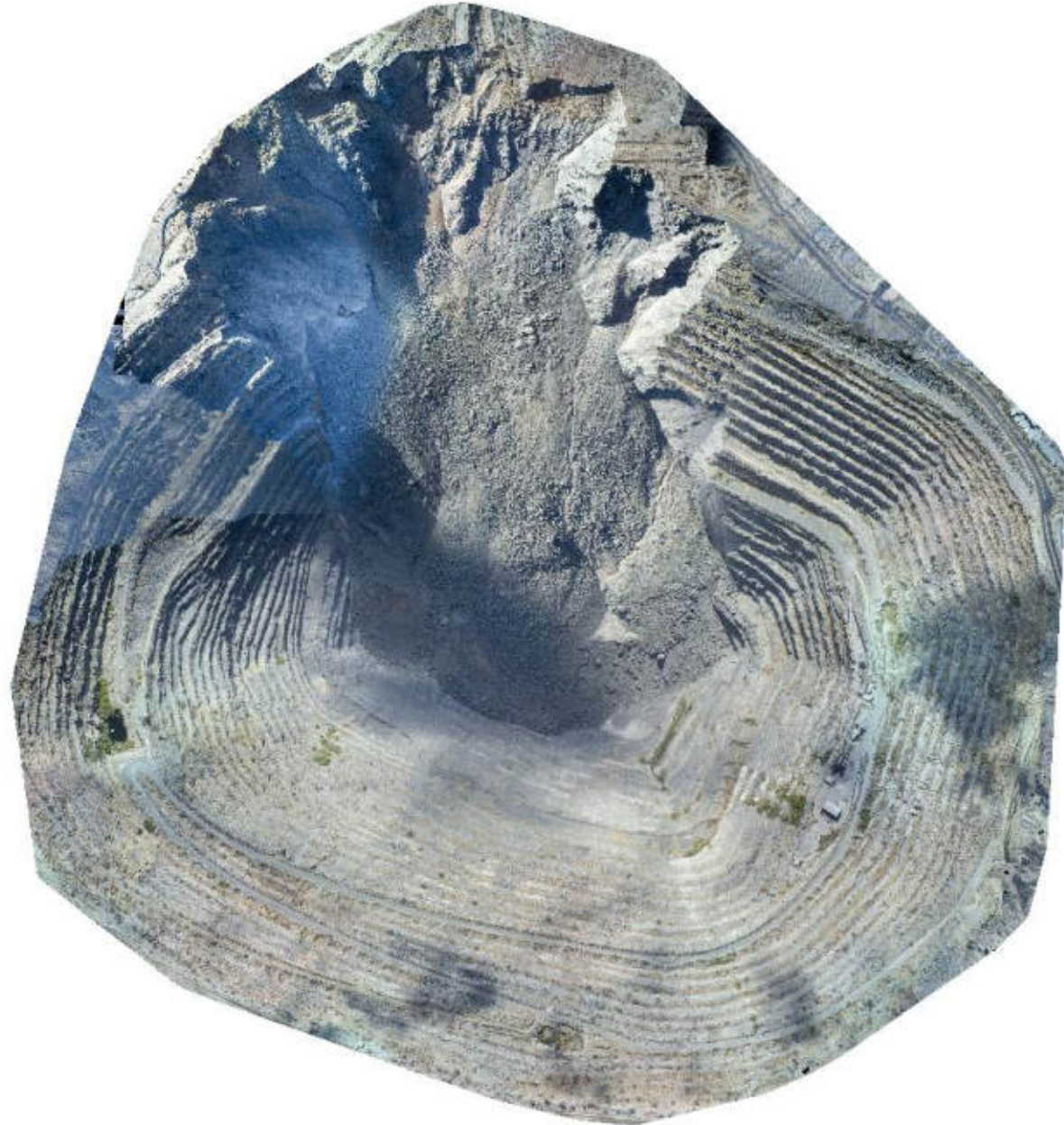
532 aerial pictures



## 2. Digital Surface Model – Example: Openpit Mine

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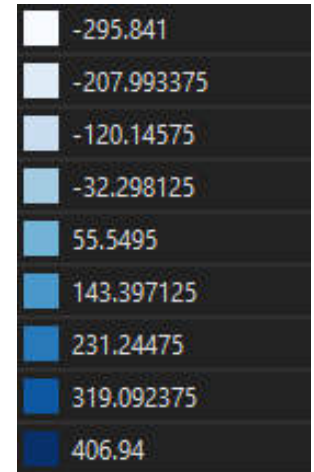
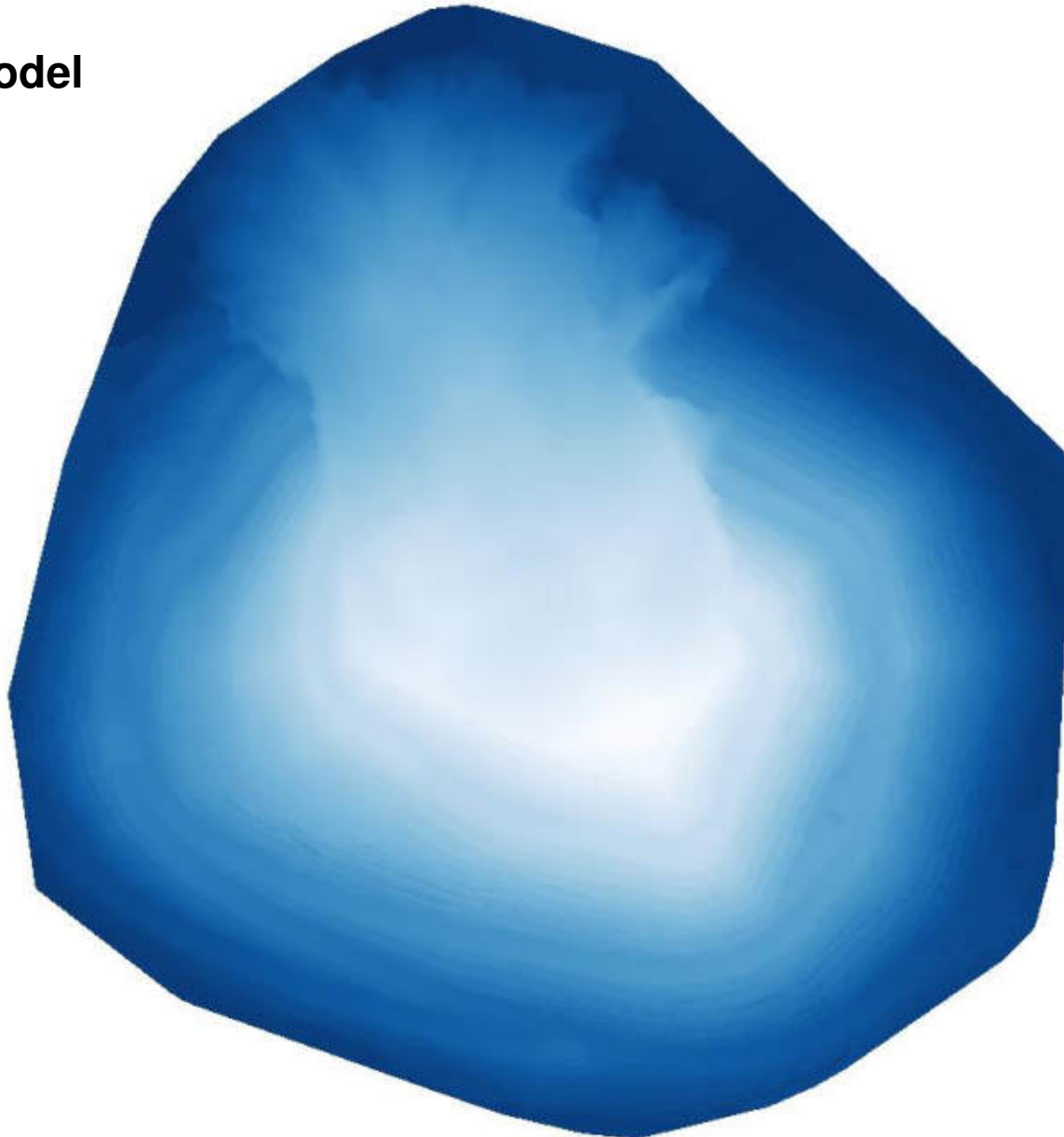
**Aerial Mosaic:**



