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Towards river discharge estimation for ungauged sites

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Knowledge of the freshwater dynamic and volumes on a global scale is an essential information for climate studies and, at local level, for water resources management and flood risk mitigation.
Although the ground hydrological monitoring network is quite widespread throughout the world, many sites are still not monitored due to problems related to cost issues, political aspects and inaccessibility of the areas. Lack of information, besides being harmful to the knowledge of the hydrological processes, is a deterrent also for the operative aspects, i.e. early warning system, contributing to worsen the already difficult living condition of many countries, especially developing countries (i.e. in Asia and Africa).
Satellite remote sensing demonstrated to be a reliable support together with in-situ measurements for the estimation of river discharge. Radar altimeter and near infrared sensors independently showed their effectiveness providing estimates of river discharge with good accuracy. Moreover, the merging between the two sources of satellite data, radar altimeter and near infrared sensors, has also demonstrated to be the best solution for the monitoring of river discharge. Previous studies, showed the feasibility only for two test sites in the Niger (Nigeria) and Po (Italy) rivers, but the encouraging results suggest that the methodology can be successfully applied at global scale. To this scope, we used the water level measurements derived by satellite radar altimetry and made available on different platforms (Hydroweb, Theia, River & Lake, HydroSat, Dahiti). For the near infrared sensors, we used the Google Earth Engine to process long time series of MODIS product at 500 m and daily resolution and derive the signal proxy of river discharge.
Artificial Neural Network (ANN) has been used to merge the information coming from altimetry and near infrared sensors, by using the ground observed discharges for thirty sites sampled across the world. Following the hydrological similarity, we tried to estimate river discharge for other ungauged sites by using the ANN trained for gauged sites. The results confirm the capability of the integration of different satellite sensors to provide useful estimates of the river discharge also where the data is scarce or completely missing.