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Unmanned Aerial Vehicles as a Tool for Monitoring and Evaluating Natural Channel Designs

Bryce Molder & Paul Villard
GEO Morphix Ltd.

TRIECA Conference
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Pearson Convention Centre, Toronto





OUTLINE

1. Background

UAV

How it functions

2. UAV Applications

ESC monitoring

Monitoring NCD's

Topographical surveys

Specialized applications

3. Limitations

Vegetation / Water

Weather

4. Conclusions

Summary

Next steps

Flying requirements



BACKGROUND



- DJI Phantom Vision 2+
- DJI Phantom 4 Pro
- HD Playback
- Flight Time: 15 mins
- Flight Speed: < 10 m/s

BACKGROUND

HOW IT FUNCTIONS

- **Photogrammetry**
- **Generate 3D models from 2D photos taken at different angles**
- **Processing Softwares**
 - Pix 4D
 - PrecisionMapper

GEO
MORPHIX





BACKGROUND

HOW IT FUNCTIONS

The screenshot displays a drone flight control interface. At the top, there are navigation icons (back, map, camera) and status information: "PHANTOM 4", a gear icon for settings, a Wi-Fi signal icon, and a battery level of 53%. The main view is a top-down aerial perspective of a mission plan. The mission plan is a green square with a white border, containing a white 'X' shape and a small grey circle. The square is surrounded by eight green circular markers. To the left of the mission plan, the altitude is shown as "Alt 270", "240", and "210". To the right, there are four sliders for mission settings: "speed" (set to "slow"), "angle" (set to "90°" and "horizontal"), "overlap" (set to "80%"), and "face" (set to "forward"). At the bottom right, there are three large buttons: "RESET", "SAVE", and "START". At the bottom left, there are icons for a compass, a zoom-in/out control, and a map thumbnail. At the bottom center, the mission details are displayed: "328x328 ft, 4min:00s 25.88261°, -80.28554°".

Alt
270
240
210

PHANTOM 4

speed: slow fast
angle: 90° horizontal vertical
overlap: 80% low high
face: forward center