## 2. Digital Surface Model – Example: Openpit Mine

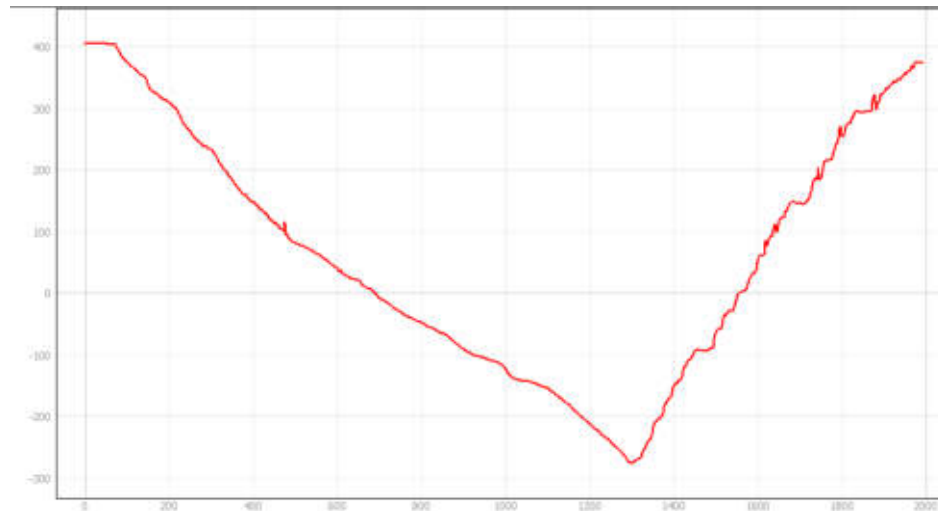
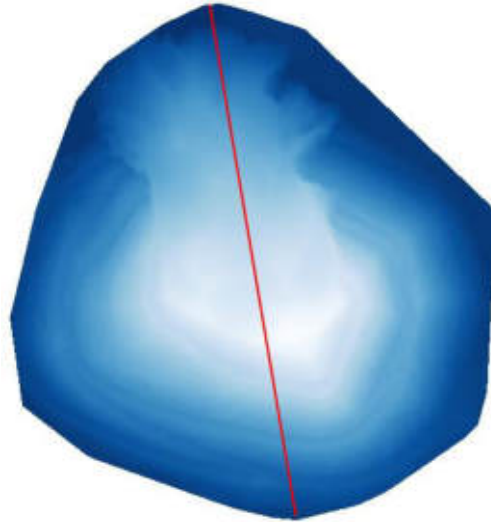
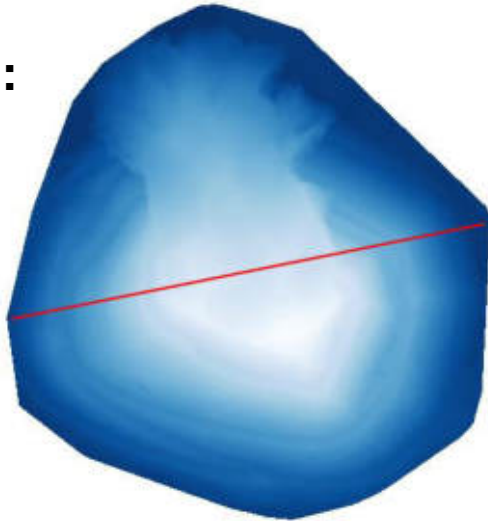
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### Elevation Model



## 2. Digital Surface Model – Example: Openpit Mine

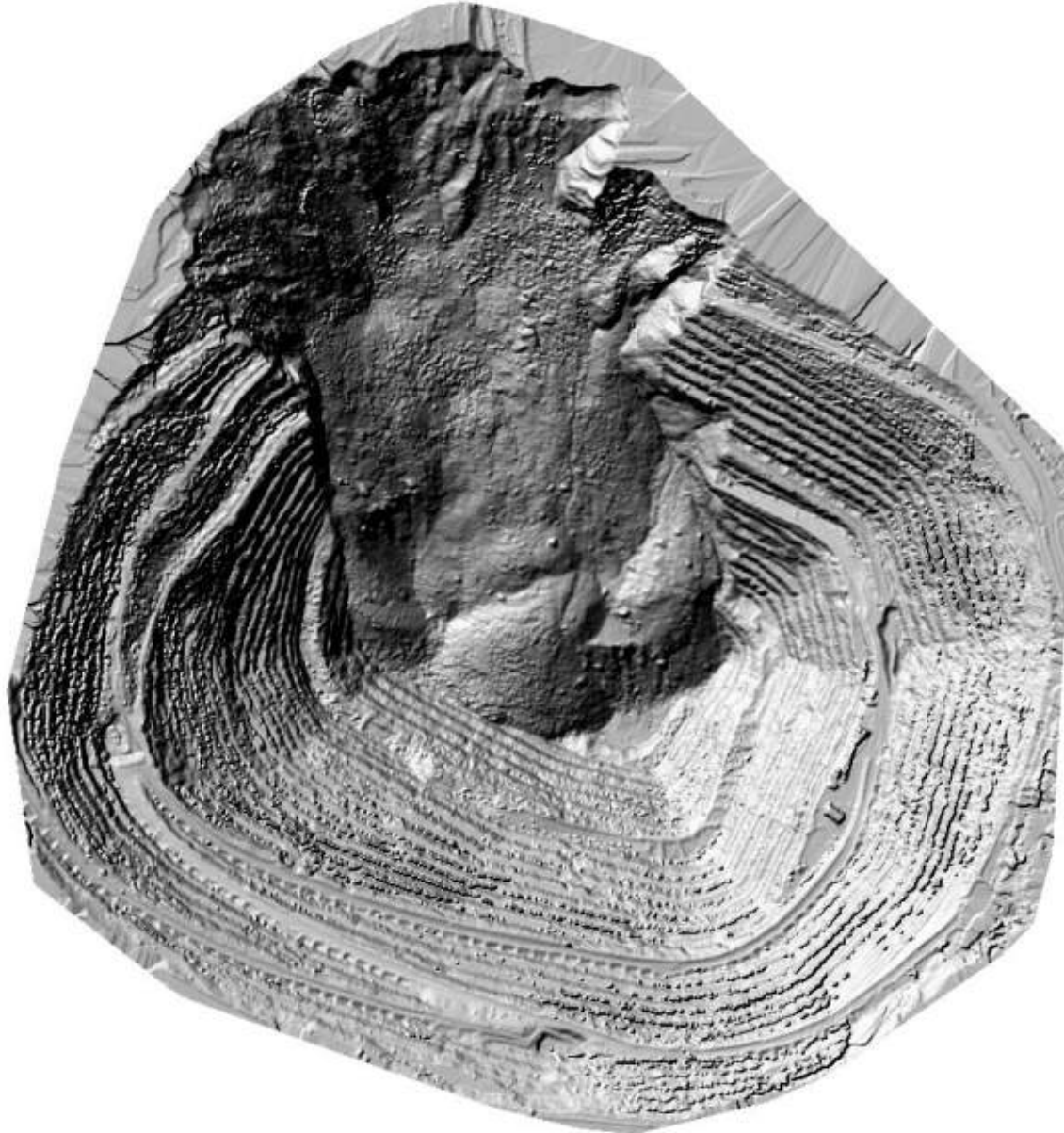
Cross Sections:



