Deriving and evaluating bathymetry map using remote sensing data and in situ measurements

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Abstract

Urmia Lake as a most vital water bodies in Iran, has been shrinking since the late twentieth century and its area has dramatically decreased. To develop and apply any plans to survive the lake, qualitative and quantitative analysis and any modeling, deriving physical information such as volume, area and their changes are very crucial. The objectives of this study were therefore, intended firstly, to study the bathymetry of Urmia Lake with a more satisfactory approach using Landsat- LDCM satellite image and in situ measurement data. The polynomial model was developed to predict the water depth in Urmia Lake area. This model was developed with the input series of reflectance values from blue, green, red and NIR bands in the Landsat- LDCM satellite imagery for Urmia Lake taken on 12 April 2013 of the sampling sites from actual depth measured were taken on the same date. Also, using a large archive of Landsat imagery (TM, ETM+ and LDCM), a counter of equivalent elevation were established for deriving the bathymetry of desiccated areas by mapping the edges of the lake and finally assembled with bathymetry derived from polynomial model. In-situ depth measurements were used to evaluate resultant derived bathymetric map. This comparison shows reasonable agreement between the Landsat-derived depths and those measured in the field with RMSE of 0.27 cm and $R^2=0.91$. The maximum and mean depths measured were 4.9 and 11 m respectively. The maximum depth measured was located at the upper part of the lake.

Secondly, to make stage curves of lake, multi-temporal changes of water body have been derived from Landsat, MODIS and AVHRR satellite image sets since 1972. In this regard, the area of Urmia Lake at

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different level was estimated base on object oriented and pixel base classification using 78 satellite images. Finally, stage curve (volume-area-elevation relations) was derived from Bathymetry map. These findings will provide valuable information and can be utilized for various water related resource management systems and environmental impact assessments.

**Keywords:** Urmia Lake, Remote sensing, In situ measurements, Bathymetry, Water Depth, Water Level
Fig. 2. Bathymetric map of Urmia Lake (derived from Landsat OLI image).
Fig. 3. Urmia Lake surface change detection at different water level during last 29 years (from 1984 to 2014).
Fig. 4. Stage curve of Urmia Lake.