EVALUATION OF SAR INTERFEROMETRY FOR DEM GENERATION OVER FORESTED AREAS

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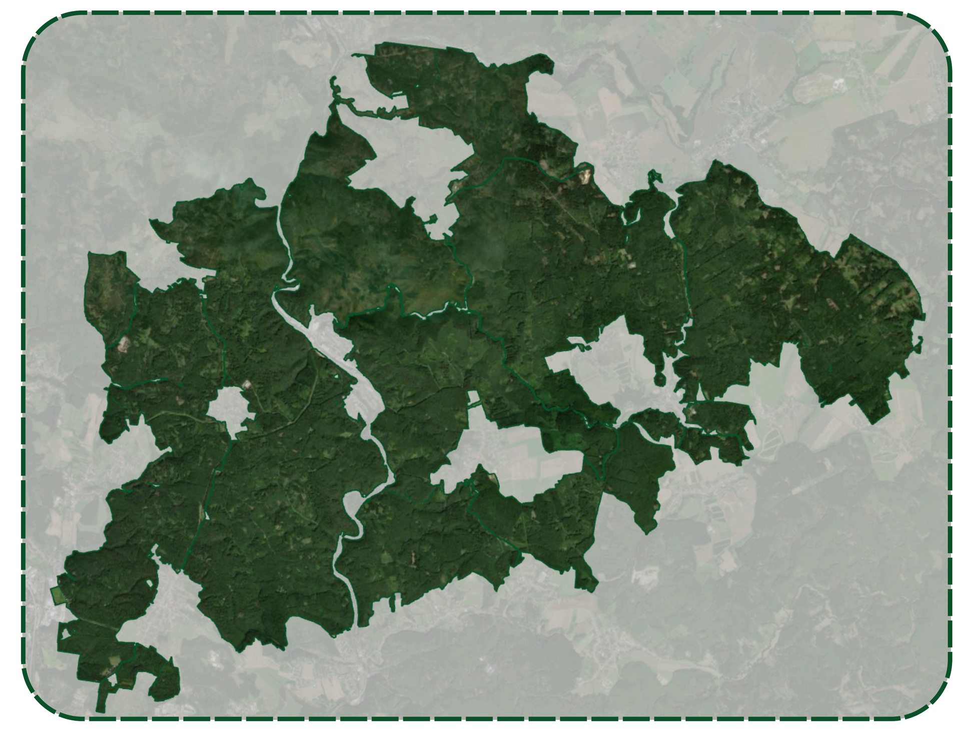
INTRODUCTION

The focus of this project dealt with the possibilities of forest heights assessment using radar polarimetry and interferometry of SAR (synthetic aperture radar). LiDAR remote sensing is commonly used to make high-resolution maps because of its narrow beam, to derive information about canopy cover, height, leaf area index, vertical forest structure, species identification, and others; but because of its optical sensors, LiDAR is dependent on reflected light to capture images, whereas Radar polarimetric interferometry, which uses SAR (synthetic-aperture radar) data for mapping, can detect how the backscattering is occurring, which means they can work through darkness or cloud cover.