## 2. Digital Surface Model – Example: Openpit Mine

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Hillshade:

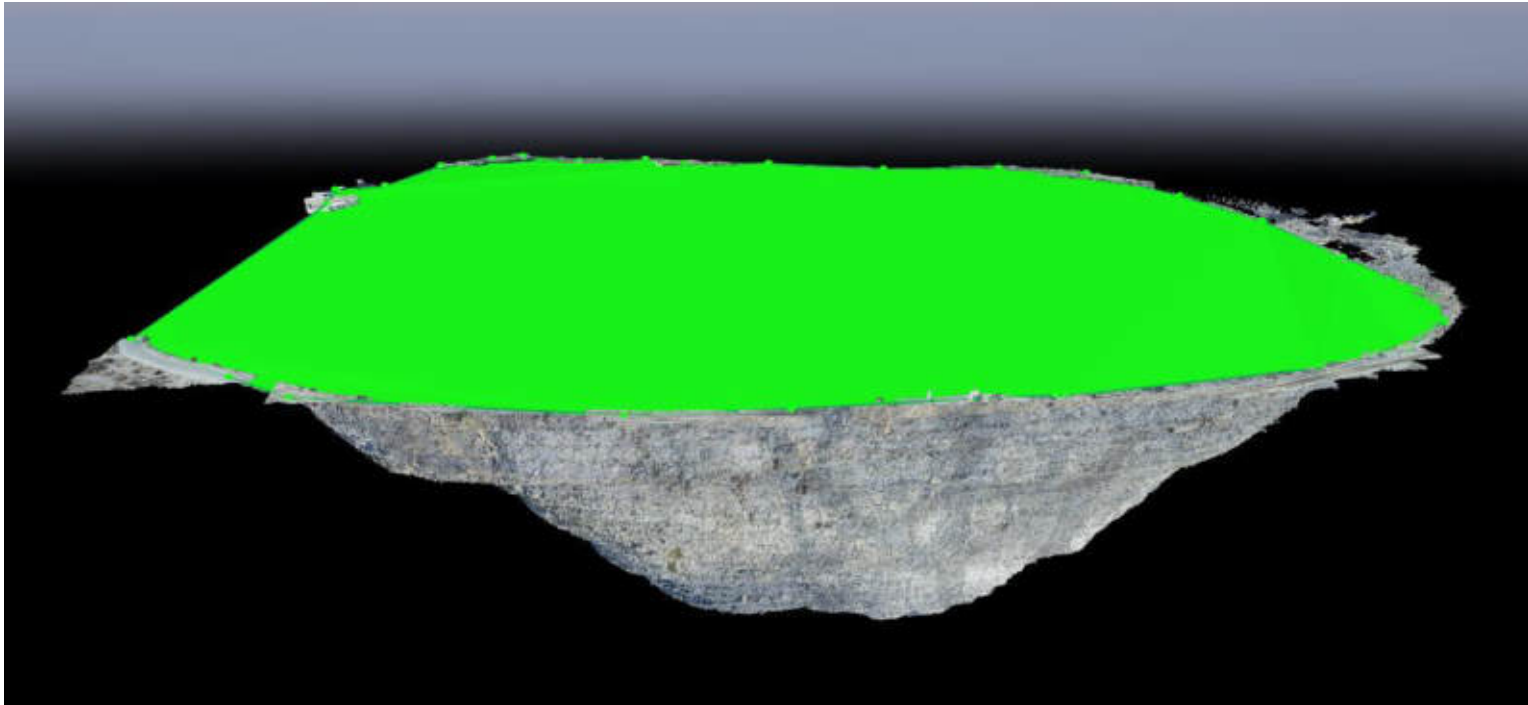


3D-Model  
Openpit Mine Phalaborwa

Video can also be found on: [https://www.instagram.com/gewaesser\\_experten/](https://www.instagram.com/gewaesser_experten/)

## 2. Digital Surface Model – Example: Openpit Mine

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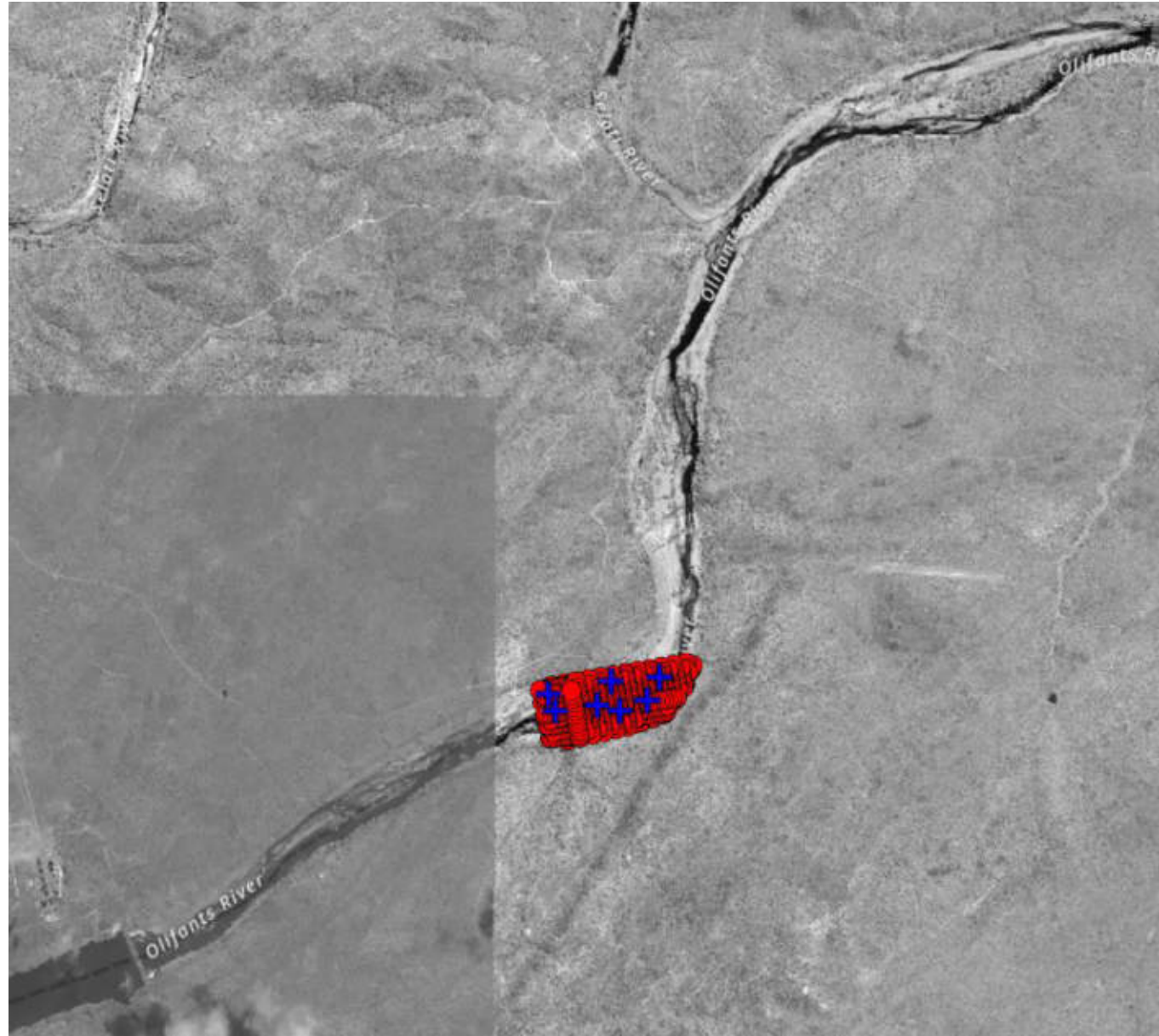
3D-surface: 4.644.850 m<sup>2</sup>  
4,644 km<sup>2</sup>

