Agricultural University of Athens

Assessing soil erosion and sedimentation through high accuracy tLiDAR and UAV-Photogrammetry techniques. Implications for validating soil erosion models

MINERALOGY - GEOLOGY LAB

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Introduction

Soil Erosion estimation through:

- **Soil Erosion Modeling (lack validation)**
- **Remote Sensing (Lidar, UAV Photogrammetry)**

Accurate results on change detection research through Remote sensing- based tools such as:

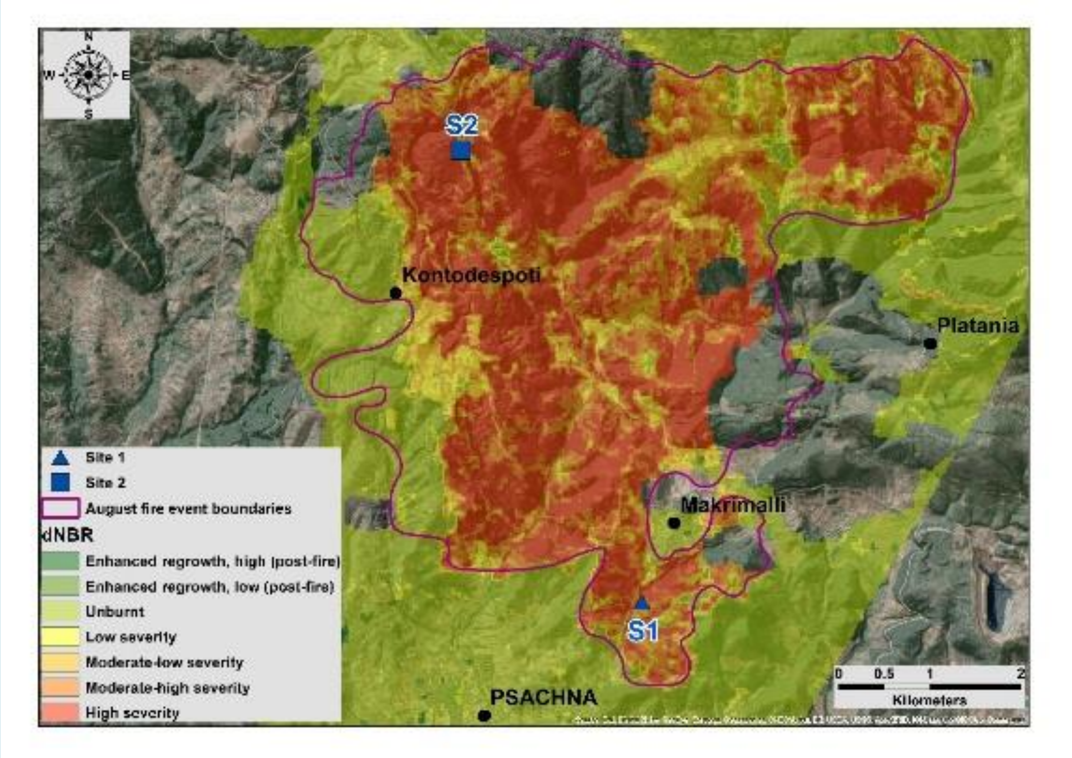
1. ALS (Airborne Laser Scanning)
2. TLS (Terrestrial Laser Scanning)
3. UAV (Unmanned Aerial Vehicle Photogrammetry)

This study presents the combined application of these two methods in the same sites, aiming to introduce the scientific community to a multi-source (TLS and UAV-derived) point cloud comparison at multitemporal perspective, under fast changing circumstances in terms of erosion and vegetation growth after a wildfire.

