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The water balance of Lake Tana and the surrounding catchments using satellite data and routine weather data

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Lake Tana is the largest lake in Ethiopia. The outflow is the source of the Blue Nile and this water is fundamental for many livelihoods and delivers ecosystem services to downstream – international – stakeholders. It is essential to estimate the major hydrological flow processes of the Lake Tana Basin, including the runoff from ungauged catchments that feed the lake as well as the outflow through weirs and turbines. Flow releases from many lakes and reservoirs in the world are often kept tight by responsible agencies, and this abstract shows how smart hydroinformatics based on freely accessible earth observation data can be explored to inform stakeholders. Routine weather data were added for calibration of rainfall and for the computation of evapotranspiration rates.

The monthly inflow from catchments draining into Lake Tana was computed from the difference in rainfall and land evapotranspiration, including a minor correction term for storage changes in the unsaturated/saturated zone. The large majority of the inflow is ungauged, so this provides more information on the total water yield. The rainfall map at 1 km resolution was obtained from Version 7 TRMM 3B43 product using a new published downscaling-calibration procedure with measured rainfall from 20 rain gauges. The 1 km resolution evapotranspiration map was modeled from newly developed ETLook model using data from MODIS, AMSR-E and Meteosat systems.

The water balance of the lake area was computed from rainfall, lake evaporation and the changes in water volumes. The rainfall over the lake area was estimated from TRMM 3B43 product with a calibration factor. The De Bruin-Keijman model was used to compute lake evaporation. Monthly heat storage changes were modeled using a newly developed hysteresis model using monthly MODIS surface temperature data. The water volume changes in the lake were estimated using Landsat TM/ETM imagery and satellite altimetry data. The satellite altimetry data were obtained from Hydroweb which provides time-series of water levels of large lakes and reservoirs using merged Topex/Poseidon, Jason-1, Jason-2, ENVISAT and GFO data. The monthly outflow from the lake was computed and compared with in-situ measurements. This methodology based on earth observation data can be used for any lake and reservoir, and is extremely suitable for cases with tension on scarce water resources and limited data democracies.