

Determination of water surface area and evaporation losses from Jebel Aulia reservoir

Location	Jebel Aulia reservoir, Sudan
Contractor	Eastern Nile Subsidiary Action Program
Period	2006

Scope of the project

The Jebel Aulia reservoir south of Khartoum was constructed in 1937 to regulate White Nile flows. It delays outflow of the White Nile to supplement the Blue Nile in low flow season. The reservoir level reaches its maximum in September, and starts to drop in February to continue until the end of May. The storage capacity of the reservoir was originally 3.22 BCM but decreased with 21% to 2.54 BCM due to siltation. Estimates of the reservoir surface area range from 600 to 1500 km² and mean depth is around 2.3 m. Due to its large area and limited depth, evaporation losses are large. This project aimed at determining the water surface area and the evaporation losses of Jebel Aulia reservoir.

Study approach

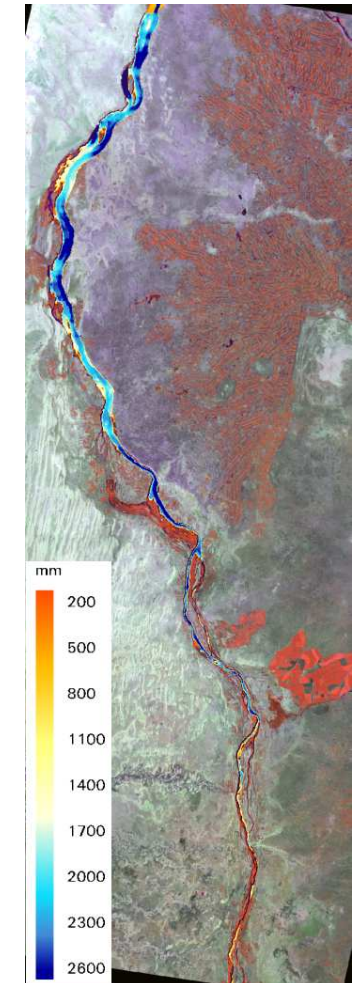
Satellite imagery is very suitable for water surface detection because water is the only natural body that has a near-infrared reflectance that is lower than the red reflectance. Two Landsat 30-m scenes of 2001, one acquired in the dry and one in the wet period, are used to calculate the water surface area under two extreme conditions. 22 250-m MODIS Images are used to determine the water surface area throughout 2001. Subsequently the water surface areas derived from MODIS are corrected using the water surface area from Landsat. Monthly evaporation of the reservoir was calculated using SEBAL in combination with 2001 MODIS imagery.

Results

The water surface area calculated by Landsat was 591 km² in the dry season, and 1051 km² in the wet season. MODIS underestimated the water surface for both dates with approximately 120 km², and this value was used to correct the other water surface estimates from MODIS. The corrected MODIS surface estimates varied from 190 km² in June up to 1050 km² in September. The monthly evaporation rate included advection and was determined from pure MODIS pixels located in the reservoir. Average monthly evaporation ranged from 143 mm in June (rainfall, cloud cover) to 324 mm per month in April (dry and hot desert air). Combining the water surface area and the average evaporation of each month resulted in the total monthly evaporation in BCM. In 2001 the Jebel Aulia reservoir lost 2.106 BCM to evaporation.

Conclusions

The total water surface area of Jebel Aulia reservoir calculated with satellite imagery is lower than the estimates in literature. This number however relates to open water areas only, and riparian vegetation and wetlands might also be exposed to river water. Annual evaporation of the Jebel Aulia reservoir is 7.5 % of the total flow at Mogren, just downstream of the dam, which seems to be a reasonable number.



Total annual evaporation in Jebel Aulia reservoir