Evaluation of MERIS Water Quality Products for Inland Waters at Itumbiara Reservoir, Brazil.

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Assessing the quality of surface waters in reservoirs, lakes and rivers is a key issue for environmental monitoring and management. Traditional water quality monitoring depends on in situ measurements and subsequent laboratory analysis of water samples, which may give detailed measurements, but they are time and funds consuming. Additionally, they can't give a near-real-time synoptic coverage that is necessary for the monitoring of water quality. Satellite remote sensing may provide suitable ways to integrate limnological data collected from traditional in situ measurements. Remotely sensed data from satellites have been used for the monitoring of water quality since the early '80s. The Landsat Thematic Mapper (TM) sensor has been the most widely used sensor to monitor inland waters. Ocean monitoring also uses data from remote sensors (e.g., MODIS, AVHRR, RADARSAT), which guarantee repetitiveness, improving the detection of water parameter changes. But for lakes or reservoir areas with a small extension, the coarse resolution of such kind of sensors is not easily applicable. The Envisat MERIS sensor has a spatial resolution of 300 m (at nadir), which enables inland waters monitoring.

The objective of this work is to estimate water quality parameters like chlorophyll-a (CHL) and total suspended matter (TSM) concentration, including inherent optical properties such as absorption coefficients of coloured dissolved organic matter (a_cdom) and phytoplankton (a_pig) in a Brazilian hydroelectric reservoir, evaluating the MERIS case 2 waters processors and MERIS product level 2. The validation campaign was carried out at Itumbiara Reservoir, Goias State (Figure 1), at high water level, on May 12th and 13th 2009.

The in situ data included limnological field measurements analyzed in the laboratory such as CHL and TSM concentration, besides CDOM and phytoplankton absorption coefficients. Above-water radiometric measurements were also made. The data set included 25 observations of CHL, TSM, a_pig, and 23 of a_cdom. The radiometric measurements were used to compute remote sensing reflectances (Rrs) that were compared with MERIS estimates. The Rrs(λ) was calculated by the following equation: $Rrs(\lambda) = L_w(\lambda)/E_d(\lambda)$ where $L_w(\lambda)$ is the water leaving spectral radiance and $E_d(\lambda)$ is the downwelling spectral irradiance incident on the water surface. A full-resolution geo-located and atmospherically corrected (level-2) MERIS image was acquired on May 7th. Also, a MERIS level-1b image, of the same day, was processed by the C2R processor, the Boreal Lakes, and the Eutrophic Lakes processors. These processors were developed by the ESA project "Development of MERIS Lake Water Algorithm" as a plug-in module for the BEAM toolbox. A spectral comparison between average MERIS-derived Rrs, average MODIS-derived Rrs (product MOD09) and in situ estimates for 6 "match-ups" was performed by rmsd calculation. For MODIS the values are 22.7% at 645nm, 90.5% at 585.5 nm, 30.7% at 469 nm, and 49.42% at 555 nm. For MERIS we found 26.1% at 412.5 nm, 57.9% at 442.5 nm, 79.2% at 490 nm, 76.3% at 510 nm, 70.3% at 560 nm, 60.17% at 620 nm, 28.4% at 665 nm, and 27.6% at 681.25 nm. The spectral shapes for the MERIS reflectances and the spectroradiometer data appeared to be similar, but the MERIS reflectances were considerably lower over the entire spectrum. The performance of the processors was better in comparison with the MERIS L2P reflectances.

The MERIS products were statistically compared with in situ measurements through linear regression analysis, root mean square error (rmse) and transformed-rmse (rmse-L), and the relative mean difference percentage (RPD). The best results were found for TSM (r^2 = 0.26, rmse = 0.31, rmse-L = 1.02, RPD = 81.6) and a_cdom (r^2 = 0.76, rmse = 0.24, rmse-L = 0.88, RPD = 49.7) for product level 2 and boreal processor, respectively. The relatively better result for a_cdom with Boreal Lakes processor can be explained by the fact that Itumbiara reservoir is a yellow-substance-dominated Case 2 water, at least during the sampling period. This classification was based on the relative contributions to the absorption coefficient at 440 nm from three optically active constituents - phytoplankton, gelbstoff and detritus. The other comparisons did not present good results, maybe due to the limited number of sampling points. The delay between the MERIS image acquisition time and the collection of the in situ data can also be a source of differences for comparisons.

