Geophysical Research Abstracts
Vol. 16, EGU2014-10286, 2014
EGU General Assembly 2014

River discharge estimation by using remote sensing data in absence of bathymetry: the Po River case study

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River discharge is an important quantity of the hydrologic cycle and it is essential for both scientific and operational applications related to water resources management and flood risk prevention. The absence of flow measurements along the natural channels and, sometimes, their poor accessibility, contribute to make difficult the discharge estimation. In recent years, also thanks to the increased availability of remote sensing data, the great potential of satellite sensors for discharge estimation has been already demonstrated. In particular, recent advances in radar altimetry technology have improved the accuracy in the water levels monitoring of both large rivers and lakes located in ungauged or poorly gauged inland regions. However, the remote sensing based technologies cannot observe river channel bathymetry below the water surface, limiting their value for estimating river depth and/or discharge.

This study focuses on the estimation of discharge by coupling information coming from Moderate Resolution Imaging Spectroradiometer (MODIS) and radar altimetry and by using the entropy theory for simulating the river channel bathymetry. Specifically, the MODIS-derived velocity is obtained by exploiting the different behavior of water and land in the Near Infrared (NIR) portion of the electromagnetic spectrum (MODIS channel 2). The ratio of reflectance values between two pixels located within and outside the river increases with the presence of the water and, hence, with flow velocity. The flow area is then assessed considering the dataset of water surface elevation derived by radar altimetry and the maximum flow velocity derived by MODIS images. Based on the dataset, an optimization method for estimating the lowest river bottom level is applied and the cross-section flow area is assessed considering the bathymetry simulated by maximization of entropy. The procedure is tested by comparing in-situ and satellite-derived discharge data for a gauged river site along the Po River.