Pan-sharpening methods applied on Sentinel-2 imagery for mapping inland water bodies

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In the last two years great importance was given to Sentinel-2 mission because it provides high resolution and high frequency multispectral images, which can be employed in different applications.

In this context, this work investigates the use of Sentinel-2 imagery with the aim of detecting inland water bodies in natural and man-made environment. According to literature, the Modified Normalized Difference Water Index (MNDWI) gives reliable results in terms of mapping water bodies. This index is derived from the green and the short-wave infrared (SWIR) bands, that have different spatial resolution in Sentinel-2 imagery, 10 m and 20 m respectively. MNDWI maps with resolution of 20 m can be obtained by upscaling the green band, instead maps with higher spatial details can be generated by downscaling the SWIR band with the application of pan-sharpening on Sentinel-2 data. Since there is no panchromatic (PAN) band in Sentinel-2 images, the 10 m resolution channel with the highest correlation with the SWIR one is chosen as PAN-like band. Considering the high number of pan-sharpening methods, this work evaluates four common algorithms, usually available in image processing software packages: the Intensity, Hue, Saturation (IHS) transformation, the Principal Component Analysis (PCA), the Brovey method and the Gram-Schmidt method. All the algorithms are implemented in Matlab$^{®}$, starting from codes available online and specifically adapted to fit to Sentinel-2 data.

Two different study cases are reported in this work. Preliminary studies are conducted on the Po river delta area, mainly natural environment, in order to test and compare the methods. According to correlation values, the near infrared (NIR) band is selected as PAN-like band. MNDWI maps produced by the application of the Brovey method and the IHS transformation give the most reliable results. The first algorithm can find better no water areas, while the latter detects more accurately water bodies. Other studies are carried out on a more urban site: the eastern area of the city of Milan, both rural and man-made environment, full of canals and quarries.