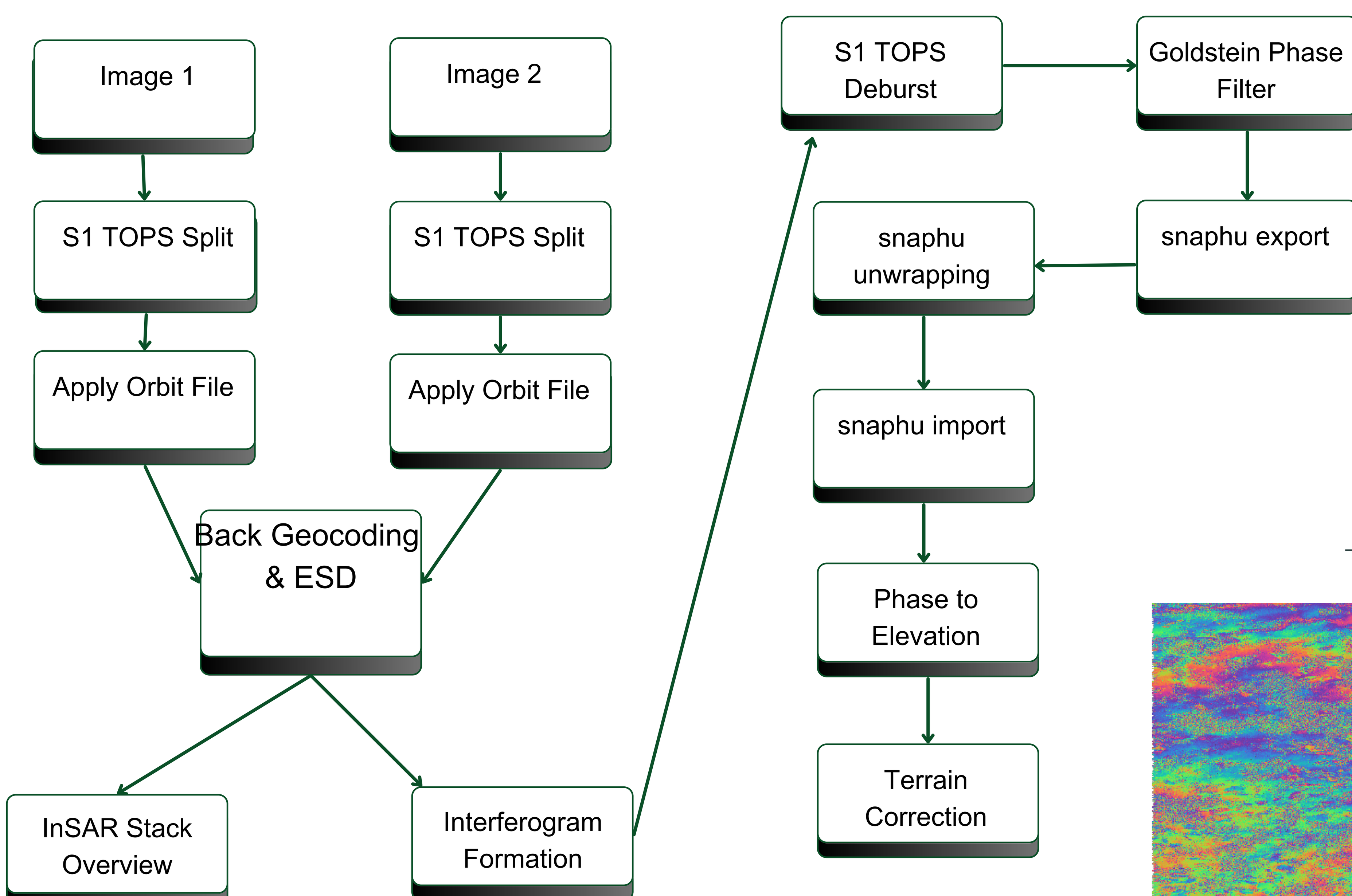
OBJECTIVE

Produce Digital Elevation Model of Training Forest Enterprise (TFE) using InSAR and evaluate its feasibility as a vegetation height derivation source based on comparison to LiDAR-based DEM.

AOI

The Training Forest Enterprise Masaryk Forest Křtiny is an organizational unit of Mendel University in Brno and a special-purpose facility of its Faculty of Forestry and Wood Technology. The total area is 10,495 ha. The forest cover is approximately 98%.

