



Contribution of InSAR coherence images to evaluate surface elevation change detected from multi-temporal photogrammetric imagery

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Introduction

The **landscape** pattern and topography are **affected** by **natural events** and **anthropic processes**. Detecting and estimating these topographic changes is crucial for understanding the underlying processes.

The **combination** of various datasets obtained from different **remote sensing approaches**, each with specific resolution, enables the detection of **3D** surface elevation **change**.

The **aim** of this work is to **explore** the **potential** of **InSAR** data to validate the **detected changes** in the 3D Earth surface, extracted from the **photogrammetric** approach.

Material and methods

The **study area** is the **Lebna watershed**, located in the coastal plain in northeastern Tunisia, in the **Cap Bon** peninsula. This watershed is prone to **soil erosion** mostly enhanced by agricultural practices and Mediterranean climate (Mekki et al., 2018).

The **tri-stereo Pléiades** satellite images were acquired in **2015, 2018** and **2023** covering the Lebna watershed. These images were processed using **Agisoft Metashape Pro 1.6.3.** based on the **Time-SIFT** photogrammetric approach introduced by Feurer & Vinatier (2018) to derive digital elevation models (**DEMs**). The DEM of differences (**DoD**), calculated by **subtracting** the 2023 DEM from the 2015 DEM, using **QGIS**, allows **detecting** geomorphological **changes**.

A total of 154 **Sentinel-1** images, covering the study area, from **2017** to **2022** were processed using the advanced DInSAR technique known as Parallel-Small Baseline Subset (**P-SBAS**) approach (Casu et al., 2014). This approach uses small temporal and spatial baselines to limit the decorrelation phenomena. The Sentinel-1 images were processed using P-SBAS InSAR S-1 service implemented in Geohazard Exploitation Platform (**GEP**).

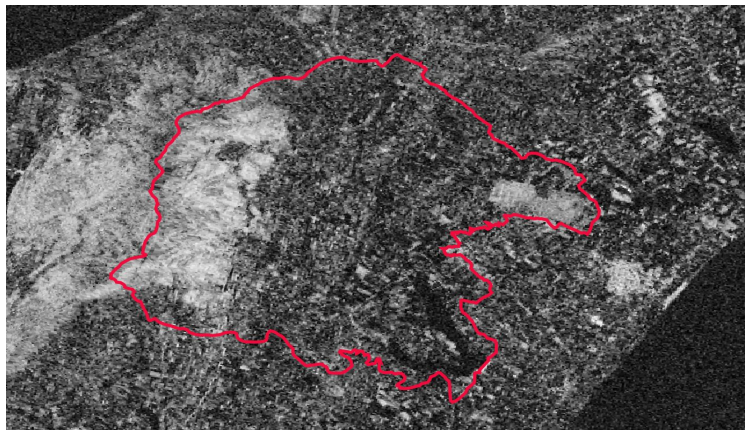


Results

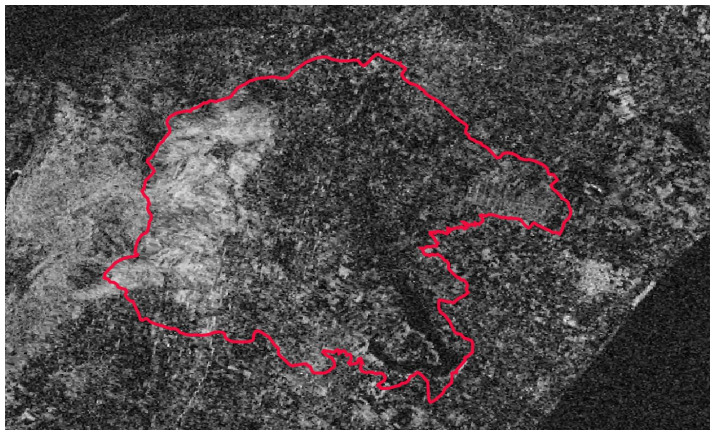
The derived **DEMs** for the satellite images have a **spatial resolution of 1m**, showing different landforms. The **DoD** between 2023 and 2015 shows some **3D changes** such as eroded areas, excavations, newly constructed buildings ...

The **InSAR** imagery products were used to **compare/validate** the **results derived** from the **photogrammetric** approach.

