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Integrating remote sensing and subsurface geological data to characterize a tidally-influenced paleodrainage from the mid-late Holocene succession of the Po Delta Plain (Italy)

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A tidally-influenced, mid-late Holocene paleodrainage system from the Po Delta Plain (N Adriatic Sea, Italy) is reconstructed coupling remote sensing (RS) and subsurface geological data. Optical satellite images, DTM LiDAR, soil reflectance spectral features and core stratigraphy were combined in a GIS environment following a fully integrated methodological approach. The stratigraphic significance of RS-derived data (traces) was defined in terms of both depositional facies and depth, furnishing new insights on the role of RS in reconstructing the recent evolution of paleodrainages in coastal-deltaic settings. Sixteen images from Landsat 7 ETM+ (Enhanced Thematic Mapper Plus), Landsat 8 OLI (Operational Land Imager), Sentinel-2 MSI (Multispectral Instruments), and Hyperion satellites were collected from the USGS and the Scientific Hub ESA-Copernicus on-line databases, and integrated with Google Earth imagery. The visual interpretation of the images, mostly based on the brightness contrast (high and low reflectance values) and aimed to the recognition of traces, has been facilitated by the RGB combinations of the spectral bands most sensitive to lithology and moisture content and supported by a semi-automatic processing, including unsupervised classification and the spectral bands Principal Component Analysis (PCA). Multitemporal analysis of satellite imagery have been also performed. Two main traces, interpreted as meanders, have been analyzed for their sedimentological and stratigraphic characteristics. Following a field survey aimed to describe the morphology, grain-size, colors, and accessory materials of surface deposits, 11 soil samples have been collected for the extraction of the reflectance spectral signature and coring along the traces and in adjacent areas (bright and dark portions). Cores have been sampled for benthic foraminifer/ostracod analysis (42 samples) and stratigraphic cross-sections were constructed transversal to the meandering traces. Nine radiocarbon ages allowed to set the depositional evolution of the two meanders into a definite chronological framework. The integrated, RS-stratigraphic methodological approach revealed a meandering paleodrainage system buried > 2 m below the ground level. Its surface visibility is guided by the spatial distribution of surface moisture, which mainly depends on subsurface stratigraphic architecture and, in particular, on the distribution of organic-rich deposits laterally to the migrating meanders. The formation and activity of the buried paleochannels dates back to the early Holocene highstand (6000-2500 cal yr BP), when a drainage system likely developed under tide-influenced conditions.