DEM GENERATION FROM SENTINEL-1 SLC DATA



INSAR METHODOLOGY

According to well-established methodology [1], DSM is generated using SAR Interferometry with Sentinel-1 Toolbox in the SNAP application. After acquiring two (or more) IW SLC images from Copernicus Open Hub, a stack containing both products is created (Coregistration). After that, sub-swaths that are required for the analysis is selected (TOPS Split) and prepared for Interefrogram formation, according to the [2]. Phase Unwrapping operator is used to provide a measurement of the actual altitude variation. To get the metric measurements from the unwrapped phase, the phase is translated into surface changes along the line-of-sight with the help of the Phase to Displacement Operator. Finally, after correcting SAR geometric distortions, the DSM image is exported, ready to be differenced by DEM (SRTM), for generating the height layer of the trees.

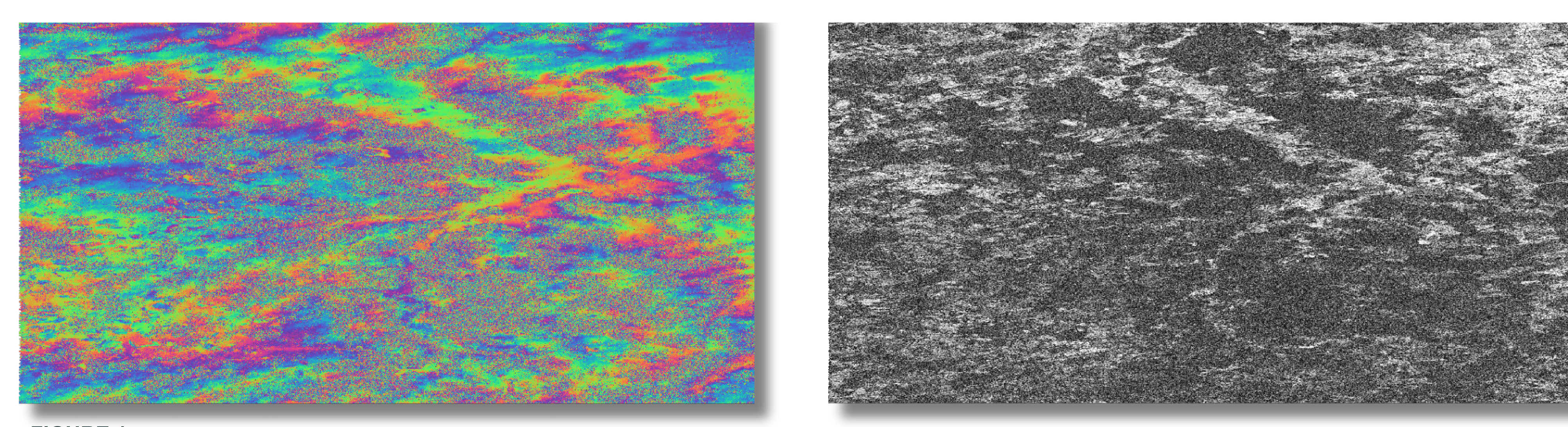


FIGURE 1
Succsessfully formed Interferogram of SAR image pairs (left), coherence of the succsessful interferogram (right)

