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# TERRAIN RESTITUTION IN VEGETATED TERRACED LANDSCAPES FROM SFM OR LIDAR:

## TOWARDS A SPECIFIC DSM/DTM FILTER

JEAN-STÉPHANE BAILLY, ANTON PIJL\*, DENIS FEURER AND PAOLO TAROLLI



### RATIONAL AND OBJECTIVES

Long-term observation systems which monitor Mediterranean cultivated rainfed areas often focus on physical processes and areal land use monitoring. However, full understanding of these processes - especially for long-term periods - also require the monitoring of anthropogenic landscape structures that can have high impacts on fluxes and can change over time, and for which methods providing spatial data are lacking. Recent progresses in 3D mapping and geomorphometry give new insights into this monitoring issue [1].

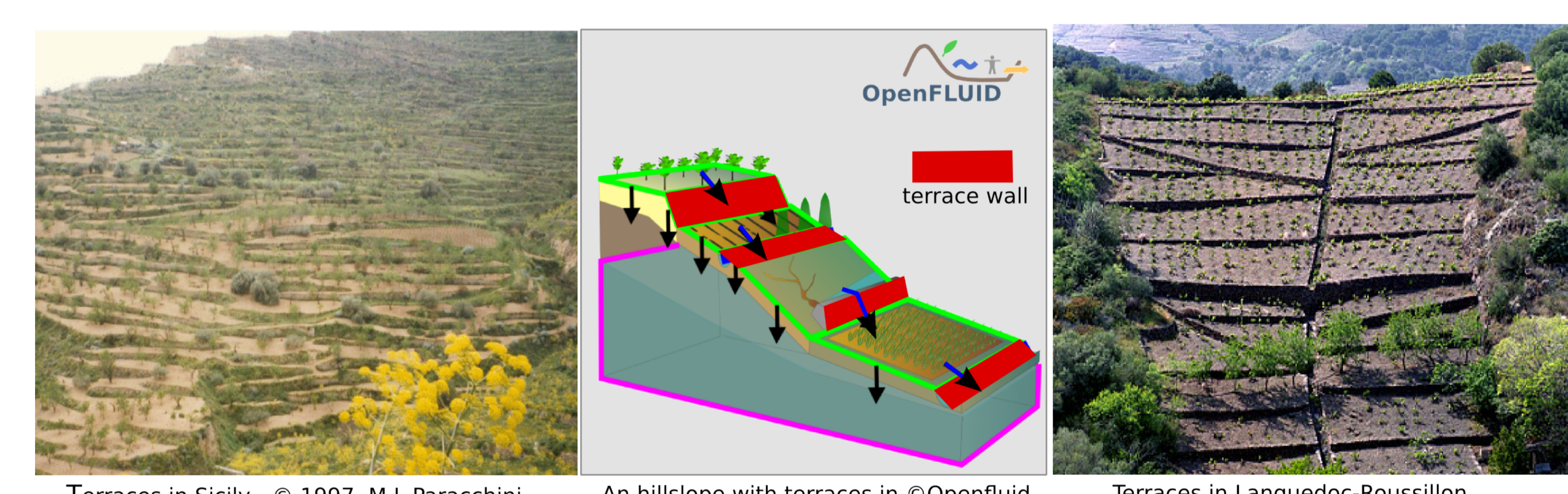
Amongst the artificial structures used for soil and water conservation, Mediterranean farmers have adopted terraces from Roman times [2]. Indeed, terraces decrease slope intensities and lengths favour infiltration. The spatial pattern of terrace walls is heterogeneous and depends on natural terrain slope. In erosion and hydrological studies, maps of terraces walls may be needed [3].

Methods to automatically delineate terraces from high resolution DTM were already proposed [4]. However, an accurate terrain restitution in vegetated terraced landscapes from SfM or LiDAR points clouds, where terrace front is usually located under vegetation (hedges, vine lines, etc) is still an open question, even from very high resolution data and with data acquired at the leaves-off period.

