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Using MODIS data to estimate river discharge in ungauged sites

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The discharge prediction at a river site is fundamental for water resources management and flood risk prevention. An accurate discharge estimation depends on local hydraulic conditions which are usually detected by recording water level and carrying out flow measurements, which are costly and sometimes impractical for high flows. Over the last decade, the possibility to obtain river discharge estimates from satellite sensors data has become of considerable interest. For large river basins, the use of satellite data derived by altimeter and microwave sensors, characterized by a daily temporal resolution, has proven to be a useful tool to integrate or even increase the discharge monitoring. For smaller basins, Synthetic Aperture Radars (SARs) have been usually employed for the indirect estimation of water elevation but their low temporal resolution (from a few days up to 30 days) might be considered not suitable for discharge prediction. The Moderate Resolution Imaging Spectroradiometer (MODIS) aboard of Terra and Aqua Earth Observing System (EOS) satellites, can provide a proper tradeoff between temporal and spatial resolution useful for discharge estimation. It assures, in fact, at least a daily temporal resolution and a spatial resolution up to 250 m in the first two channels. In this study, the capability of MODIS data for discharge prediction is investigated. Specifically, the different spectral behavior of water and land in the Near Infrared (NIR) portion of the electromagnetic spectrum (MODIS channel 2) is exploited by computing the ratio of the MODIS channel 2 reflectance values between two pixels located within and outside the river. Values of such a ratio should increase when more water and, hence, discharge, is present.
Time series of daily water level, velocity and discharge between 2002 and 2010 measured at different gauging stations located along the Upper Tiber River (central Italy) and the Po River (North Italy), as well as MODIS channel 2 data for the same period are employed to testing the procedure. The agreement between MODIS-derived and in situ discharge time series is found to be fairly good with maximum correlation coefficient values equal to $\sim$0.8. The empirical relationships between satellite and in-situ time-series are investigated in-depth to regionalize their parameters and, hence, to estimate the discharge also for ungauged river sites based on MODIS data.