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On the integration of Airborne full-waveform laser scanning and optical imagery for Site Detection and Mapping: Monteserico study case

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This paper analyses the capability of airborne LiDAR derived data in the recognition of archaeological marks. It also evaluates the benefits to integrate them with aerial photos and very high resolution satellite imagery.
The selected test site is Monteserico, a medieval village located on a pastureland hill in the North East of Basilicata (Southern Italy). The site, attested by documentary sources beginning from the 12th century, was discovered by aerial survey in 1996 [1] and investigated in 2005 by using QuickBird imagery [2]. The only architectural evidence is a castle, built on the western top of the hill; whereas on the southern side, earthenware, pottery and crumbling building materials, related to the medieval settlement, could be observed. From a geological point of view, the stratigraphic sequence is composed of Subappennine Clays, Monte Marano sands and Irsina conglomerates. Sporadic herbaceous plants grow over the investigated area.
For the purpose of this study, a full-waveform laser scanning with a 240.000 Hz frequency was used. The average point density value of dataset is about 30 points/m2. The final product is a 0.30 m Digital Surface Models (DSMs) accurately modelled. To derive the DSM the point cloud of the ALS was filtered and then classified by applying appropriate algorithms. In this way surface relief and archaeological features were surveyed with great detail.
The DSM was compared with other remote sensing data source such as oblique and nadiral aerial photos and QuickBird imagery, acquired in different time. In this way it was possible to evaluate, compare each other and overlay the archaeological features recorded from each data source (aerial, satellite and lidar).
Lidar data showed some interesting results. In particular, they allowed for identifying and recording differences in height on the ground produced by surface and shallow archaeological remains (the so-called shadow marks). Most of these features are visible also by the optical dataset, whereas other only by lidar. The pattern of shadow-marks has been integrated by processing the optic imagery (aerial and satellite), which put in evidence other features related to buried deposits of archaeological interest.
Another contribution of lidar to the knowledge of the medieval site was the survey of eroded earthworks, that are very small differences in height, related to possible ancient human transformations of the hill.
The numerical modelling of DSM has allowed for integrating and managing all the different georeferenced data for the reconstruction of urban fabric of the medieval village.

[1] N. MASINI, Note storico-topografiche e fotointerpretazione aerea per la ricostruzione della '"forma urbis" del sito medievale di Monte Serico, Tarsia, 16-17 (1995), pp. 45-64.
[2] R. LASAPONARA, N. MASINI, QuickBird-based analysis for the spatial characterization of archaeological sites: case study of the Monte Serico Medioeval village, Geophysical Research Letter, Vol. 32, No. 12 (2005), L12313.