Most of existing DSM/DTM filtering based on slope gradient [5], or vegetation 3D geometry properties [6] usually fail to filter the vegetation while preserving the terrace front and foot geometry properties.

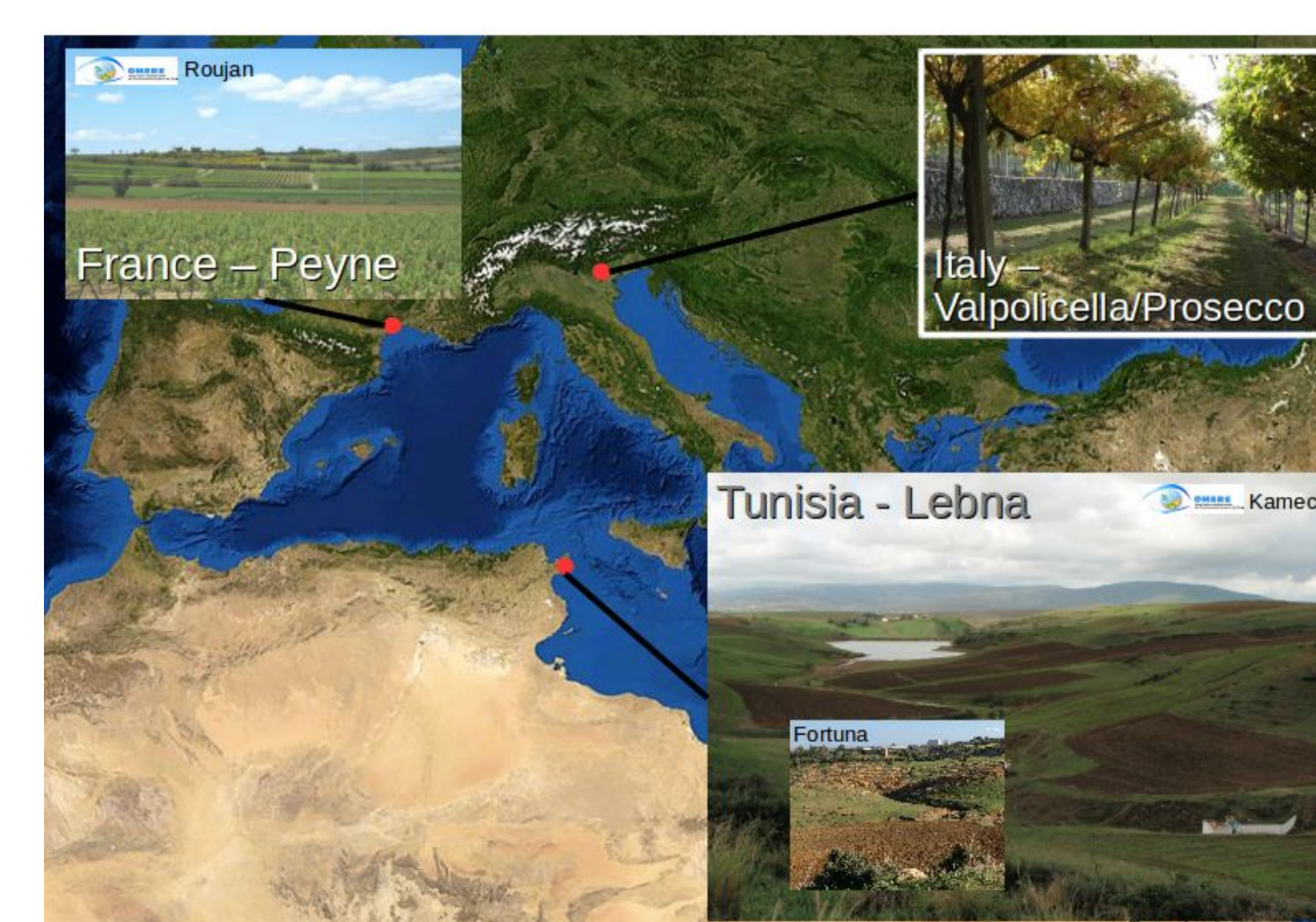
To narrow the scope of this work, the questions addressed are the following:

- Are very high resolution DEMs coming from LiDAR or UAV-based SfM point clouds suitable and accurate enough to map and diagnose the vegetated terrace of cultivated Mediterranean landscape ? And
- How to process the DSM/DTM filtering in terraced landscape to overhang vegetation while preserving the terrace front/foot morphology?