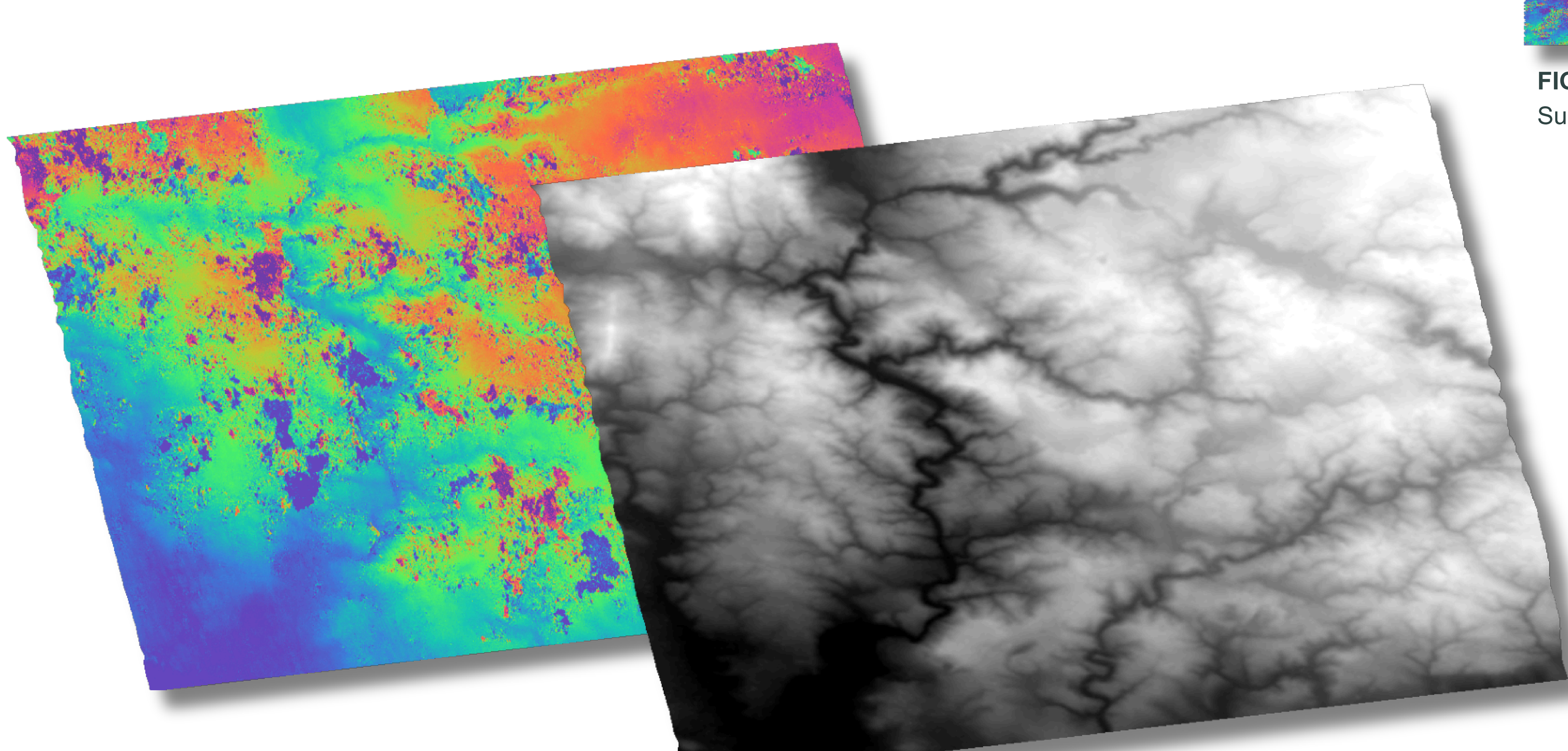


FIGURE 3
Unwrapped phase (left) and generated DEM of Inteferogram (right)

FIRST SUCCESS AND SUBSEQUENT CHALLENGES

The process of phase unwrapping proved to be challenging and prone to myriads of errors. Interferograms tend to depend heavily on temporal and spatial baselines between two images, seasonality of acquisition dates and atmospheric conditions amongst many. Even if the interferogram was formed succsessfuly, many times the quality of generated DEM was above acceptable.