Volume: 629.868.000 m<sup>3</sup>  
0,629868 km<sup>3</sup>



## 2. Digital Surface Model – Example: Sawong

Overview:





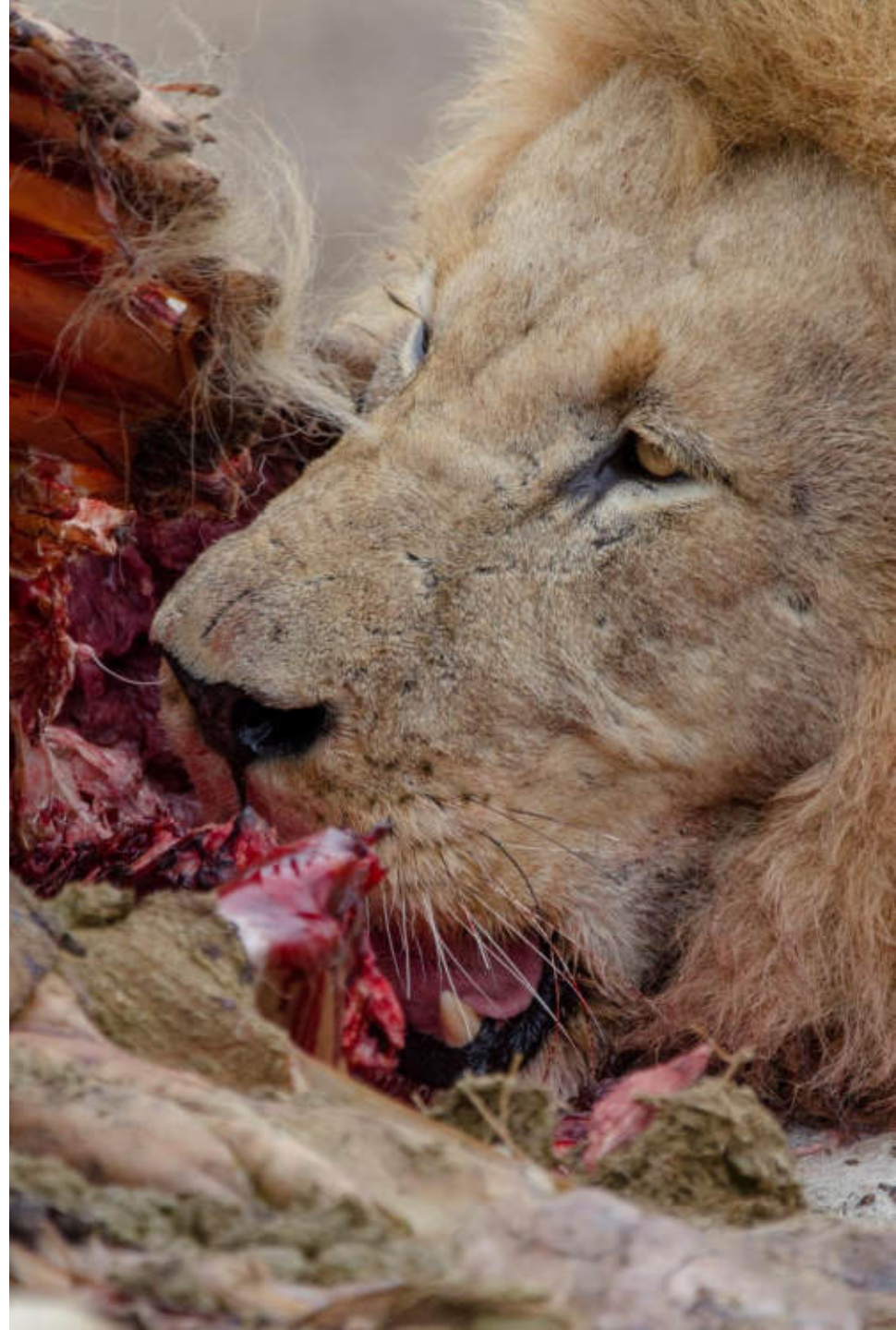
## **3D-Model Sawong**

Video can also be found on: [https://www.instagram.com/gewaesser\\_experten/](https://www.instagram.com/gewaesser_experten/)

# Agenda

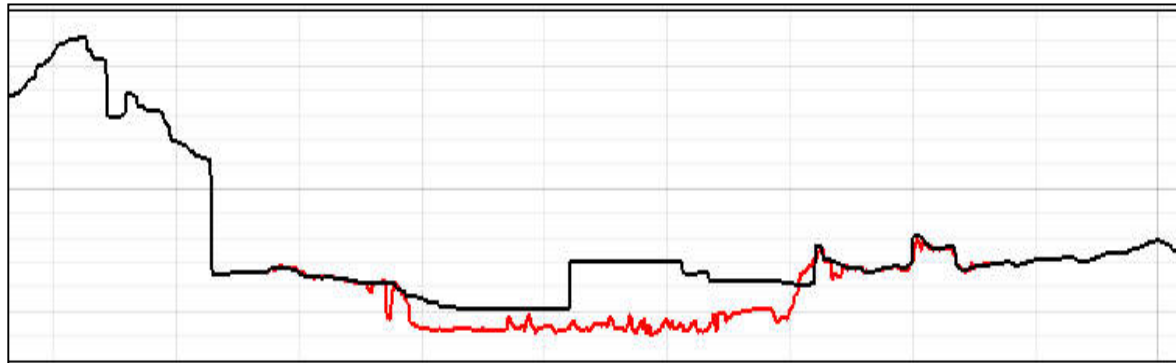
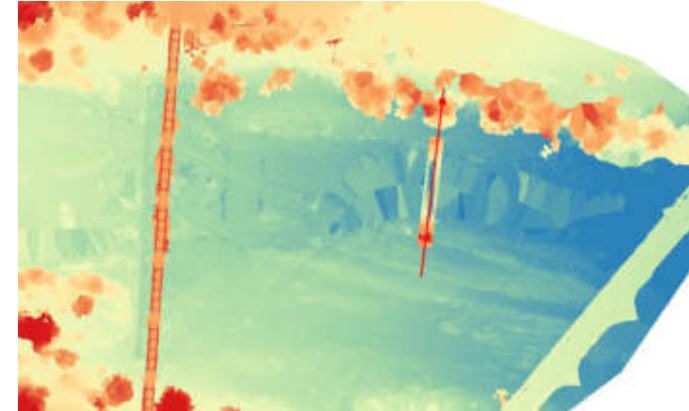
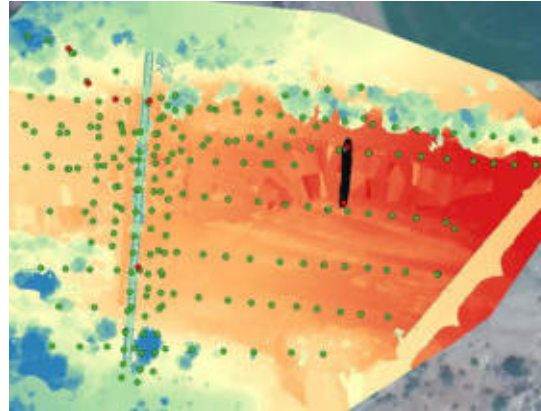
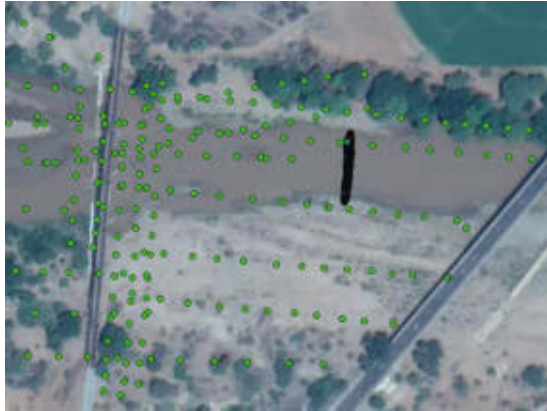
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# 3. River Cross Sections by ADCP / DSM