### THE HIGHLANDDEM PROJECT

Recent progresses in 3D mapping and geomorphometry give new insights into the cultivated landscape structures monitoring issue. Teams joined in the HighLandDEM project have each developed techniques for 3D mapping and/or artificial structures mapping, from very-high resolution Digital Elevation Models (DEM) and the HighLandDEM project is an unique opportunity to share, disseminate, cross-validate these techniques and also to evaluate their performances for different cultivated rainfed areas throughout the Mediterranean area and different DEM resolution coming from various technics. Expected results of the HighLandDEM project are the development of robust methods of cost-efficient high-resolution DEM generation and artificial linear structures mapping from ultra-fine DEMs. These will form new inputs for long-term monitoring systems and provide cutting-edge tools for water and soil resources management.

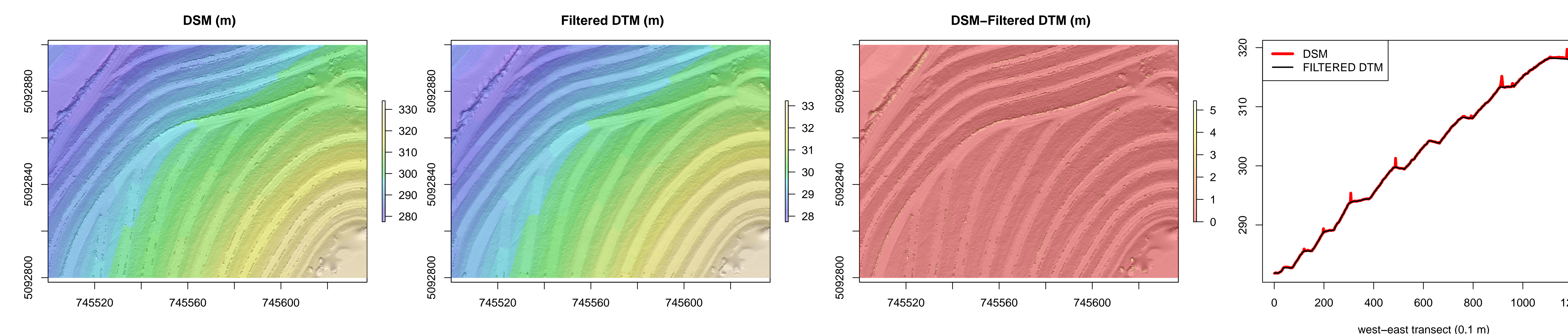


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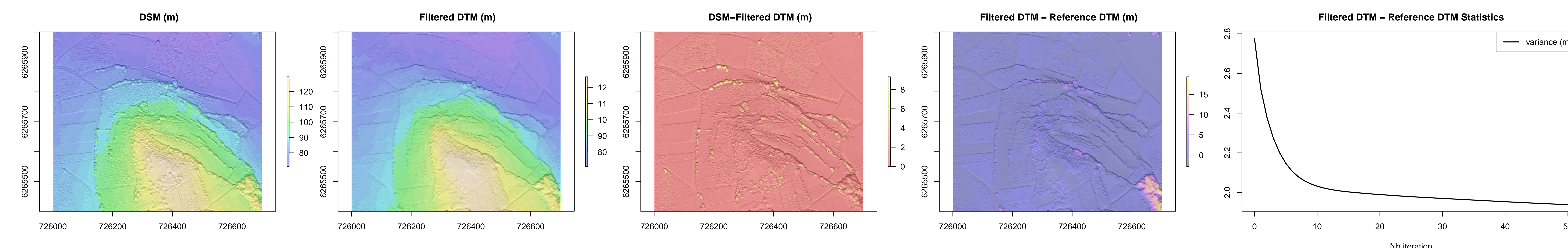
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### PROSECCO SITE: 0.05 M DSM (SfM FROM UAV)