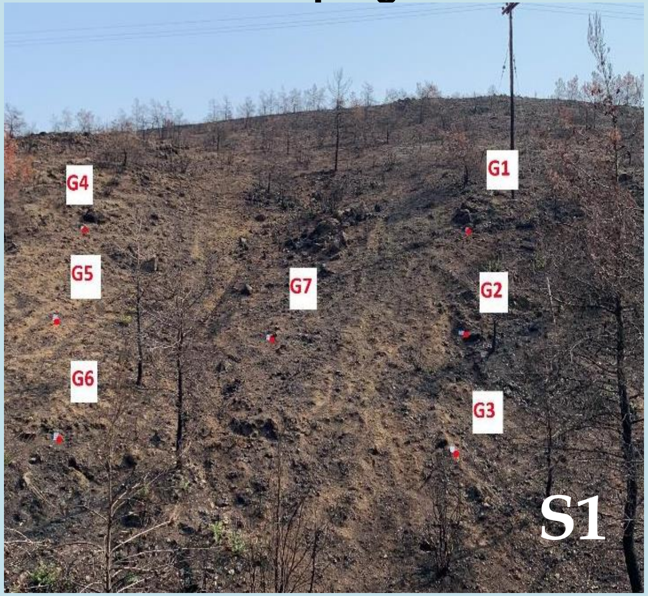
Study sites and Methods

Preliminary research included:

