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Man-made materials mapping using hyperspectral PRISMA satellite imagery: a comparative study for Prato (Italy) and surrounding areas

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Purpose of this research is to evaluate how high spectral and spatial resolution of remotely sensed imagery can provide an effective support to materials mapping of roof covering and paving in urban and suburban areas. Since Tuscany Region wants to improve the land use/land cover database with such information, in the present research, a PRISMA mission satellite image was used to classify the land cover in the urban and suburban administrative area of Prato (Italy) and the nearby cities of Montemurlo (province of Prato), Calenzano and Campi Bisenzio (province of Florence). The following commercial and freeware software were used in image processing and analysis: Erdas® Imagine, L3Harris Technologies® ENVI, Google® Earth Engine and Google® Earth Pro. The analysis was conducted by following three main steps: one focused on the collection of spectral signatures directly on the field; the second one focused on the satellite imagery processing, classification, and accuracy assessment; lastly, the third one focused on the Object-Oriented classification applied to very high-resolution hyperspectral images acquired by the HySpex airborne sensor in the very same area. The man-made materials mapped in this research are solar cells, bitumen, asphalt (parking lots and highways), plastic (air-supported structures), metal roof covering, wood paving, clay roof tiles, clay paving and concrete (paving and roof tiles). Spectral signatures of these materials were collected on the field by using an ASD® FieldSpec 3 spectroradiometer; afterward, a dedicated spectral library was created on Erdas® Imagine 2022.
The satellite VNIR (Visible Near InfraRed, 66 bands) and SWIR (Short Wave InfraRed, 173 bands) images were pre-processed by applying radiometric and geometric corrections, respectively carried out within L3Harris Technologies ENVI® and Google® Earth Engine. Erdas® Imagine was used to apply a pan-sharpening method between the panchromatic high-resolution image and the hyperspectral layers in order to create a new product with higher spatial and spectral resolutions in the VNIR and SWIR regions. Then, the output PRISMA image was classified within Erdas® Imagine using two main approaches: a supervised classification aimed at mapping the specific materials (called “Detailed Classification”) and corroborated by ground truths, and a “Generalized Classification” based on pixel reflectance. The classifications underwent a detailed accuracy assessment and, later, compared also with results obtained from similar procedures applied to a multispectral Copernicus Sentinel-2 image characterized by fewer bands and lower spatial resolution. In order to enhance the classification accuracy as resulting from PRISMA data, on the basis of the spectral library created from field signatures collection, the 1-meter spatial-resolution hyperspectral aerial HySpex image

was calibrated by L3Harris Technologies ENVI®. Then, the Object-Oriented tool of Erdas® Imagine allowed us to improve the previous preliminary results achieved from the PRISMA image processing by identifying detailed polygons discriminating specific land cover materials. The process of re-classification was conducted within a GIS (Geographic Information System) environment to carry out a new land cover map with higher accuracy.