Preliminary results applying the Terrace DSM/DTM filter (parameters :  $p = 3, n = 10, \eta = 20$ ) on the Prosecco 0.05m DSM: 1- Initial DSM ; 2- Obtained filtered DTM ; 3- Difference between DSM and filtered DTM ; 4- Transect over an hillslope showing all remaining vegetation filtering (vine) over terrace front while preserving the terrace slope geometry.

### ROUJAN SITE: 1M DSM (AIRBORNE LIDAR)



Preliminary results applying the Terrace DSM/DTM filter (parameters :  $p = 3, n = 50, \eta = 10$ ) on the Roujan 1m DSM: 1- Initial DSM ; 2- Obtained filtered DTM ; 3- Difference between DSM and filtered DTM ; 4- Difference  $d$  between DTM and a reference DTM obtained after manual vegetation filtering ; 5- Evolution of standard deviation of  $d$  depending on  $n$ . Results show : i) few required iteration (10) ii) vegetation filtering over terrace front for thin vegetation patches (hedges, vine lines) iii) remaining vegetation for large patches.

### METHODS: THE "TERRACE" DSM/DTM FILTER

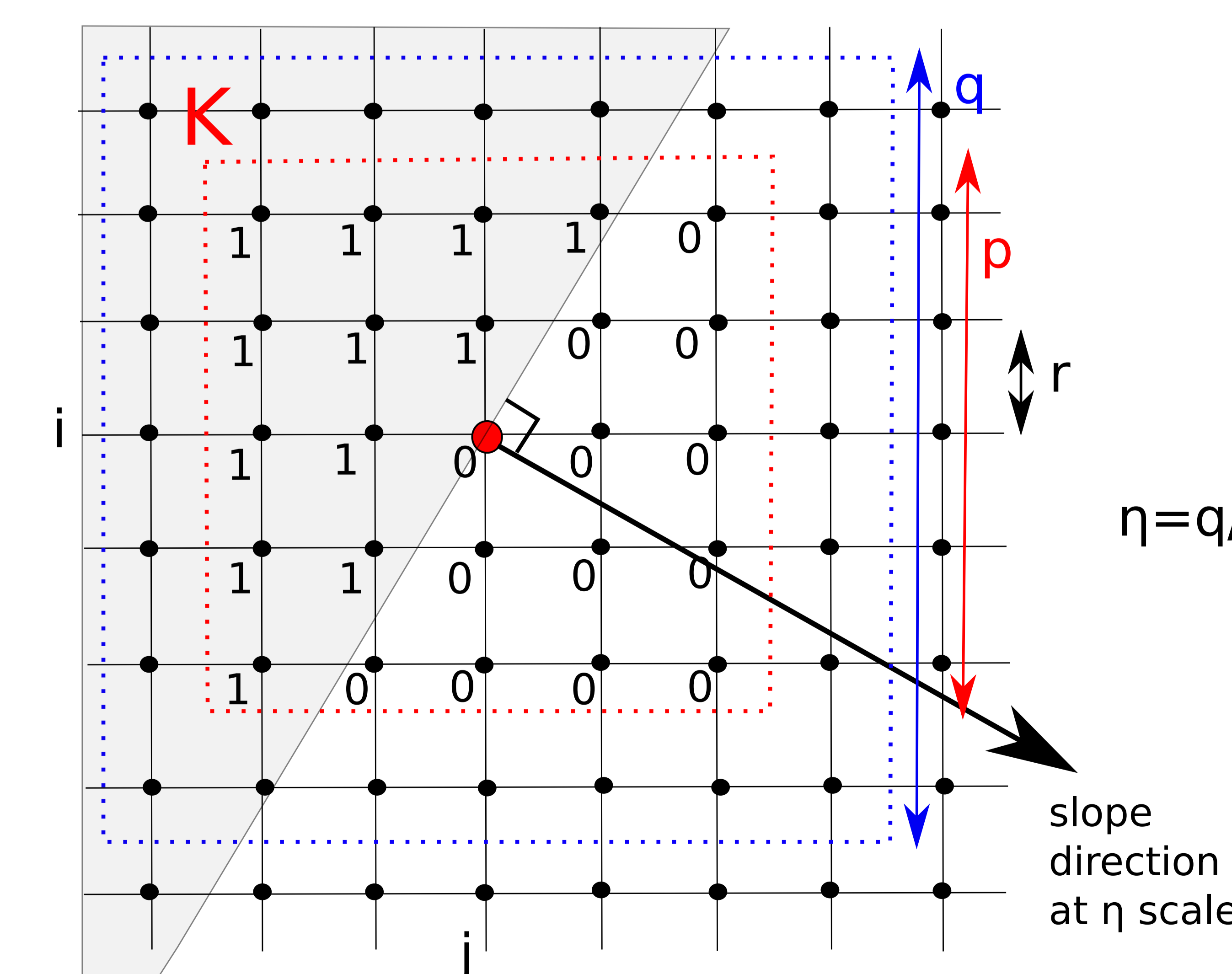
The Terrace developed filter acts as a "scraper" erasing vegetation or oversoil element in the slope direction at each DSM grid node. It computes first a slope direction at coarser resolution from the same DSM avoiding slope noising resulting from vegetation.