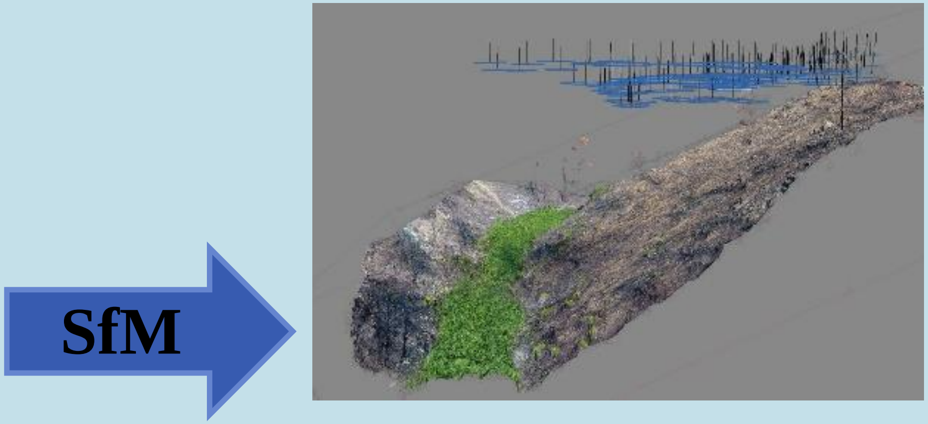
- **Study site selection (dNBR index)**

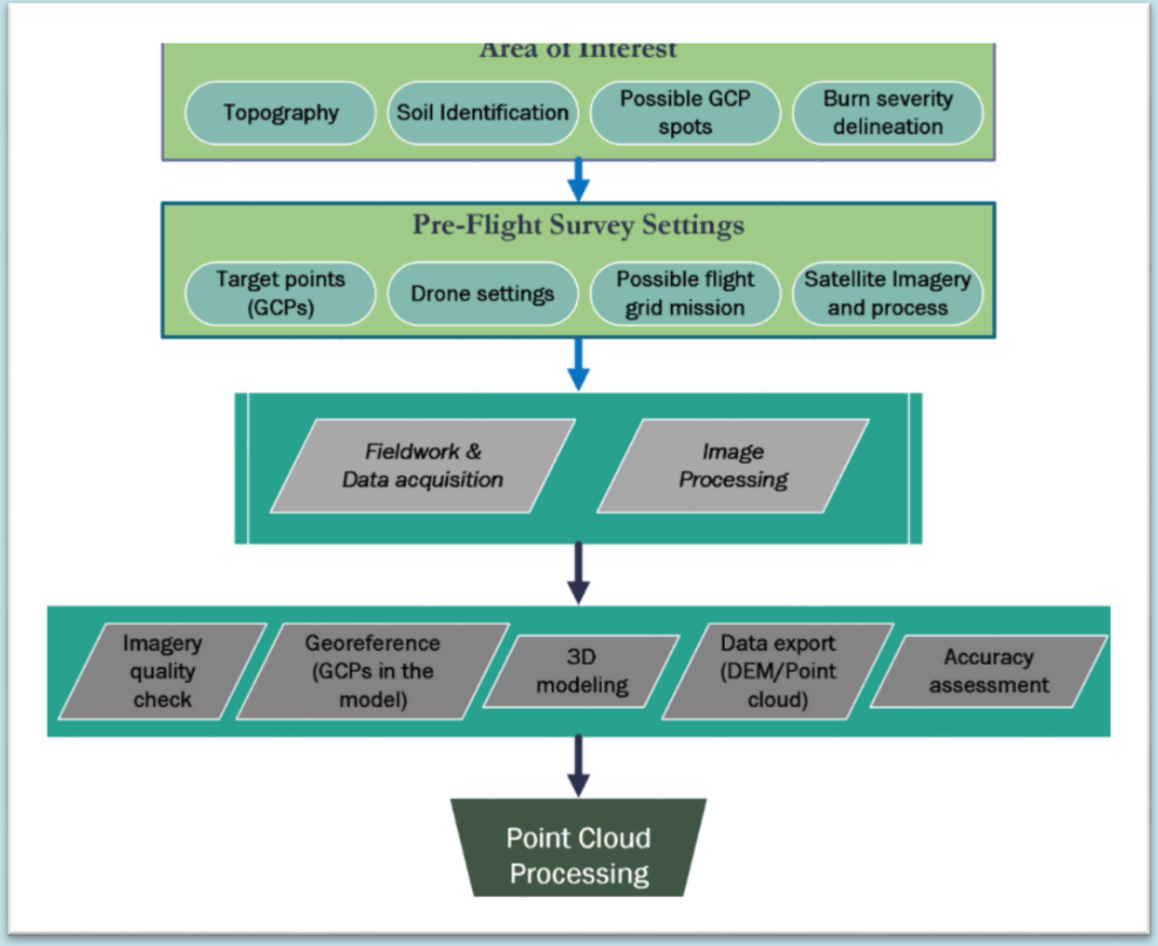


Three field campaigns were held (October 2019, February 2020 and October 2021)



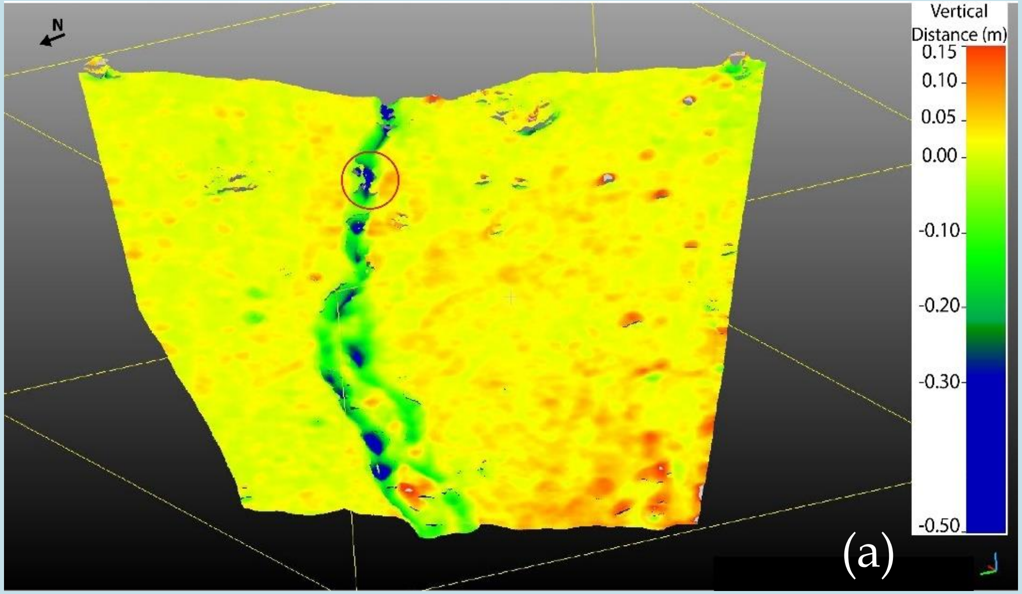
- **Point cloud analysis (derived from both DJI Phantom 4 and Ilris Optech t-LiDAR)**
- **Vegetation removal**
- **GCP registration**
- **The M3C2 algorithm**





