Geophysical Research Abstracts
Vol. 20, EGU2018-16046, 2018
EGU General Assembly 2018

Water quality monitoring of small inland reservoirs in semiarid Brazil heavily affected by macrophytes growth: From in-situ to satellite observations

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Satellite remote sensing techniques are being used for monitoring inland–water characteristics and water quality, providing a synoptic view of these environmental systems. Nevertheless, the presence of macrophytes in the water bodies constitutes a major challenge for the retrieval of attributes related to water quality dynamics, because of the high reflectance values of the vegetation as compared to the reflectance from water; and because of the effect of mixed pixels with varying proportions of water and different types of vegetation. To overcome this problem, threshold methods can be used to delineate pure water areas. This study focuses on three small surface reservoirs (Marengo-MA, Paus Branco-PB and São Nicolau-SN) located in the Brazilian semiarid region. These systems are distinct in terms of size and limnological characteristics. MA is a perennial and highly dendritic reservoir with 15.3 hm^3 of storage capacity; and it is a CDOM-moderate and highly eutrophic reservoir. PB and SN are non-perennial and have maximum storage capacities of 5.5 hm^3 and 0.89 hm^3, respectively. They are both CDOM-rich and oligotrophic-dystrophic. No macrophytes occurrence was noticeable in MA, whereas there was a dense presence of emerged macrophytes in PB and submersed species in SN. Pure water areas not mixed with the signal from macrophytes were specifically processed for each reservoir using satellite data from Landsat-8 and RapidEye collected between May 2014 and Nov 2015. MA and PB were sensitive for classification through NIR Thresholding Method than SN, due to the absence/occurrence of aquatic plant species. We applied a supervised classification based on maximum likelihood algorithm for SN, which has a dense presence of submerged macrophytes. Cloud presence and artifacts were masked manually, allowing a classification of water for both methods. Extracting pure water pixels method is proposed in the preprocessing prior to the classification of water bodies that are affected by the occurrence of macrophytes including free emerged species (floating and/or rooted) and submerged species. The result of this process is a pure water map free of floating vegetation and contamination of muddy areas, typical of the land-water surface close to the edges of the reservoirs. The main classes separated to SN reservoir included water, vegetation (included emerged vegetation), wetland/ edges areas. RapidEye data were more robust than Landsat data to classify these areas and this result stood out better for SN reservoir which afterward we included bare soil and mixed areas (wetland that became grazing areas) classes due to the low water level from June 2015. The classification is consistent with the limnological conditions verified by higher eutrophication index toward the end of the monitoring periods when compared with the initial situation. It emphasizes that monitoring period fell into a multi-year hydrological drought (2012-2016), which contributed to worsen the water quality.