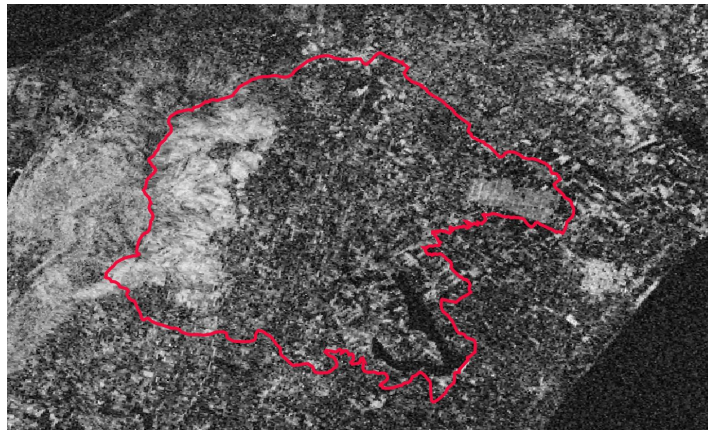
In this study, three **coherence images**, following the **flooding** event that happened on mid October **2018**, were used.



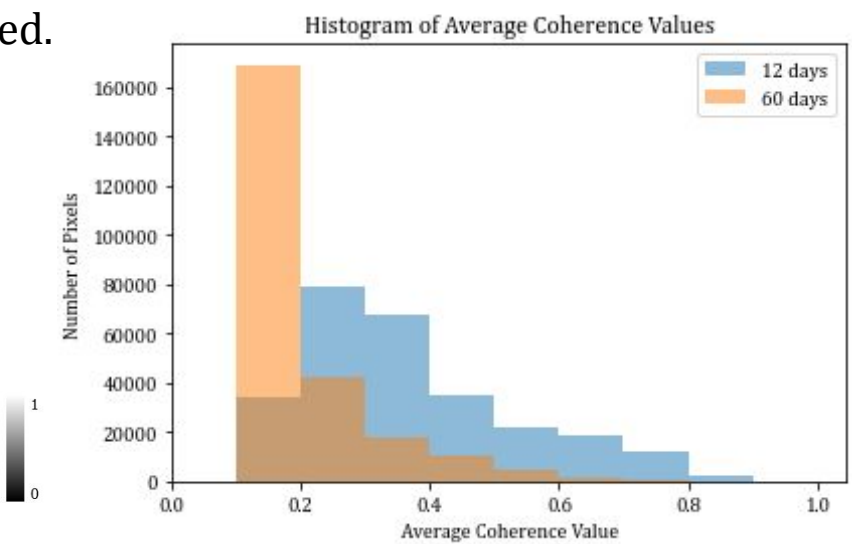
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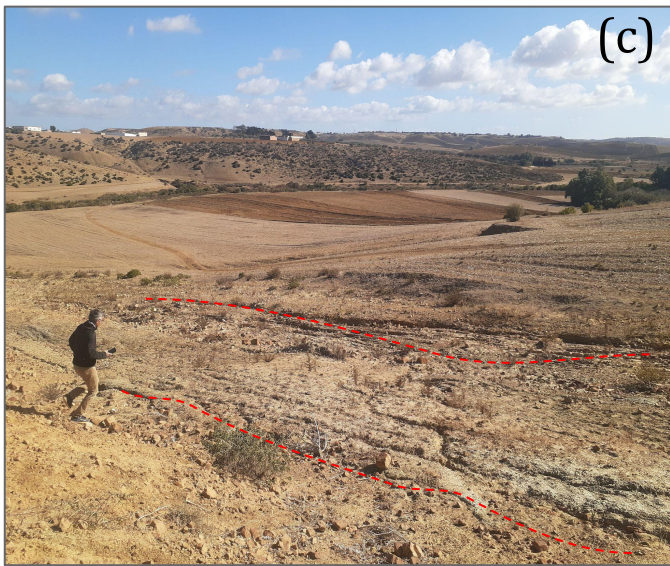
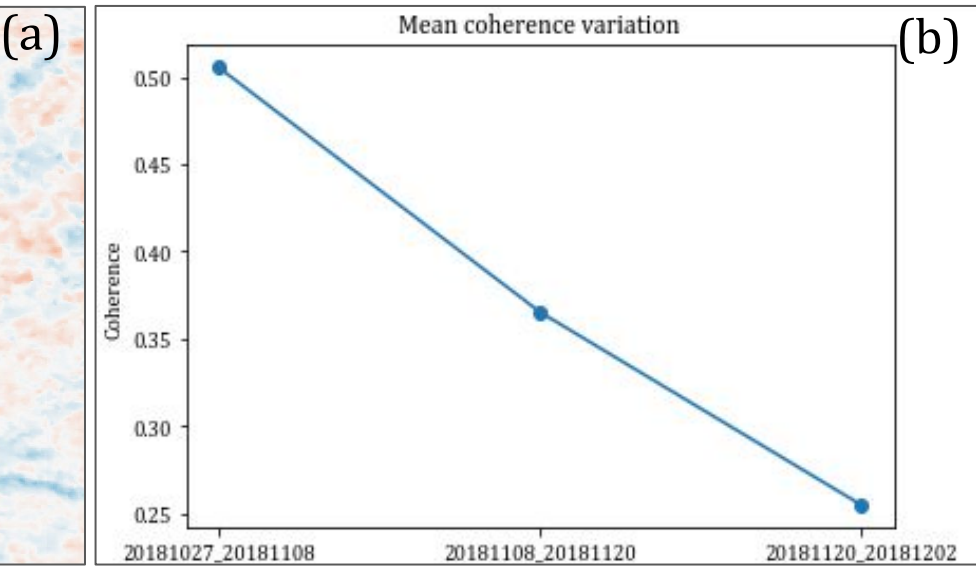
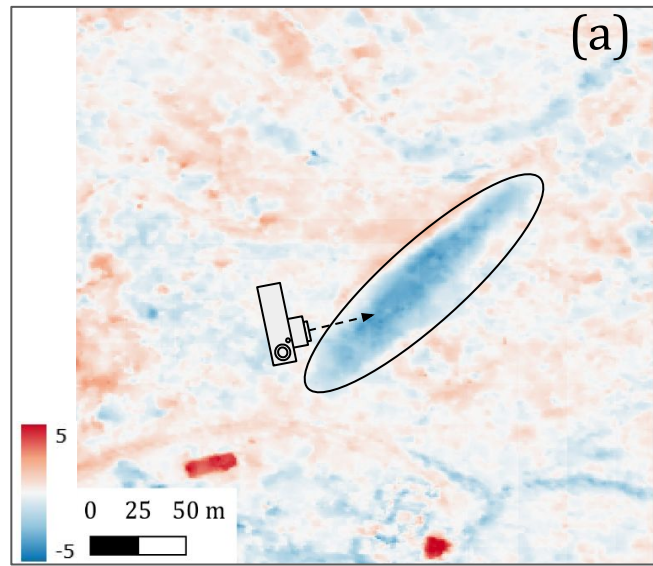