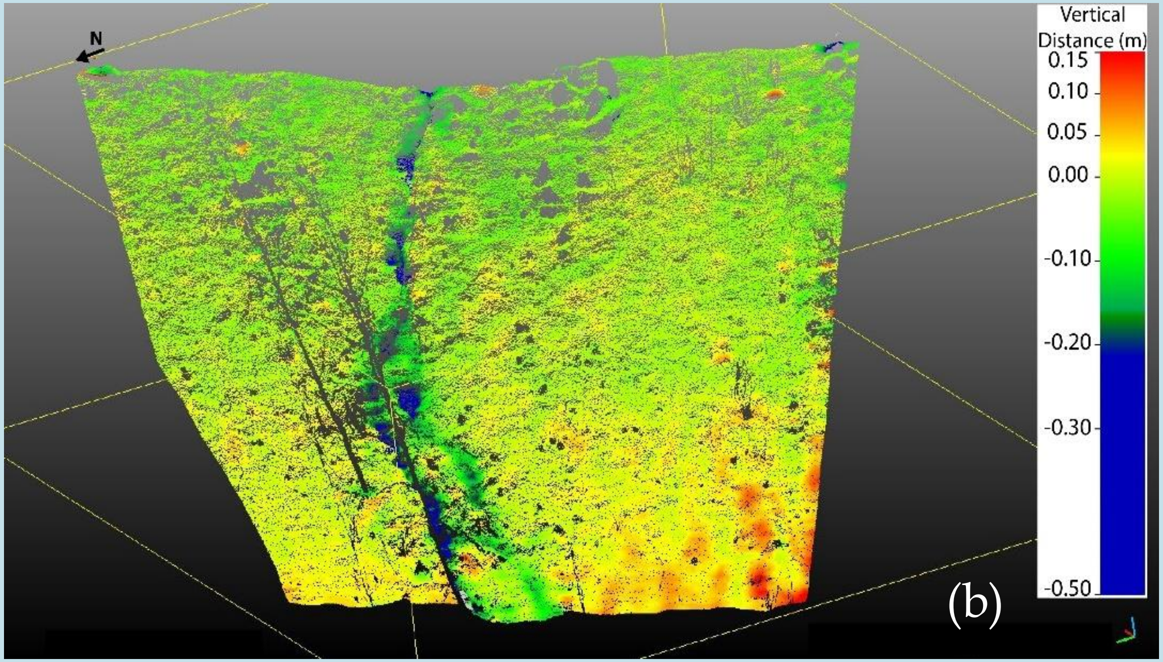
CASE STUDY

S1 total annual erosion (m)