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# 4. Vegetation Indices + Algae Monitoring 5-channel Sensor

## Micasense RedEdge MX

- 5-channel multi-spectral sensor (R, G, B, nIR, RedEdge)
- Vegetation indices
- Algae monitoring
- Evaluation and index calculation with Pix4D
- Post processing in GIS



# 4. Vegetation Indices + Algae Monitoring 5-channel Sensor

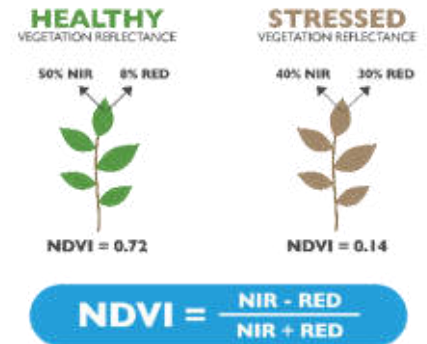
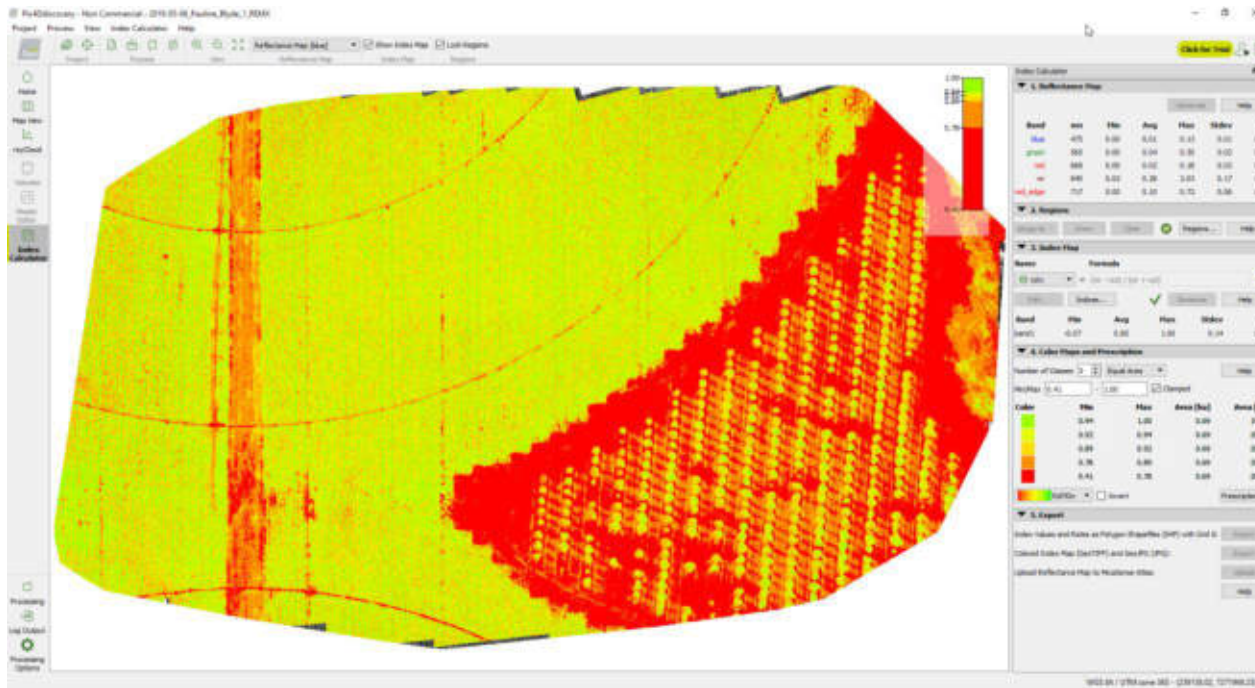
## Vegetation indices

- Significantly higher resolution than satellite data
- Detailed investigation of individual spots
- Large temporal flexibility, spontaneous aerial surveys
- Distribution and condition of plants
- Conclusions on drought stress, vitality, diseases

Vegetation Reflectance



Quelle: [www.agricolus.com](http://www.agricolus.com)



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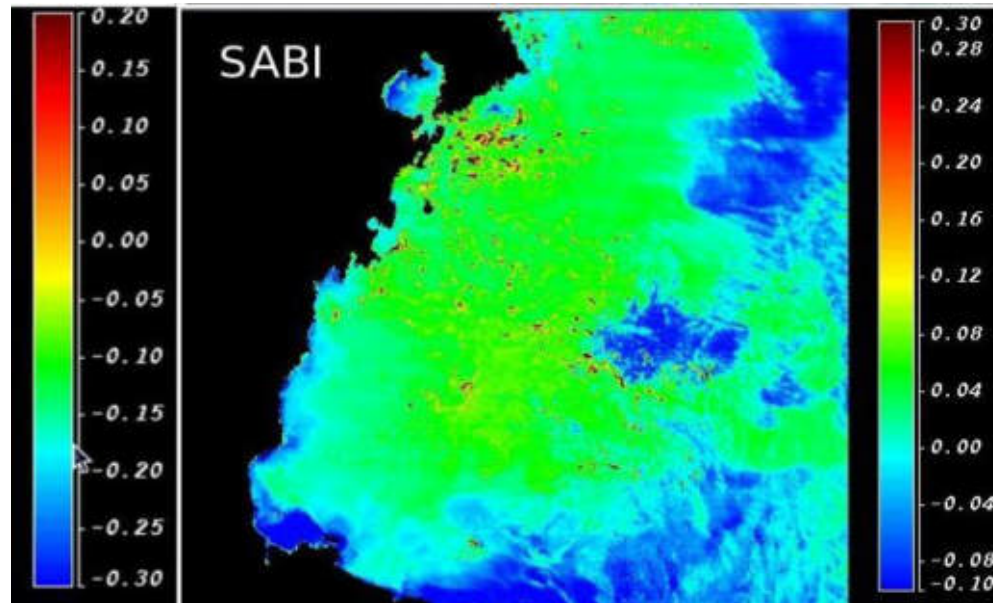
NDVI: Normalized Difference Vegetation Index



