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## Surface elevation change monitoring in northern Tunisia using multi-temporal photogrammetric imagery

Imen Brini, Denis Feurer, Riadh Tebourbi, Damien Raclot, Fabrice Vinatier,  
Riadh Abdelfattah

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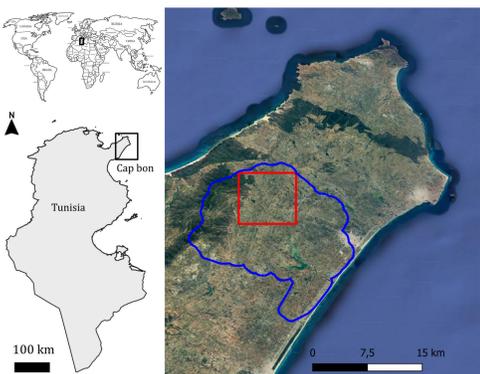
## Introduction

The **landscape pattern** heterogeneities, in both structure and composition, reflects **past events** driven by **natural** and **man-made processes** (Wilson, 2012). **Detecting** and **estimating** these patterns is crucial to understand the **processes** behind them (i.e. erosion, morphological changes, vegetation growth, anthropization ...).

The hypothesis is that **landscape** patterns have a specific **topographic signature** that **varies** over **time** and can be revealed using **photogrammetric** techniques. The **SfM-MVS** photogrammetric algorithms are commonly used for **3D reconstruction** (Eltner et al., 2016), promoting for 3D change detection. The main **aim** of this work is to **explore** the ability of **SfM-MVS** algorithms to precisely co-align point-clouds derived from **multi-temporal** datasets in order to **detect** potential **changes** in land surface.

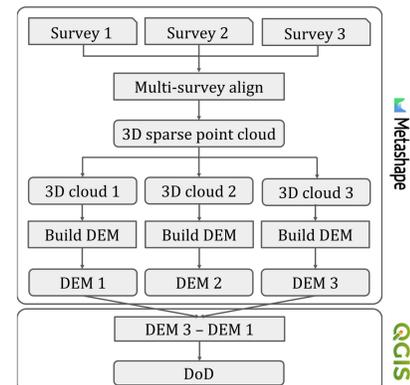
## Study area and datasets

The tri-stereo **Pleiades** satellite images were acquired in **2015**, **2018** and **2023** with a spatial **resolution** of **50 cm** for **panchromatic** channel, covering a part of the eastern coastal plain in **northeastern Tunisia**, the Lebna dam watershed (in blue). The area of interest is framed with the red box.

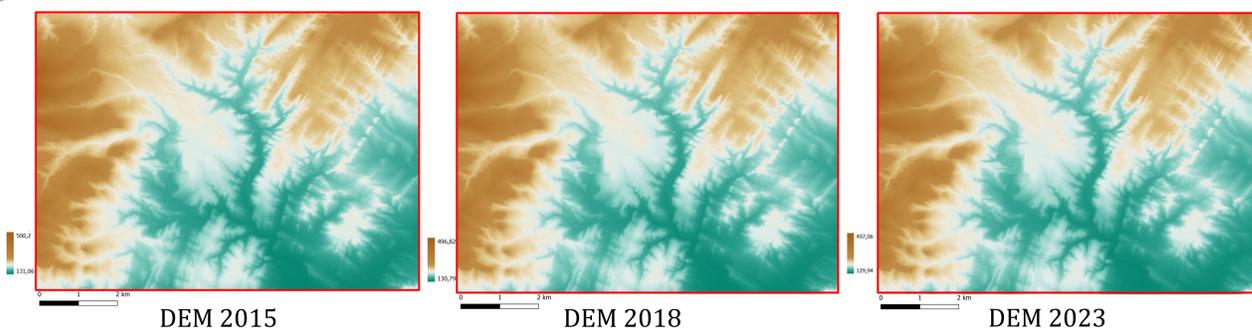


## Processing method: Time-SIFT

The workflow consists on **processing images** from **different epochs** in a **single block** to compute **geometrically coherent** multi-temporal point clouds. Images of different epochs are then separated and the **dense matching** steps are performed with images of the same epoch (Feurer & Vinatier, 2018). Computing the **DEM of Difference (DoD)** can be implemented within a geographic information system (**GIS**) environment.