20181120_20181202



The change of coherence due to temporal baseline change appears to be relatively progressive within the study area. The 12-days **coherence** pairs are expected to be **sensitive** to detect the **potential changes** in the earth surface, with coherence values between 0.1 and 0.9. Using longer temporal baseline pairs could potentially lead to a decrease of sensitivity, with most values remaining between 0.1 and 0.3. Although the temporal baseline was within 12 days, the mean coherence was around 0.36.

For an identified **eroded area** on the **DoD** (2023-2015), the mean **coherence values** are gradually **decreasing** indicating that a ground variation occurs between the SAR acquisitions modifying the structure of scattering targets.



(a) Zoom-in of the DoD, the eroded area is framed in black
(b) Coherence variation for the eroded area
(c) Field observation of the eroded area (framed with dashed lines in red): bare ground and potential signs of surface changes.
The position and view angle the photo (c) is marked in (a) with a camera icon and an arrow

Conclusion and perspectives

The **interpretation** of the **coherence** variation should be **approached carefully**. Several **components** can **contribute** to its **value**, such as the viewing geometry, evolution of vegetation cover, soil roughness and soil moisture changes.

Further **investigation** on the **decomposition** of the **coherence** according to the above mentioned decorrelation factors is required to explore the changes related to environmental processes such as erosion, by refining the extraction of the erosion information from other signals. To complement erosion detection from coherence images, **integrating precipitation dataset** could helps in understanding the environmental conditions that contribute to soil erosion.

References

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