RESET
SAVE
START

328x328 ft, 4min:00s 25.88261°, -80.28554°

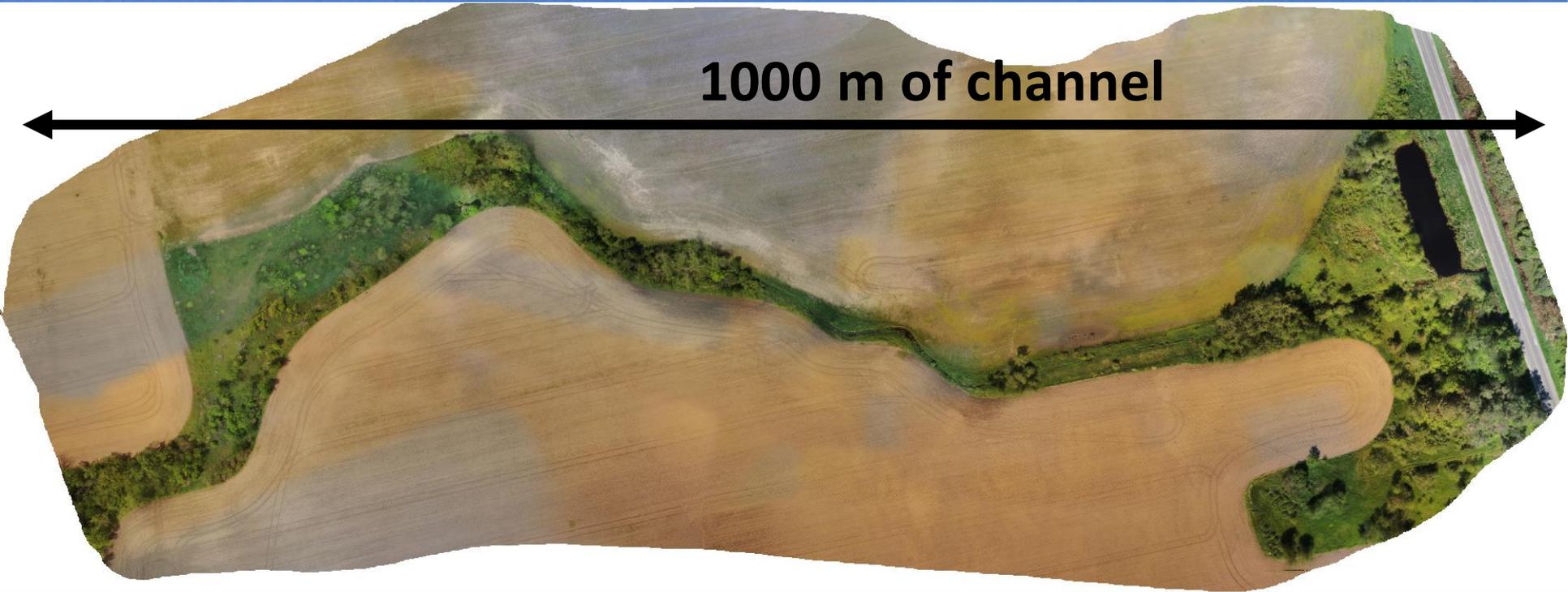


BACKGROUND

HOW IT FUNCTIONS



1000 m of channel





UAV APPLICATIONS

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UAV APPLICATIONS

ESC MONITORING



Easy Identification of...





UAV APPLICATIONS

ESC Monitoring



Aerial Perspective





UAV APPLICATIONS

ESC MONITORING



Ground Perspective





UAV APPLICATIONS

MONITORING NCD's

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UAV APPLICATIONS

MONITORING NCD's