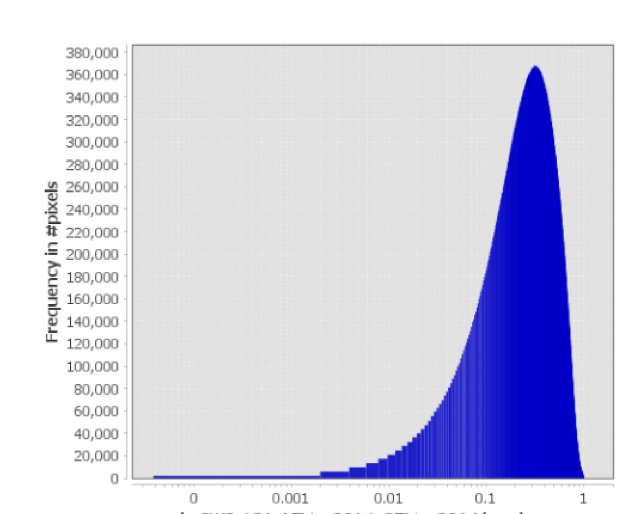


FIGURE 2
Histogram of coherence for InSAR Image

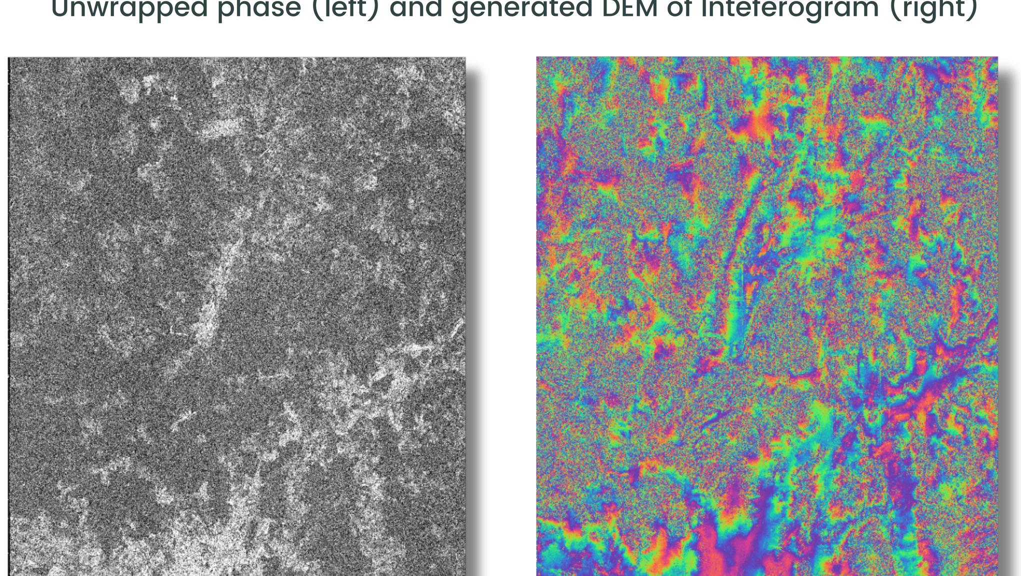


FIGURE 4
Unsuccessfully formed Interferogram of SAR image pairs (left), coherence of the unsuccessful interferogram (right)

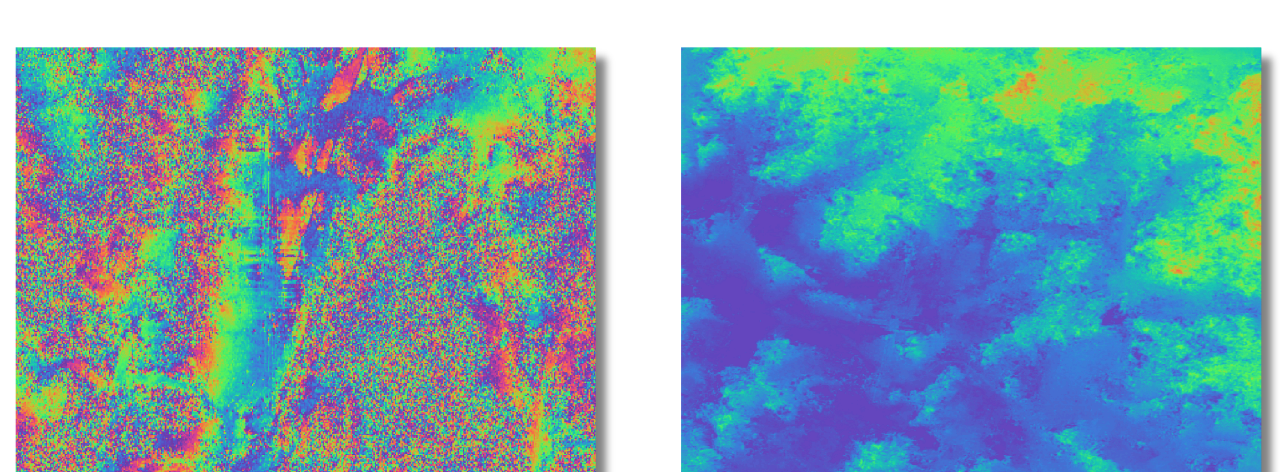


FIGURE 5
Artefacts in inteferogram (left) and unwrapped phase (right)

