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Estimation of water quality parameters applying satellite data fusion and mining techniques in the lake Albufera de Valencia (Spain)

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Linked to the enforcement of the European Water Framework Directive (2000) (WFD), which establishes that all countries of the European Union have to avoid deterioration, improve and retrieve the status of the water bodies, and maintain their good ecological status, several remote sensing studies have been carried out to monitor and understand the water quality variables trend. Lake Albufera de Valencia (Spain) is a hypereutrophic system that can present chrorophyll a concentrations over 200 mg·m^{-3} and transparency (Secchi disk) values below 20 cm, needing to retrieve and improve its water quality. The principal aim of our work was to develop algorithms to estimate water quality parameters such as chlorophyll a concentration and water transparency, which are informative of the eutrophication and ecological status, using remote sensing data. Remote sensing data from Terra/MODIS, Landsat 5-TM and Landsat 7-ETM+ images were used to carry out this study. Landsat images are useful to analyze the spatial variability of the water quality variables, as well as to monitor small to medium size water bodies due to its 30-m spatial resolution. But, the poor temporal resolution of Landsat, with a 16-day revisit time, is an issue. In this work we tried to solve this data gap by applying fusion techniques between Landsat and MODIS images. Although the lower spatial resolution of MODIS is 250/500-m, one image per day is available. Thus, synthetic Landsat images were created using data fusion for no data acquisition dates. Good correlation values were obtained when comparing original and synthetic Landsat images. Genetic programming was used to develop models for predicting water quality. Using the reflectance bands of the synthetic Landsat images as inputs to the model, values of R^2 = 0.94 and RMSE = 8 mg·m^{-3} were obtained when comparing modeled and observed values of chlorophyll a, and values of R^2= 0.91 and RMSE = 4 cm for the transparency (Secchi disk). Finally, concentration maps estimating distributions of chlorophyll a and transparency were obtained by applying these algorithms to the entire synthetic images. These results show the technique exposed as an attractive tool to monitor and study the spatio-temporal trend of these water quality parameters.