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MONITORING NCD's

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UAV APPLICATIONS

MONITORING NCD's

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UAV APPLICATIONS

SURVEYS

- Informing ESC plans
- As-builts
- Geomorphological monitoring (e.g., erosion)

Accuracy

- Photo resolution
- Ground Sampling Distance \leftrightarrow Altitude (20 – 50 m)
- Use and distribution of Ground Control Points (surveyed with RTK)





UAV APPLICATIONS

SURVEYS

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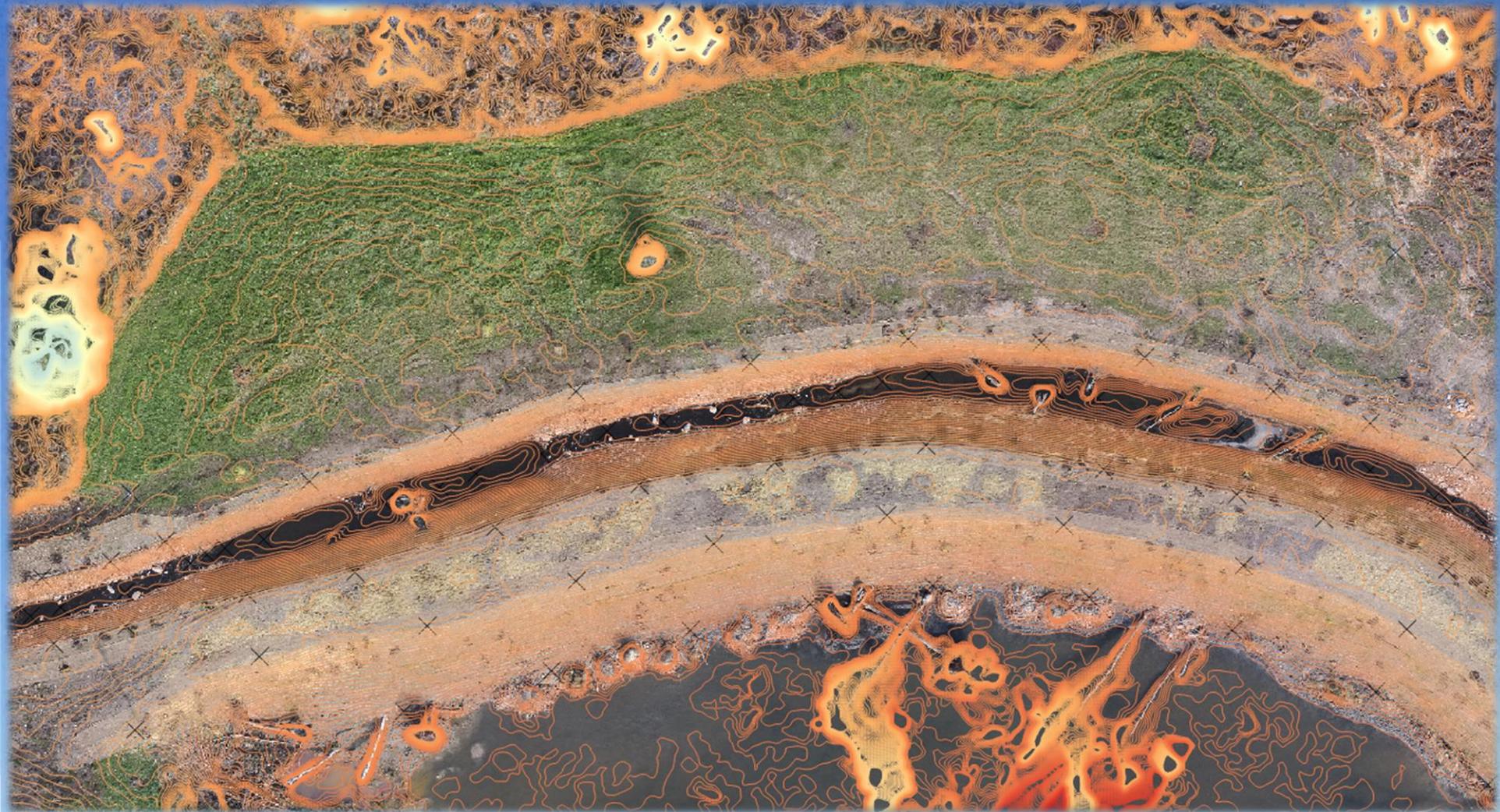




