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Satellite monitoring at high spatial resolution of water bodies used for irrigation purposes

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In a changing climate context, with an increase of the need for food, it becomes increasingly important to improve our knowledge for monitoring agricultural surfaces by satellite for a better food management and to reduce the waste of natural resources (water storages and shortages, irrigation management, increase of soil and water salinity, soil erosion, threats on biodiversity).

The main objective of this study is to evaluate the potentialities of multi-spectral and multi-resolution satellites for monitoring the temporal evolution of water bodies surfaces (mainly used for irrigation purposes). This analysis is based on the use of a series of images acquired between the years 2003 and 2011. The year 2010 is considered as a reference, with 110 acquisitions performed during the MCM'10 campaign (Multispectral Crop Monitoring 2010, http://www.cesbio.ups-tlse.fr/us/mcm.html). Those images are provided by 8 satellites (optical, thermal and RADAR) such as ALOS, TERRASAR-X, RADARSAT-2, FORMOSAT-2, SPOT-2, SPOT-4, SPOT-5, LANDSAT-5. The studied area is situated in the South-West of Toulouse in France; in a region governed by a temperate climate. The irrigated cultures represent almost 12% of the cultivated surface in 2009.

The method consists in estimating the water bodies surfaces by using a generic approach suitable for all images, whatever the wavelength (optical, infrared, RADAR). The supervised parallelepiped classification allows discriminating four types of surfaces coverage: forests, water expanses, crops and bare soils. All RADAR images are filtered (Gamma) to reduce speckle effects and false detections of water bodies.

In the context if the "South-West" project of the CESBIO laboratory, two spatial coverages are analyzed: SPOT 4 (4800km^2) and FORMOSAT 2 (576km^2). At these scales, 154 and 38 water bodies are identify. They respectively represent 4.85 km^2 (0.10% of the image cover) and 2.06 km^2 (0.36% of the image cover). Statistical analyses show that 8% of lakes have a surface inferior to 10 ha (0.1 km^2).
Temporal analyses, over the year 2010, show that only five lakes offer a strong surface dynamic (from 21% to 125% of evolution). The weak signal observed over all the other lakes are due to the banks of lakes (steep slope). The long term analyses, from 2003 to middle of 2011, show alternation of wet and dry years due to rainfalls variations. Annual cycle are also well marked showing filling and emptying phases respectively occurring in spring and at the end of summer. Filling phase is both attributed to runoff contributions over the watershed and to pumping effects. Irrigation and evaporation are the main factors during emptying phases. Two examples of water storages estimates are presented over one specific watershed.

To conclude, high spatial resolution images appear suitable for mapping water bodies at fine scale. Limitations come from the form of the edge of the lake (steep or slight slope) and only 3% of lakes can be monitored over the studied area. In the following, interferometric approaches will be evaluated to estimate the height of water bodies, improving the estimate of water storage.