# 4. Vegetation Indices + Algae Monitoring 5-channel Sensor

## Algae monitoring:

- Distribution and quantity of algae
- Chemical and physical parameters of the water possible
- Several indices, f.e. Surface Algal Bloom Index (SABI): Representation of plant biomass in the water



$$\text{SABI} = \frac{\text{NIR-RED}}{\text{BLUE-GREEN}}$$

Quelle: Eprints.soton.ac.uk





# 4. Vegetation Indices + Algae Monitoring 5-channel Sensor

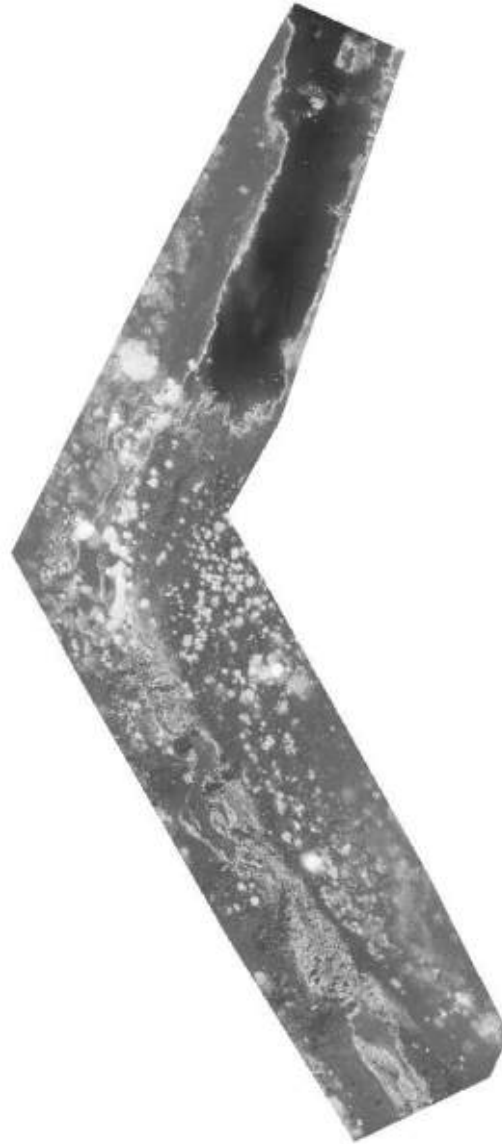
The screenshot displays the Pix4rMapper interface. The main window shows a point cloud of a riverbank area, with a large section of the point cloud highlighted in red. The interface includes a menu bar (Project, Process, View, Map View, Help), a toolbar, and a sidebar with navigation options (Home, Map View, rayCloud, Volumes, Photos, editor, Index Calculator). The Processing Options dialog box is open, showing the following settings:

- Processing Options:**
  - 1. Initial Processing
  - 2. Point Cloud and Mesh
  - 3. DSM, Orthomosaic and Index
  - Resources and Notifications
- DSM and Orthomosaic:** Additional Outputs, Index Calculator
- Radiometric Processing and Calibration:**
  - RedEdge-M\_5\_5\_1280x960 (Blue): Correction Type: Camera and Sun Irradiance; Calibration: Calibrate... Reset ✓
  - RedEdge-M\_5\_5\_1280x960 (Green): Correction Type: Camera and Sun Irradiance; Calibration: Calibrate... Reset ✓
  - RedEdge-M\_5\_5\_1280x960 (Red): Correction Type: Camera and Sun Irradiance; Calibration: Calibrate... Reset ✓
  - RedEdge-M\_5\_5\_1280x960 (NIR): Correction Type: Camera and Sun Irradiance; Calibration: Calibrate... Reset ✓
  - RedEdge-M\_5\_5\_1280x960 (Red edge): Correction Type: Camera and Sun Irradiance; Calibration: Calibrate... Reset ✓
- Resolution:** Automatic (selected), 1 x GSD; Custom: 1 m/px; Downsampling Method: Gaussian Average
- Reflectance Map:**  GeoTIFF,  Merge Tiles
- Indices:**
  - red\_edge = red\_edge
  - ndvi = (nir - red) / (nir + red)
  - SPI2 = (nir-green)/(nir-red)
  - SABI = (nir-red)/(blue-green)
- Export:**  Index Values as Point Shapefiles (SHP)
- Current Options:** No Template
- Buttons:** Load Template, Save Template, Manage Templates, Advanced, OK, Cancel, Help



# 4. Vegetation Indices + Algae Monitoring 5-channel Sensor

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# 4. Vegetation Indices + Algae Monitoring 5-channel Sensor

Layer Properties - 2019-09-04\_Sel5\_Selati\_REMX\_index\_ndvi | Symbology

**Band Rendering**

Render type: Singleband pseudocolor

Band: Band 1 (Gray)

Min: -0.40353 Max: 0.894224

**Min / Max Value Settings**

Interpolation: Linear

Color ramp: [Color ramp visualization]

Label unit suffix: [Empty]

Value	Color	Label
-0.40352964...	[Red]	-0.403529644012451
0.132442802...	[Orange]	0.132442802965641
0.207712541...	[Yellow]	0.207712541282177
0.375122821...	[Light Green]	0.375122821331024
0.892926710...	[Dark Green]	0.892926710784435

Mode: Quantile Classes: 5

Classify: [Icons]

Clip out of range values

**Color Rendering**

Bending mode: Normal [Reset]

Brightness: [Slider] 0 Contrast: [Slider] 0

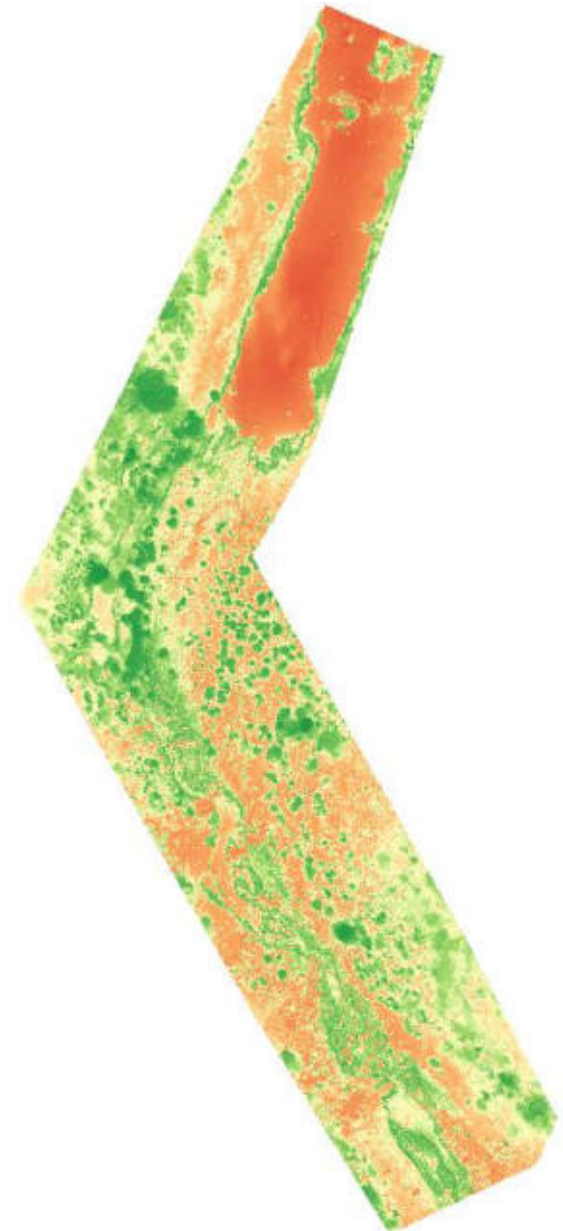
Saturation: [Slider] 0 Grayscale: Off

Hue: [Colorize] [Strength] 100%

**Resampling**

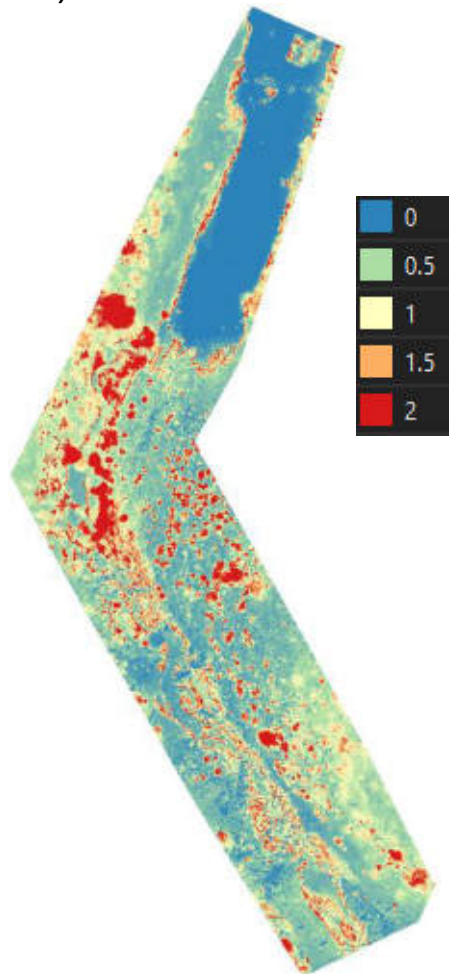
Style [Dropdown]