UAV APPLICATIONS

SURVEYS

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UAV APPLICATIONS

SURVEYS

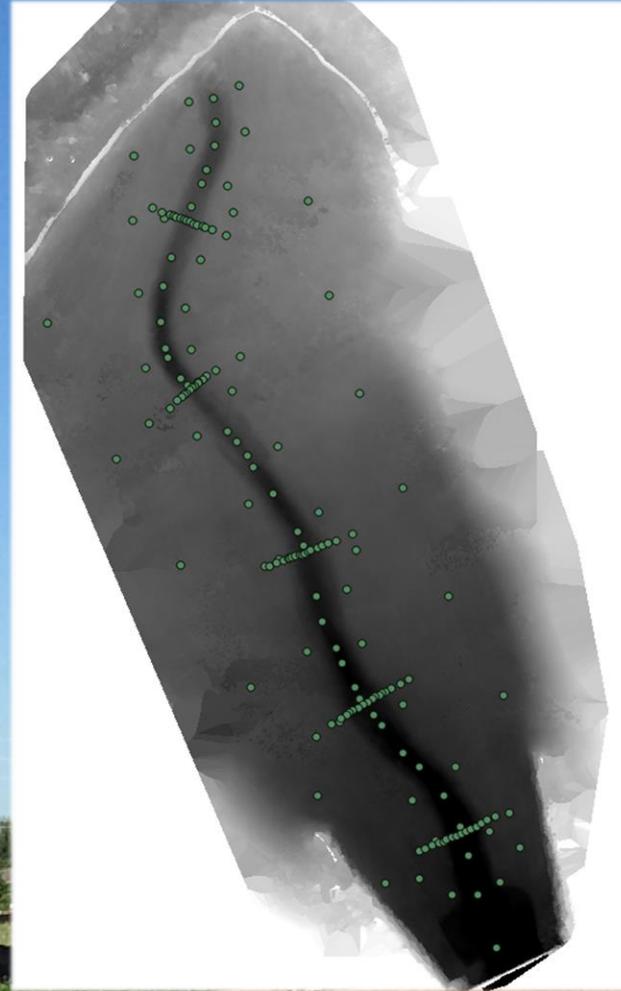
X_RTK	Y_RTK	Z_RTK	X_DSM	Y_DSM	Z_DSM	Description	ABS(Z_DSM-Z_TRK)
608125	4904224	251.695	608125	4904224	251.578	TOB	0.117
608130	4904219	251.724	608130	4904219	251.608	TOB	0.116
608135	4904216	251.664	608135	4904216	251.55	TOB	0.115
608141	4904211	251.703	608141	4904211	251.586	TOB	0.117
608147	4904207	251.611	608147	4904207	251.521	TOB	0.090
608152	4904205	251.525	608152	4904205	251.447	TOB	0.078
608157	4904203	251.385	608157	4904203	251.352	TOB	0.032
608162	4904200	251.322					0.087
608167	4904198	251.264					0.031
608171	4904194	251.158					0.024
608173	4904192	251.045					0.012
608175	4904189	250.914					0.042
608177	4904184	250.758	608177	4904184	250.775	TOB	0.016
608176	4904182	250.587	608176	4904182	250.531	TOB	0.056
608173	4904185	250.776	608173	4904185	250.733	TOB	0.043
608178	4904198	250.958	608178	4904198	250.908	TOB	0.050
608180	4904193	250.943	608180	4904193	250.889	TOB	0.054
608182	4904189	250.917	608182	4904189	250.85	TOB	0.067
608181	4904184	250.691	608181	4904184	250.672	TOB	0.019

