Geophysical Research Abstracts
Vol. 19, EGU2017-4010-1, 2017
EGU General Assembly 2017

Reading Ombrone river delta evolution through beach ridges morphology

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The present study focuses on the evolution of the Ombrone River delta (Southern Tuscany, Italy) in the last five centuries, when fluvial sediment input was huge also as a consequence of the deforestation performed on the watershed.
The aim of this study is to find a correlation between river input and beach ridges morphology and to explain the different distribution of wetlands and sand deposits on the two sides of the delta.
Visible, NIR and TIR satellite images were processed to retrieve soil wetness associated to sand ridges and interdune silty deposits. High resolution LiDAR data were analysed using vegetation filter and GIS enhancement algorithms in order to highlight small morphological variations, especially in areas closer to the river where agriculture has almost deleted these morphologies.
A topographic survey and a very high resolution 3D model obtained from a set of images acquired by an Unmanned Aerial Vehicle (UAV) were carried out in selected sites, both to calibrate satellite LiDAR 3D data, and to map low relief areas. Historical maps, aerial photography and written documents were analysed for dating ancient shorelines associated to specific beach ridges. Thus allowing the reconstruction of erosive and accretive phases of the delta.
Seventy beach ridges were identified on the two wings of the delta. On the longer down-drift side (Northern wing) beach ridges are more spaced at the apex and gradually converge to the extremity, where the Bruna River runs and delimits the sub aerial depositional area of the Ombrone River. On the shorter up-drift lobe (Southern wing), beach ridges are closer, but run almost parallel each other. In this case, a rocky headland called Collelungo promontory closes and cuts the beach ridges sequence but shallow water depth allows sediment by pass. One kilometre to the south a more pronounced promontory encloses a small pocket beach (Cala di Forno) and identifies the limit of the subaerial depositionary area.
Beach ridges heights were analysed through LiDAR data and some of them were found higher than average. Conceptual models in literature allowed us to explain higher beach ridges as periods of stability or a very initial erosion stage interesting the beach. The high resolution DTM produced from LiDAR and UAV data permitted a better reconstruction of the last five centuries of delta evolution and to characterize the difference of beach ridges morphology of the up-drift and the down-drift sides of the delta. Within this framework the presence of interdune swales in the down-drift side has been explained.