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Analysis of the water balance of Lake Victoria

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Lake Victoria is situated within an elevated plateau in the western part of Africa's Great Rift Valley and lies within the territory of three countries: Tanzania, Uganda and Kenya. It is Africa's largest lake and the second widest fresh water lake in the world in terms of surface area. It is also the source of the longest branch of the River Nile, the White Nile. The lake's shallowness, limited river inflow, and large surface area relative to its volume make it vulnerable to climate changes and fluctuations of the water level. This affects the surrounding countries and their people a lot, especially in terms of their food supply and economy.

The aim of this study was to get more information on the causes of these fluctuations by analysing the water balance of the lake for the period 1970-1974. It was based both on historical data and measurements and new calculations, and compared with previous studies (e.g. Suttcliffe and Parks, 1999).
Precipitation and evaporation over the lake surface were calculated with the Thiessen Polygons method, using measurements from stations around the lake and on the islands. The total inflow of the lake is the sum of the contributions of twelve subbasins. One of these subcatchments, the Nzoia-catchment, was modeled with SWAT (Soil and Water Assessment Tool), a physically based, semi-distributed river basin simulator, as a contribution to the development of a water balance model for Lake Victoria. To calculate the outflow at the Owen Falls Dam in Jinja (Uganda), gauge heights of the lake were used in combination with the "Agreed Curve" (the relationship between water level and flow that was set by the policy makers).

As the lake is assumed to be a system with a closed mass balance, the combination of the variations in the above mentioned components resulted in changes of the lake's storage, leading to fluctuations of the water level.

For the period 1970-1974 the calculated mean monthly evaporation is 133 mm, with a standard deviation of 11% and variations similar with previous studies. The mean monthly precipitation was calculated as 150 mm, with a standard deviation of 55%, which is very high, but previous studies also show large fluctuations and similar results. The monthly inflow has an average value of 26 mm (standard deviation 39%), with a large peak from April till May and a smaller from August till November due to the rainy seasons. The study of Suttcliffe and Parks showed even larger peaks for the April-May period. The results for the outflow (monthly 49 mm, standard deviation 9%) are almost equal to the results of Suttcliffe and Parks. Remarkable is the decreasing trend of the outflow value, indicating the lowering of the water level.

As a result of the analysis of the components of the water balance in this study, the water level of Lake Victoria was calculated and the results were compared with historical measurements. The level shows (both in measurements and calculations) a large peak in April and May and a smaller one in November. For the period 1970-1974 a decrease of 360 mm of the water level was measured resulting in a yearly decrease of 72 mm. The calculation results in an average yearly decrease of 76 mm. Although this is very similar to the measurements, there is a big standard deviation (113 mm) on the difference between the monthly measured and calculated fluctuations. This is caused by the uncertainty on some of the components. If however the difference between calculated and measured water level is too large (e.g. three times the standard deviation), this can be seen as human interference.

Suttcliffe J. and Y. Parks, 1999, The Hydrology of the Nile. Institute of Hydrology, Wallingford, Oxfordshire, UK: International Association of Hydrological Sciences Press.