RMS = 0.11
Mean = 0.09



UAV APPLICATIONS

SURVEYS





UAV APPLICATIONS

SURVEYS

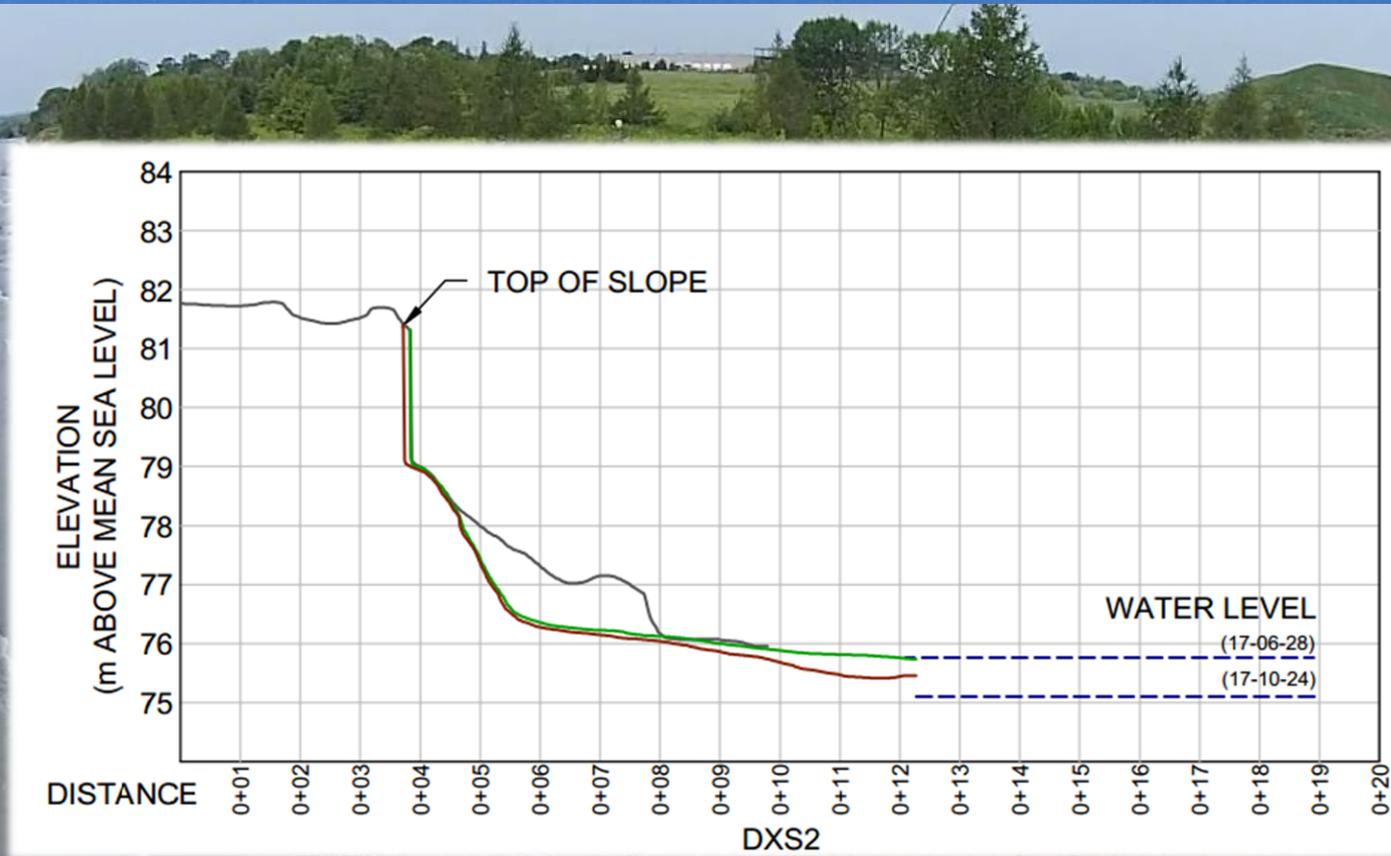
X_RTK	Y_RTK	Z_RTK	X_DSM	Y_DSM	Z_DSM	Description	ABS(Z_DSM-Z_TRK)
603150	4816407	172.421	603150	4816407	172.394	CL	0.026
603149	4816411	172.394	603149	4816411	172.363	CL	0.031
603148	4816413	172.42	603148	4816413	172.447	CL	0.028
603148	4816415	172.545	603148	4816415	172.563	CL-CREST	0.019
603148	4816415	172.404					0.086
603147	4816417	172.381					0.083
603145	4816419	172.438					0.062
603144	4816420	172.515				-BTM	0.070
603143	4816421	172.61					0.045
603142	4816423	172.734				-CREST	0.016
603141	4816424	172.58					0.048
603140	4816425	172.568	603140	4816425	172.622	CL	0.054
603140	4816426	172.622	603140	4816426	172.659	CL	0.037
603139	4816428	172.779	603139	4816428	172.801	CL-BTM	0.022
603139	4816429	172.772	603139	4816429	172.827	CL	0.055
603138	4816433	172.904	603138	4816433	172.918	CL-CREST	0.014