OK Cancel Apply Help

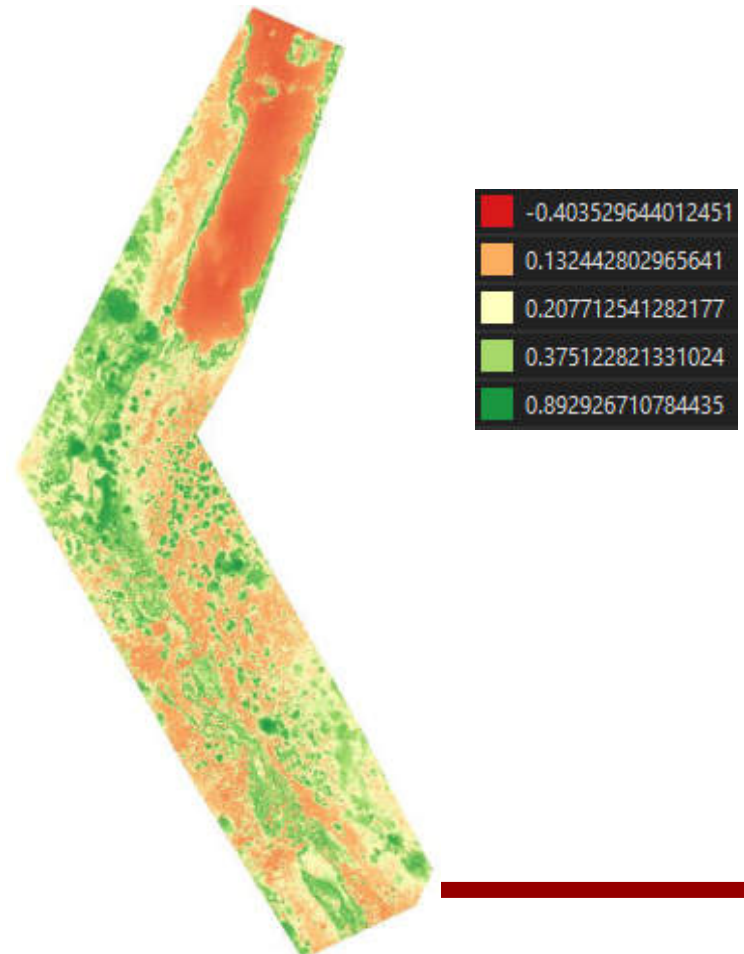


# 4. Vegetation Indices + Algae Monitoring 5-channel Sensor

SABI (Surface Algae Bloom Index)



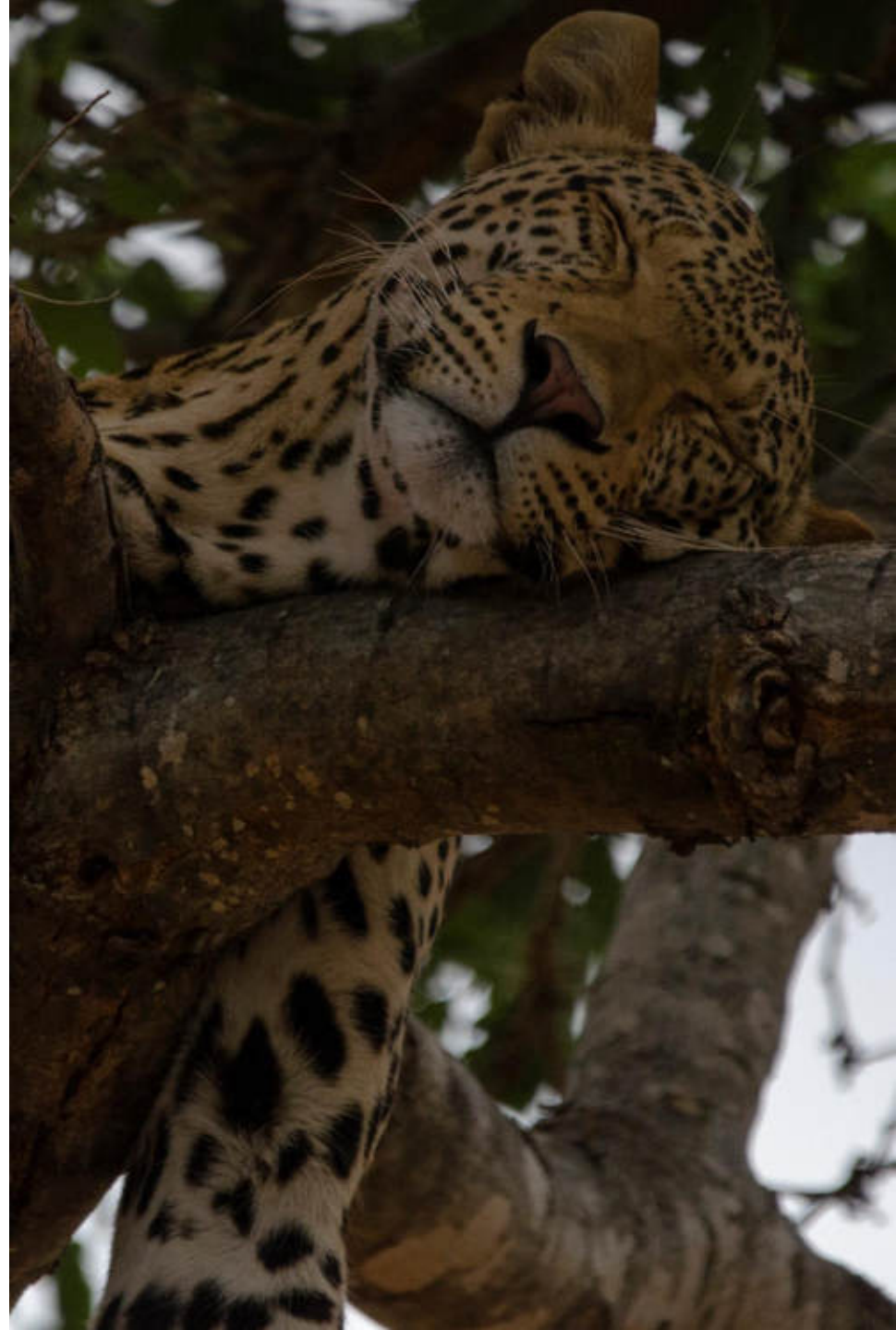
NDVI (Normalized Difference Vegetation Index)



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# 5. Experimental Field Work – Water Sampling by Drone



## Water sampling with drone

- Sampler „Dispo Dipper“
- Lightweight Pouch with long handle and closure
- Content: 250 ml
- Direct measurement or transfer to laboratory

