بسم اللّه الرحمن الرحيم

شبكة المعلومات الجامعية
التوثيق الالكتروني والميكروفيلم

جامعة عين شمس

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DEVELOPING AN INNOVATIVE TECHNIQUE TO ENABLE ESTIMATE OF SURFACE AREA AND VOLUME OF ASWAN HIGH DAM LAKE USING SATELLITE IMAGES

By

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M.Sc. Environmental Engineering,
Institute of Environmental Studies & Research,
Ain Shams University, 2012

A Thesis Submitted in Partial Fulfillment
of
The Requirement for the Doctorate of Philosophy
in
Environmental Science

Department of Environmental Engineering
Faculty of Graduate Studies and Environmental Research
(Ain Shams University)

2021

<u>APPROVAL SHEET</u>

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ABSTRACT

This study focused on developing an innovative technique that enables the accurate calculation of the lake water surface area and volume at any specific time using satellite images. To achieve the objectives of the study, many water Indices of image-processing techniques were investigated to accurately delineate the High Aswan Dam reservoir (HADR) water body boundary. The study shows that the MNDWI is most useful technique to delineate water surface from other land features. The processing of Landsat-8 and setienal-2 satellites images for the purposes of this research -water surface delineation- shows very high degree of consistency for the scale up to 1:50,000. The calculation of water body is applied for all satellite data coverages representing the lake surface area in different dates in the years 2015, 2016 and 2021 using 41 scenes from both satellites (Lansat-8 and sentinel-2). The 41 scenes are chosen from more than 150 scenes downloaded to select the proper scenes representing the nine complete lake surface coverages. The selected nine dates images were representing different lake levels varies from 173.49 to 181.24 meters which corresponds to the surveyed data by HYDROWEB project.

Analyzing the water levels as a variable and the corresponding lake surface area, lead to a new mathematical power equation. The equation found to fit a curve that represents the relation between the water level (WL) and surface area with a very good -proportional of variance statistical measure- R2 value of 0.997 as follows.

Lake Surface area = $\mathbf{8.12548 * 10^{-12} * (WL)^{6.589258217} Km^2}$

The integration of the lake surface area equation is used to obtain the lake volume equation as a function of WL as follows:

Lake volume at *wl* water level

$$= 1.07065 * 10^{-15} * (wl)^{7.58926} - 1.614989474 \quad \text{BCM}$$

For validation purposes four test images obtained in dates different from those used to develop the surface and volume equations (24/7/2020 and 25/1/2021, by sentinel-2). The investigated water levels, corresponding to the test images acquisition dates, are compared to water level values obtained from HYDROWEB data. The HYDROWEB water level value at 27/7/2020 was 178.19 m, and at 25/1/2021 was 181.04. It is concluded that the deviation RMS of the investigated water level values from HYDROWEB, as a reference, is 13 cm.

For the purposes of accuracy assessment of the lake area calculation, the google earth images with sub-meter resolution are used for the corresponding lake levels. 7 sites around the lake boundary are randomly selected. It is found that the difference in area percentage varies from 1.34% to 3.44% with an average difference of 2.22%. It is also noticed that the difference is always positive in reference to Google images. It means that, the water body area calculated from the low resolution images (Lansat-8 and sentinel-2) is slightly greater than the corresponding Google Earth images by 2.22%.

The validation process was proven to be a very successful monitoring system for lake level estimation and consequently, the surface area and volume in any date by acquiring a single satellite image such that it covers any small part of the generated monitoring sites.

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