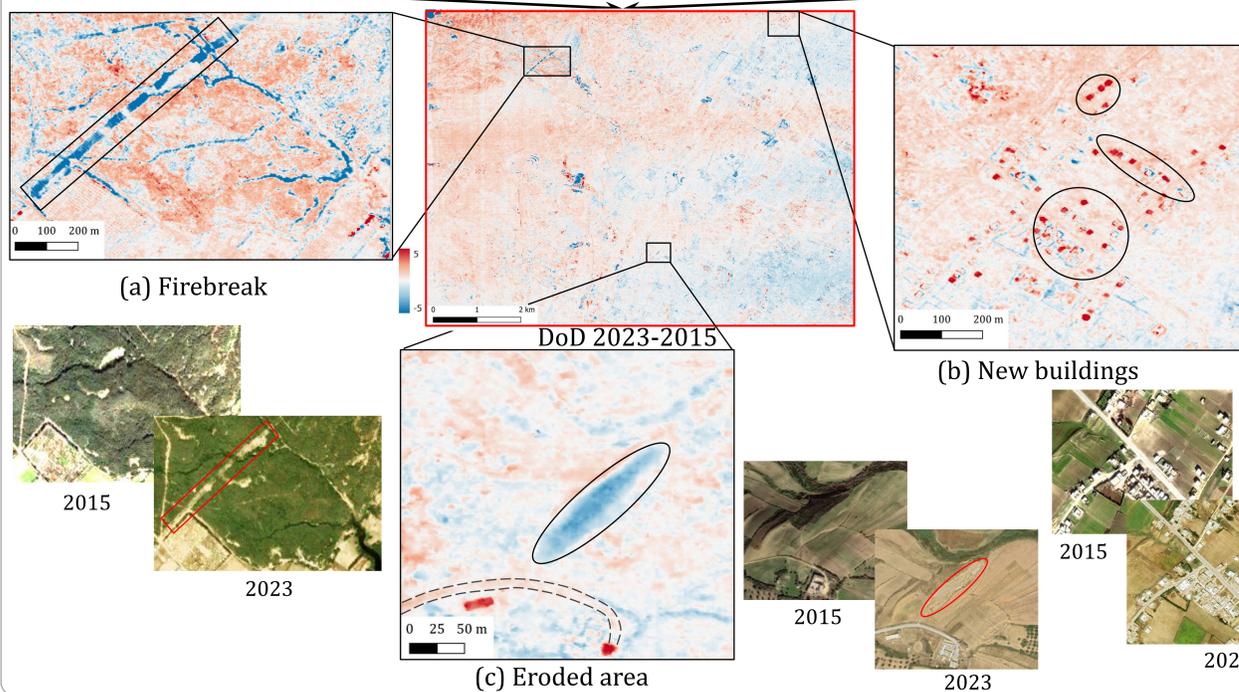
## Results



**Agisoft Metashape Pro** managed to **co-align** the 3 surveys, and derive 3 digital elevation models (**DEMs**) for each survey.

The root mean square reprojection errors of the surveys is averagely 0.47, 0.61, and 0.68 (pix) for 2015, 2018, and 2023 respectively.

The **DEMs** have a spatial **resolution** of **1m**, depicting some building shapes and different landforms.



Although the DoD between 2023 and 2015 shows a systematic error (wavy effect), some **3D changes** can be identified:

- (a) **Firebreak** that was checked using Google satellite imagery.
- (b) **New constructed buildings** that were checked using Google satellite imagery.
- (c) **A potential eroded area** (hardly visible in 2D imagery) that can be explained by two hypothesis:
  - A newly constructed road (framed with dashed grey lines) has enhanced runoff,
  - Some soil was extracted for construction purposes.

## Conclusion and perspectives

The results show that **SfM-MVS** techniques are **suitable** for the alignment of the **Pleiades** satellite datasets, and the generation of the DEMs. However, these results are preliminary and still need **further processing** to eliminate the wavy effect on the DoD. Adding ground control points (GCPs) to the same workflow is a potential perspective to resolve this issue.

Advanced researches will be conducted in order to **develop** an **automatic method** for **recognizing** these **3D changes** in the land surface.

## References

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 Feurer, D., & Vinatier, F. (2018). Joining multi-epoch archival aerial images in a single SfM block allows 3-D change detection with almost exclusively image information. *ISPRS Journal of Photogrammetry and Remote Sensing*, 146(July), 495–506.