## Direktmessung vor Ort

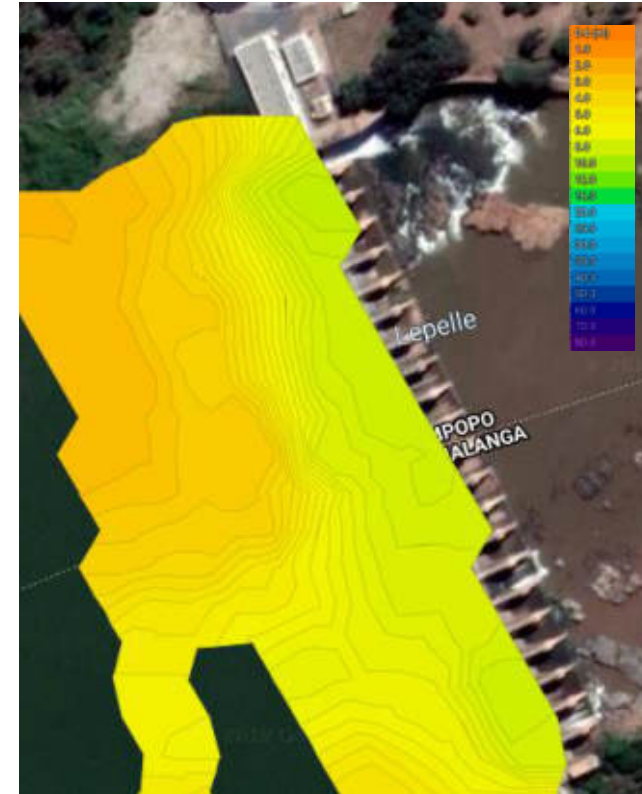
- Measurements in the field directly from the sampler possible
- Measurement device: WTW Multi 3630 IDS
- Parameters: Temperature, pH value, oxygen content, conductivity
- Data transmission from the sensor to the handheld device via Bluetooth



# 6. Experimental Fieldwork - Underwater Maps by drone

- Deeper Smart Sonar Pro +
- Kompaktes drahtloses Sonargerät
- Genauigkeit: 0,1 m, Mindesttiefe: 0,7 m
- Erstellung von Tiefenkarten, Bearbeitung in GIS möglich

REAL TIME MAPPING (BOAT MODE)



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# 7. Overview of Field Activities

## 2. Fieldtrip: 05.2018 Yuneec Typhoon H (old drone)

Spot	River	Description	Flugdatum	UAV	GCPs	ADCP
Confluence Olifants_Selati	Olifants River, Ga-Selati River	Confluence of the two rivers	03.05.2018	X	X	-
Oxford_Three Bridges	Olifants River	southwest of Phalaborwa (40 km as the crow flies), between a railway bridge and an expressway bridge (R40)	07.05.2018	X	/	X
Blyde	Blyde River	south-southwest of Phalaborwa (70 km as the crow flies), near the Blyde River Canyon at Selati River Lodge	08.05.2018	/	X	X
Selati	Ga-Selati River	west of Phalaborwa (33km as the crow flies) on the Barrage	09.05.2018	X	X	-
Barrage	Olifants River	south of Phalaborwa (33km as the crow flies, directly on the dam east of the Barrage	10.05.2018	-	-	X
Sawong	Olifants River	south of the Confluence of Ga-Selati and Olifants, adjacent to a military area	10.05.2018	X	X	-

## 3. Fieldtrip: 10.2018 Yuneec Typhoon H 520 (new drone)

Spot	River	Description	Flugdatum	UAV	GCPs
Barrage westlich	Olifants River	just west of the Barrage Dam, near the water reservoir	17.10.2018	X	X
Barrage oestlich	Olifants River	immediately east of the Barrage Dam, below the dam	17.10.2018	X	X
Sawong	Olifants River	east of the Barrage, south of the Confluence of Ga-Selati and Olifants, adjacent to a military area	16.10.2018	X	X
Mine	-	open pit of the Phalaborwa Mining Company	05.10.2018	X	X
Selati River Lodge	Ga-Selati River	at the Selati River Lodge, west of Phalaborwa (33km as the crow flies)	18.10.2018	X	X
Ngwabitsi	Ngwabitsi, Ga-Selati River	west of Phalaborwa (79km as the crow flies), immediately adjacent to the bridge over the Ngwabitsi and Ga-Selati rivers, the rivers run side by side at this point, the R36	07.10.2018	X	X
Confluence	Olifants River, Ga-Selati River	confluence of the two rivers that continue as the Olifants River flow	17.10.2018	X	X
Mulati	Mulati	along a bridge, the R71, which leads over the Mulati. 24 km west of Phalaborwa (linear distance)	11.10.2018	X	X
Selati Baluale Reserve	Ga-Selati River	West-southwest from Phalaborwa (63 km straight line), just east of the spot the Baluale Reserve	11.10.2018	X	X
Oxford	Olifants River	adjoins to the southwest of Phalaborwa (40 km as the crow flies), between a railway bridge and an expressway bridge (R40)	13.10.2018	X	X



# 7. Overview of Field Activities

## 4. Fieldtrip: 05.2019 Yuneec Typhoon H 520 (new drone) + MicaSense RedEdge MX (5 Channel)

Spot			Flugdatum	UAV	GCPs	MicaSense
Oxford	Olifants River	Southwest of Phalaborwa (40 km as the crow flies), between a railway bridge and an expressway bridge (R40)	14.05.2019	X	X	
Sawong	Olifants River	east of the Barrage, south of the Confluence of Ga-Selati and Olifants, adjacent to a military area	17.05.2019	X	X	
Confluence	Olifants River, Ga-Selati River	confluence of the two rivers that continue to flow as Olifants River	15.05.2019	X	X	
Barragev2	Olifants River	west of the dam Barrage	07.05.2015	X	X	
GaSelati	Ga-Selati River	west of Phalaborwa, south of Leydsdorp	05.05.2019	X	X	
Timbawati 1	Timbavati	north of the city of Acornhoek, adjacent to road R531	09.05.2019	X	X	
Timbawati 2	Timbavati	northeast of the city of Acornhoek, on road R531	09.05.2019	X	X	
Blyde River 2	agriculture area	adjacent to road R36, north of Kroonkop	08.05.2019	X	X	X
Steelport 2	agriculture area	south of Burgersfort, west of Kroonkop, on road R37	06.05.2019	X	X	X
Blyde River 1	agriculture area	115 km (as the crow flies ) south-southwest of Phalaborwa, on road R36, just south of Kroonkop	06.05.2019	X	X	X

## 5. Fieldtrip: 09.2019 Yuneec Typhoon H 520 (new drone) + MicaSense RedEdge MX (5 Channel)

Spot			Flugdatum	UAV	GCPs	MicaSense
Mine_Open_Pit		Phalaborwa Mining Company open pit	03.09.2019	X	X	X
Sel1_Feld	Ga-Selati River	west of Phalaborwa, just north of the R71	04.09.2019	X	X	X
Sel1_Teich	Ga-Selati River	road west of Phalaborwa, just north of the R71 road, just north of the Sel1_Feld	04.09.2019	X	X	X
Sel1_Selati	Ga-Selati River	less than 100 meters above the confluence of Ga-Selati and Olifant's	04.09.2019	X	X	X
Sel1_Confluence	Olifants River, Ga-Selati River	confluence of the two rivers as Olifants River continues to flow	04.09.2019	X	X	X

# 8. Outlook

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## Further (last) Steps:

- The technical development is done, there will not be produced more applications.
- The workflow and post-processing of the 5-channel-data and vegetation indices is in process
- A [training](#) will be planned for 2020
- If it works: 3D-model of the Olifants Canyon in cooperation with SAEON and SanParks

## Data

- We divide our produced data in „[experimental data](#)“ and „[excellent data](#)“ – the „[excellent data](#)“ will be made available
- There will be data sets with (1) only aerial mosaic, (2) aerial mosaic and 3D-model and (3) aerial mosaic, 3D-model and sets with vegetation indices
- The data will also be available in the [Application produced by DISY](#)

Thanks for your interest!

# iWagSS

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DIE GEWÄSSER-EXPERTEN!