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An eye on small reservoirs: remote sensing of storage volumes, their use as remotely sensed runoff gauges, and evaporation losses

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Small reservoirs are important sources of water supply for the scattered rural population in semi-arid areas. Due to their small size, and their existence in large numbers, such reservoirs have not been studied much. Little is known about their storage volumes, their impact on their watershed's contribution to runoff downstream, and their evaporation losses are frequently stated to be prohibitive.

Satellite remote sensing can be used to assess and monitor small reservoirs' storage volumes with regional area-volume equations. Radar remote sensing of small reservoirs was found suitable especially during the rainy season due to its capability to penetrate clouds, but is affected by wind and lack of vegetation context during the dry season. Reservoirs were extracted most often successfully with a quasi-manual classification approach, as stringent classification rules often failed under less than optimal conditions. Especially wind speeds above 2.6 m s^{-1} at the time of image acquisition were detrimental (Bragg scattering) to the extraction of reservoirs. Due to lower wind speeds, the use of night time acquisitions was more effective than the use of daytime images.

With a time series of radar images, small reservoirs were used as remotely sensed runoff gauges, and to calibrate hydrological rainfall-runoff models. Eight small reservoirs in the Upper East Region of Ghana, and Togo, were monitored to calibrate modified Thornthwaite-Mather models, in which increasing precipitation leads to exponentially increasing contributing areas. Model results indicate that the reservoirs captured, on the average, 34% of the quick flow, and 15% of overall runoff from their watersheds.

Reservoir evaporation losses were measured directly with a floating evaporation pan and were compared to evaporation rates determined from the reservoir's energy budget, and Penman's equation. The direct pan measurements were generally lower than the evaporation determined with the energy budget or Penman. Compared to land based potential evaporation, the reservoir evaporation was not excessive. Regional wind patterns influence evaporation dynamics from the reservoir. Northeast winds with a high saturation deficit lead to significant evaporation losses, while the evaporation losses under moister, more prevalent southwest winds were moderate.