UAV

tLiDAR



Alexiou et al 2021

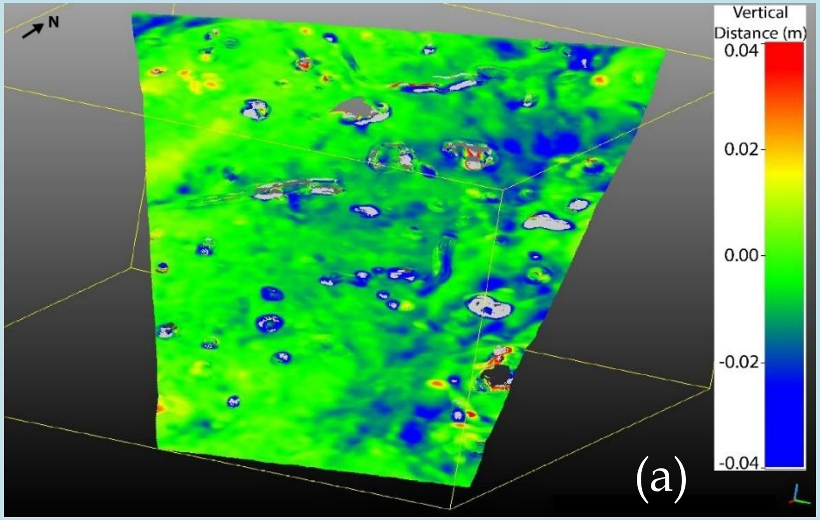
Dates		19/10/2019	23/02/2020	11/10/2020
(a) XYZ Error (m)	S1 SfM	0.02	0.02	0.02
	S1 TLS	0.02	0.02	0.02
(b) GCP registration error (m)	S1 SfM cloud	0.02	0.02	0.02
	S1 TLS cloud	0.03	0.03	0.025
	S2 SfM cloud	0.02	0.02	-
	S2 TLS cloud	0.03	0.03	-
(c) Number of points	S1 SfM	3,572,811	6,124,336	31,535,718
	S1 TLS	730,260	1,052,429	1,566,387
	S2 SfM	1,472,680	3,594,027	-
	S2 TLS	453,124	128,632	-
(d) Surface density (mean points/m^2)	S1 SfM	7676	13,234	67,881
	S1 TLS	2037	2924	4714
	S2 SfM	19,214	46,969	-
	S2 TLS	21,688	11,955	-

(a) Mean XYZ error (m), calculated by the GCPs (GNSS technique),

(b) (b) GNSS- registration error (m) of each point cloud

(c) (c) Total amount of points observed in each scan and

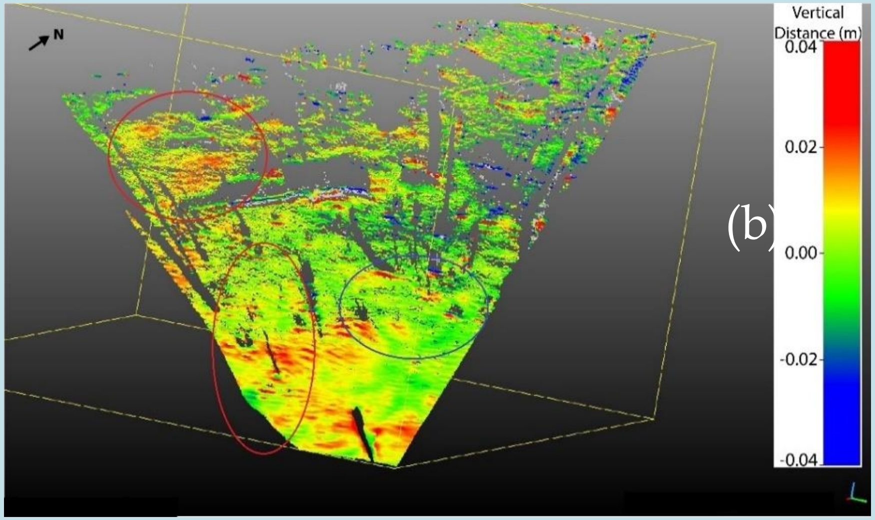
(d) (d) Density of the derived point clouds, demonstrating the mean number of points per m^2 of each point cloud.



