



An analytical framework for extracting hydrological information from time series of small reservoirs in a semi-arid region

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Small water reservoirs for water resources management have as important socio-economic advantage that they bring water close to villages and households. This proximity allows for many water uses in addition to irrigation, such as fisheries, household water, building materials (loam, reeds), tourism and recreation, and cattle watering. These positive aspects are offset by the relatively large evaporative losses in comparison to larger reservoirs, although, it is not exactly known how large these losses are. For decision makers, investors and donors, the decision to construct a small reservoir should be multifactored; and based on economic, socio-cultural and environmental factors. For the latter, getting the water balance and the energy budget of small reservoirs right is key for any environmental impact analyses.

For Northern Ghana, the relation between volume of a small reservoir and its' surface area has been established in a robust equation as: $Volume = 0.00857Area^{1.4367}$ with the surface area explaining more than 95% of the variation in water volume of the reservoirs. This allows the use of remote sensing observations for estimating water volume of small reservoirs in northern Ghana. Hydrological analyses of time series of small reservoir areas comprises estimates of evaporation fluxes and cumulative surface runoff curves. Once the reservoirs are full, spillage will occur and volumes and surface areas remain stable at their maximum extents. This implies that the time series of reservoir surface area contains information concerning the on-set of downstream surface runoff. This on-set does not coincide with the on-set of the rainy season but largely depends on the distribution of rainfall events and storage capacity in the subsurface. The main requirement for this analysis is that the reservoir has negligible seepage losses or water influx from the underlying subsurface.

In our research, we carried out a time series analysis of surface area extent for about 45 small reservoirs in the Upper East Region of Ghana. Reservoirs without obvious large seepage losses (field survey) were selected. To verify this, stable water isotopic samples are collected from groundwater upstream and downstream from the reservoir. By looking at possible enrichment of downstream groundwater, a good estimate of seepage can be made in addition to estimates on evaporation. We estimated the evaporative losses and compared those with field measurements using eddy correlation measurements. Lastly, we determined the cumulative surface runoff curves for the small reservoirs. We will present this analytical framework for extracting hydrological information from time series of small reservoirs and show the first results for our study region of northern Ghana.