The Terrace developed filter is an iterative focal anisotropic filter. Anisotropy, for each grid node  $(i, j)$  at a given iteration, comes from null weights given to all neighbouring nodes at  $p$  level which are located in the opposite direction of the slope aspect beside the  $(i, j)$  node (downstream). The slope aspect is computed at coarser resolution with the  $\eta$  aggregation factor. This filter acts as an erosion morphological filtered but locally directed along the slope.

At each iteration  $k$  over the grid, the value  $Z$  on grid node  $(i, j)$  is computed as:

$$Z_k(i, j) = \operatorname{argmin}(Z_{k-1}(i, j), K_{i,j}(p, \eta))$$

with  $K_{i,j}(p, \eta)$  is the local kernel at  $(i, j)$  grid node depending on  $p$  and  $\eta$  parameters which is function of local slope aspect (See figure on the right).



### REFERENCES

- [1] Giulia Sofia, Giancarlo Dalla Fontana, and Paolo Tarolli. High-resolution topography and anthropogenic feature extraction: testing geomorphic parameters in floodplains. *Hydrological Processes*, 28(4):2046-2061, 2014.
- [2] Paolo Tarolli, Federico Preti, and Nunzio Romano. Terraced landscape: from an old best practice to a rising land abandoned-related soil erosion risk. In *EGU General Assembly Conference Abstracts*, volume 15, page 3355, 2013.
- [3] Francesc Gallart, Pilar Llorens, and Jerome Latron. Studying the role of old agricultural terraces on runoff generation in a small mediterranean mountainous basin. *Journal of Hydrology*, 159(1-4):291 - 303, 1994.
- [4] Giulia Sofia, Jean-Stéphane Bailly, Nesrine Chehata, Paolo Tarolli, and Florent Levasseur. Comparison of pleiades and lidar digital elevation models for terraces detection in farmlands. *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing*, 9(4):1567-1576, 2016.
- [5] George Vosselman. Slope based filtering of laser altimetry data. *International Archives of Photogrammetry and Remote Sensing*, 33(B3/2: PART 3):935-942, 2000.
- [6] Nicolas Brochu and Dimitri Lague. 3d terrestrial lidar data classification of complex natural scenes using a multi-scale dimensionality criterion: Applications in geomorphology. *ISPRS Journal of Photogrammetry and Remote Sensing*, 68:121-134, 2012.

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