Final DRAFT of Abstract

A Completely Remote Sensing Approach To Monitoring Reservoirs Water Volume

Ron Abileah, jOmegak, San Carlos CA, USA
*Stefano Vignudelli, Consiglio Nazionale delle Ricerche (*CNR*), Pisa, Italy*
Andrea Scozzari , CNR *Institute of Geoscience and. Earth Resources, Pisa, Italy*

This paper follows on earlier work in the Small Reservoir Project (***Application of satellite remote sensing to support water resources management in Africa: Results from the TIGER Initiative*, UNESCO, 2010**), which, among other achievements, produced a remote sensing methodology for the assessment of the storage capacity (C) of small reservoirs. In this context, Liebe (2002 and later papers) showed how to employ the equation: $C = const \cdot A^p$, where *A* is the reservoir surface area measured at some instant in time, as determined with a remote optical imagery platform such as Landsat; the coefficients *const* and *p* depend on the slope and shape of the reservoir, e.g. for reservoirs in the shape of an upside down pyramid *p=1.5*. For the more concave shaped reservoirs *p* is in the range of 1 to 1.4. Liebe derives the coefficients with detailed (and time consuming) bathymetric mapping of a small sample of reservoirs. The coefficients from the small sample were than applied to the large set of reservoirs of the same type and in the same region of the world.

This paper describes a modified Liebe approach, where the *in situ* bathymetry is replaced with information derived from radar altimetry observations. We begin with a temporal sequence of Landsat imagery and radar altimetry. 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 frustum volume sections. (Footnote: the frustums volumes were first derived by Heron of Alexandria!)

Our approach is entirely based on Earth Observation satellite data and is based on fusing Landsat imagery and radar altimetry. The modified approach allows the extension of Liebe's method to many more reservoirs even in remote regions of the world.

The technique is demonstrated on Lake Nasser with satellite data from the period 1998 to 2010. Analysis is presented for sections of the lake with areas in the range of 100 to 10,000 km^2, and on smaller areas of connected tributaries (including the canal connection to the Toshka Lakes).

Our paper also provides some general information on Landsat images and radar altimetry. It is especially notable that both data are available free of charge

which makes multi-temporal data analysis practical and affordable. Landsat 4-5- and 7 data cover 1988 to present, revisiting the entire Earth every 16 days. Various radar altimetry systems have been collecting data since 1992 and revisiting sites along the satellite ground track every 10 days (TOPEX/Poseidon and Jason 1/2 series) and 35 days (Envisat).

There is thus a long and temporally dense record of data of both types available for the modified Liebe method. We also discuss recent improvements in processing Landsat images, including more precise, sub pixel accurate area measurement. Finaly, we touch briefly on other hydrological applications possible with these data.