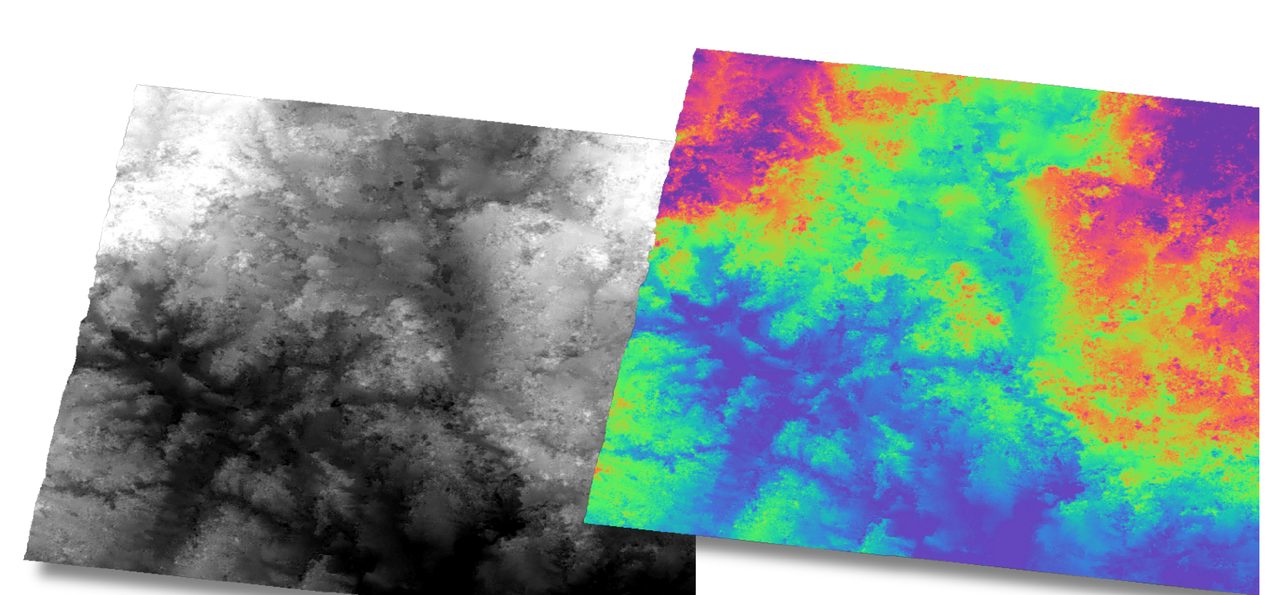


FIGURE 6
Unsuccessfully generated DEM (left) of Inteferogram and unsuccessfully unwrapped phase (right)

CONCLUSION

The process of DEM generation from Sentinel 1 SAR imagery proved to be complicated, but still completely feasible way of DEM generation. More research will be done to provide best possible metholodogy of SAR DEM generation over forested areas.

RELATED LITERATURE

1.15.Burgmann, R, A.; Rosen, P, J.; Fielding, E. Synthetic Aperture Radar Interferometry to Measure Earth's Surface Topography and Its Deformation. Earth Planet

2.Braun, A. (2021): Retrieval of digital elevation models from Sentinel-1 radar data – open applications, techniques, and limitations. Open Geosciences, 13(1), 532-569. doi:10.1515/geo-2020-0246

ACKNOWLEDGEMENT

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