Max = 0.14
Min = 0.004
RMS = 0.07
Mean = 0.06



UAV APPLICATIONS

SURVEYS

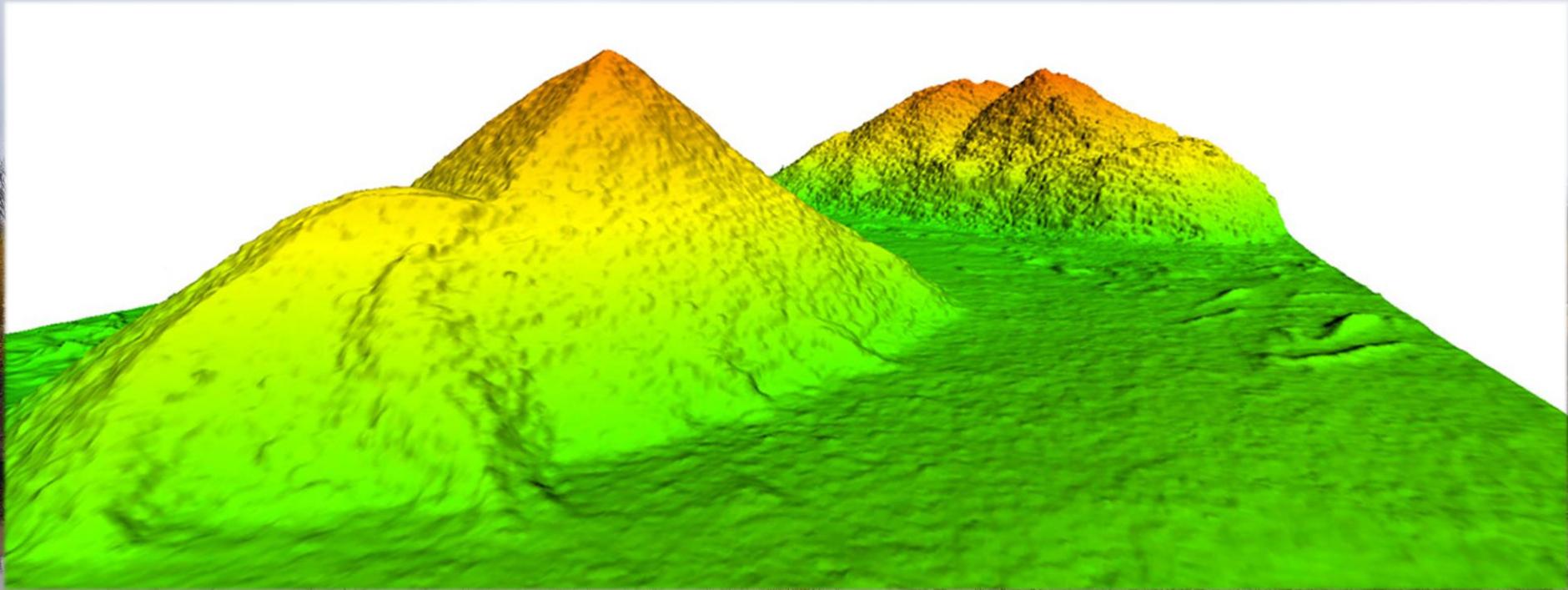




UAV APPLICATIONS

OTHER APPLICATIONS

- Stockpile / Volume estimation
 - Material availability

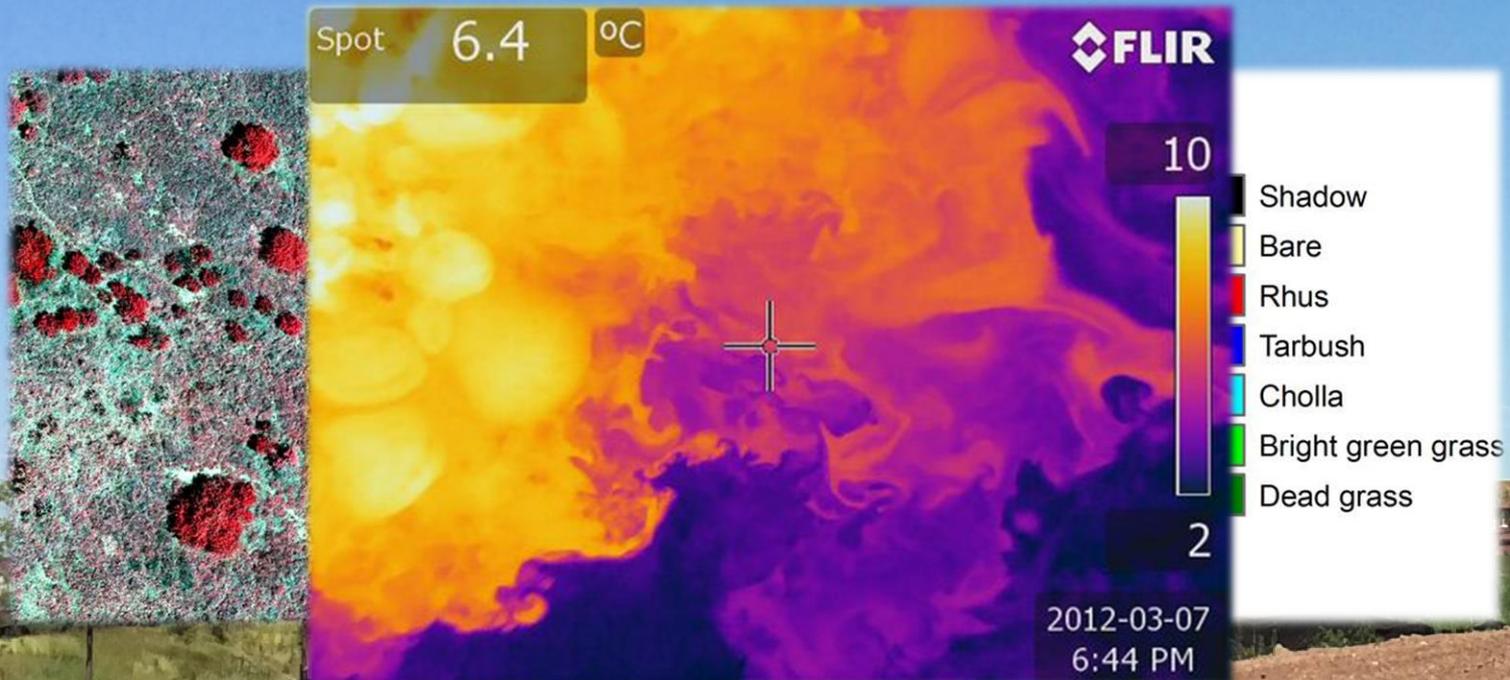




UAV APPLICATIONS

OTHER APPLICATIONS

- Stockpile / Volume estimation
- Vegetation I.D. (multispectral camera)
- Groundwater inputs (thermal infrared camera)



LIMITATIONS

- **Weather (wind, rain)**
- **Vegetation cover and water surface (Supplement survey with RTK, LiDAR)**
- **Range of operation (flight time, communication distance)**
- **Low precision without GCPs**
