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On Combining Landsat Imagery and Radar Altimetry To Estimate Reservoirs Water Volume: Case-Study of Lake Nasser (Egypt)

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Measurements of volume variations in water reservoirs provide information critical to climate change and resource monitoring, especially in the context of the growing challenges for the management of the resource. However, many reservoirs are located in remote regions, which make difficult the deployment and regular maintenance of traditional in-situ measurement systems; also, the new perspective of free and public satellite data is encouraging new monitoring opportunities in areas which were not possible before. All of these factors make satellite remote sensing an attractive tool for a global monitoring of reservoirs. In particular, remote sensing resources that are freely available nowadays represent a great opportunity to support the study and monitoring of hydrological and hydraulic processes.

Several data sets from different satellites are currently available for providing the area of the water surface and/or the water level, providing indirect information about the stored quantity. Typical methods for estimating water reservoir volumes from satellite data are based on radar or optical imagery, and the usual approach is to monitor changes in surface area that are translated into volume on the basis of regional bathymetric surveys and/or surface models.

In this poster, we propose an approach entirely based on satellite data, where the in situ level measurements are replaced with information derived from radar altimetry observations. Thus, the possibility to extract water level information from Landsat images, by using altimetry for calibration and validation phases, is investigated in this work. In this context, Landsat images are used to determine the surface water extent and radar altimetry data from the Hydroweb data base (http://www.legos.obs-mip.fr/en/soa/hydrologie/hydroweb/) for measuring instantaneous water level. Each image is an instance of the water body characterised by a different water level. The instantaneous shoreline defines a depth contour. A temporal sequence thus provides a bathymetric profile which can in turn be transformed into volume sections.

The free availability of both datasets makes multi-temporal data analysis practical and affordable. In this work, the approach is demonstrated on Lake Nasser (Egypt) with satellite data from the period 1998 to 2003. Analysis is presented for sections of the lake with areas in the range of 100 to 10,000 km2, and on smaller areas of connected tributaries (including the canal connection to the Toshka Lakes). Recent improvements in processing Landsat images, including more precise, sub pixel accurate area measurement are also discussed. Finally, other hydrological applications possible with these data are briefly touched.