The tested MERIS products seem to have potential for determining water quality parameters at the Itumbiara Reservoir. For better results it would be recommended to increase field sampling efforts, also during other seasons. Another field campaign was carried out in September 2009. This new dataset is being processed and analyzed comparatively with the previous campaign. The final results will be presented in the near future.

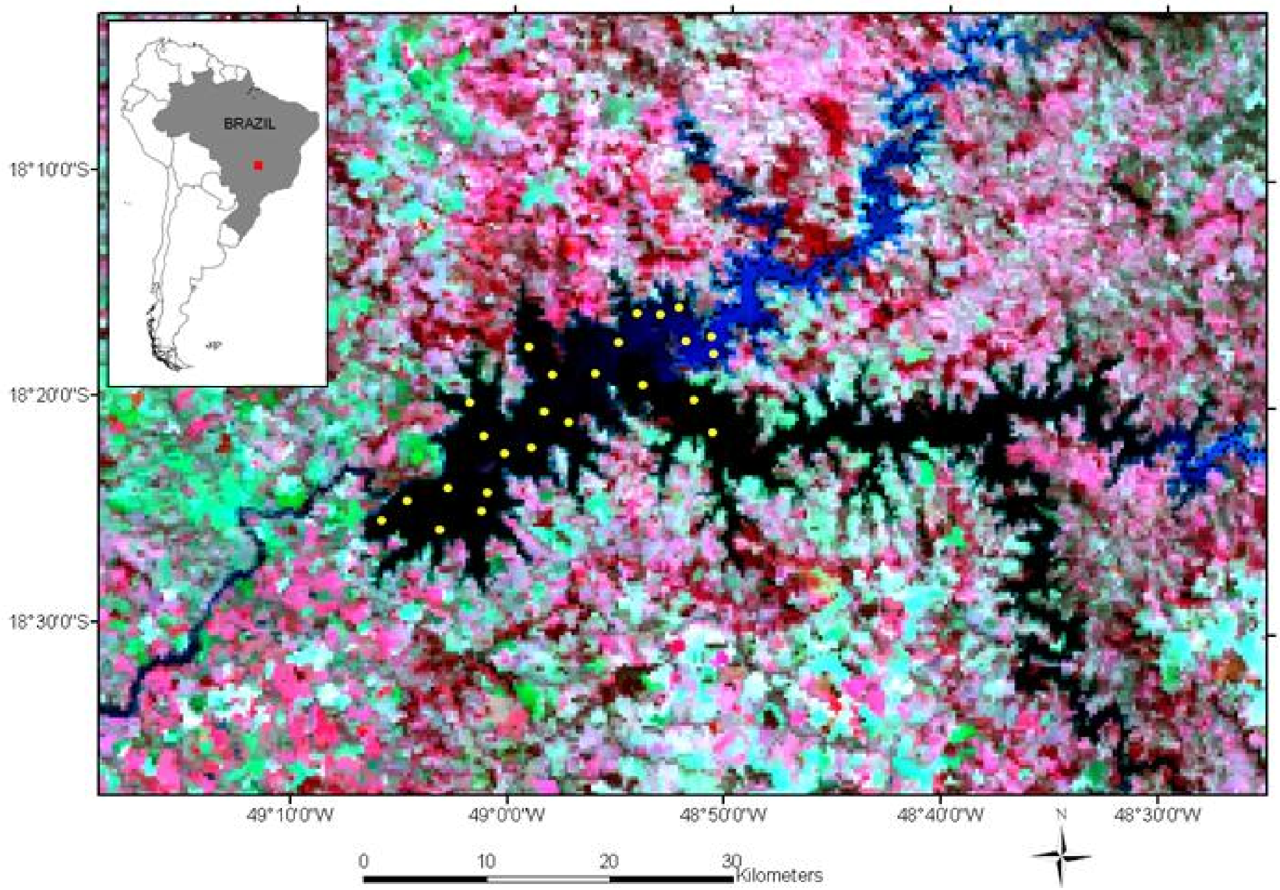

Figure 1. Study area and sampling stations (yellow circles) during May 2009 at Itumbiara Reservoir, Goias State, Brazil (MERIS image composition 13R7G5B of 09/07/2009).