- **Flying requirements (e.g., permits, privacy etc.)**



CONCLUSIONS

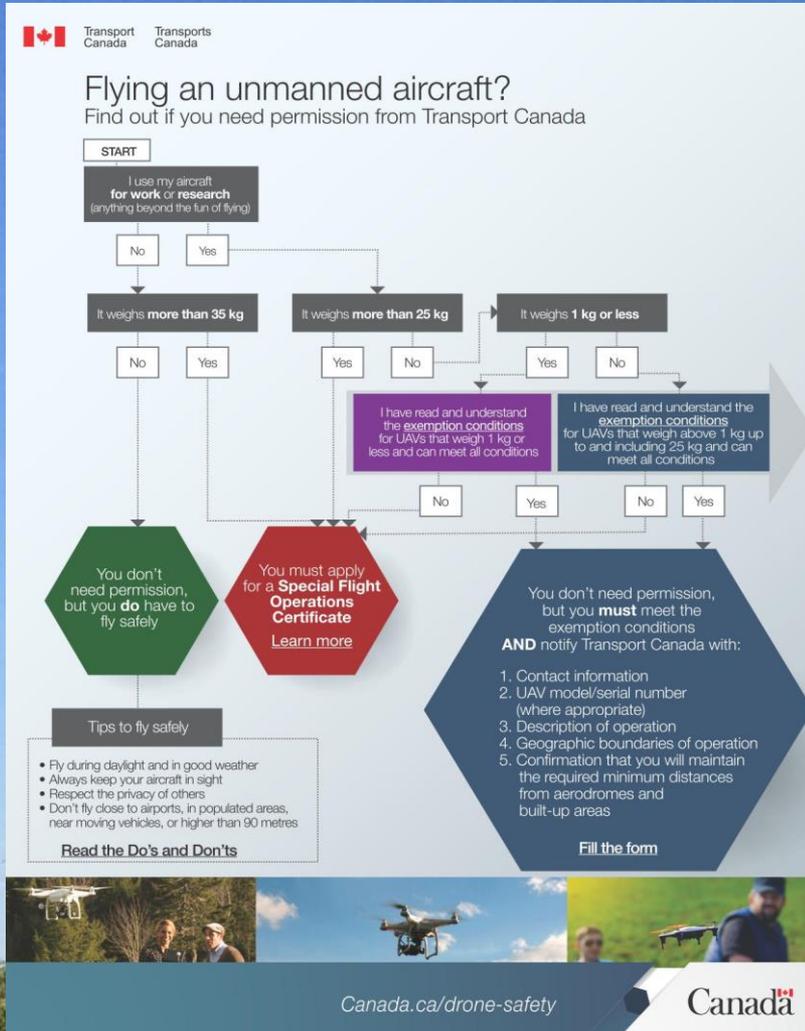
- **Affordable**
- **Efficient (rapid surveys with good coverage)**
- **Birds-eye perspective facilitates review of corridor conditions / ESC**
- **Steep slopes**

NEXT STEPS

- **Compare Photogrammetry software**
- **Develop UAV inspection / survey standards**



FLYING REQUIREMENTS



- SFOC Special Flight Operations Certificate
- Flight Training
- 100 ft distance to people, buildings, etc.
- Flight Log
- Contact Air Control Centres in case of emergency
- Blowhorn, fire extinguisher



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