S2 4-months erosion estimation

UAV

tLiDAR



Results

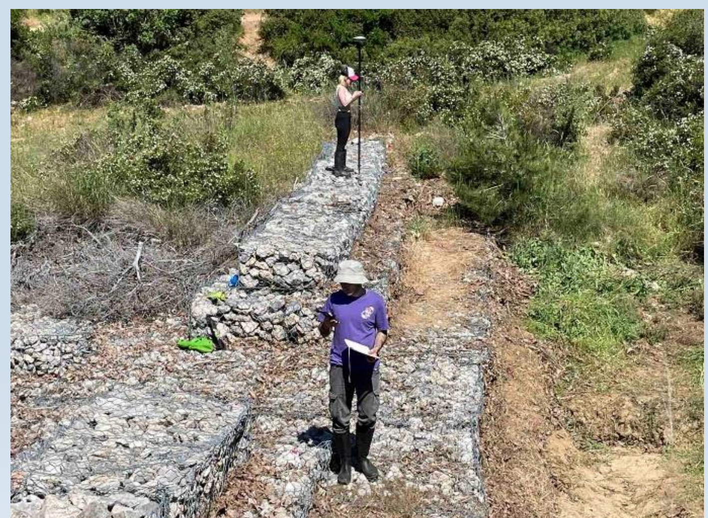
- Accurate estimation of soil erosion.
- A more precise local erosion assessment by UAV photogrammetry.
- TLS technique represents more accurately the total slope erosion rate.
- Erosion at S2 is precisely delineated by both methods, yielding a mean value of 1.5 cm within four months
- At S1, UAV-derived point clouds’ comparison quantifies annual local channel soil erosion more accurately, showing a maximum annual erosion rate of 48 cm

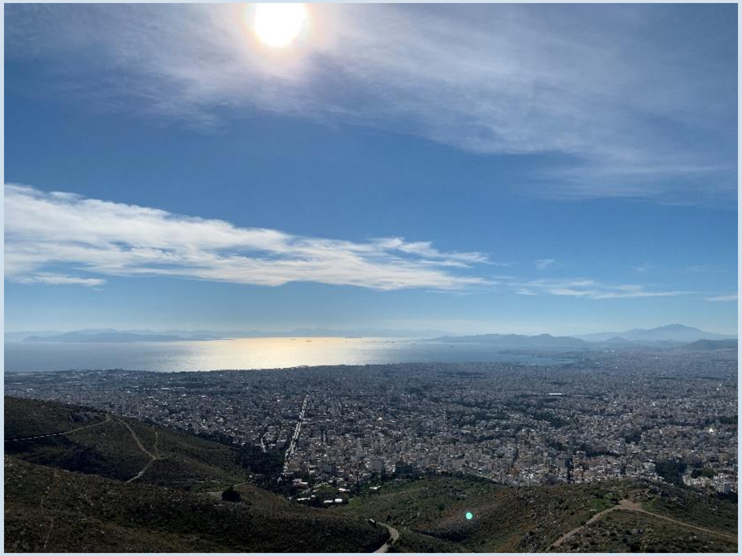
More details in Alexiou et al. 2021

Ongoing research: SOIL EROSION MODELING and VALIDATION PESERA-SWAT-RUSLE

VALIDATION?

Soil erosion monitoring





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Comparing High Accuracy t-LiDAR and UAV-SfM Derived Point Clouds for Geomorphological Change Detection

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Conclusions

✓Our study introduces the scientific community to a multi-source (TLS and UAV-SfM-derived) point cloud analysis at multitemporal perspective under fast changing environments such as erosion-prone areas.

✓UAV based photogrammetry is a more suitable, cost-effective technique when focusing on <u>local erosion</u> rates (representing sites of maximum channel erosion), while TLS approach appears to be more accurate when focusing on <u>slope wash</u>. However, TLS performed better in total erosion rate computation, compared to UAV based photogrammetry, due to the existence of grass height of 1–2 cm.

✓Shadow effect due to the line-of-sight angle of the TLS considered a great issue where scan position change is limited.

✓High accuracy soil erosion validation is ongoing.

Thank you for your attention

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Operational Programme Human Resources Development, Education and Lifelong Learning

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