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Reservoir siltation mapping uncertainties – experiences from South Africa

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Mapping reservoir siltation is an often-used method for assessing sediment yield and soil erosion from catchments. An advantage of this approach is that measurements can potentially provide mean values that represent timeframes of several decades and thus overcome the bias induced by climate fluctuations, especially in semi-arid and arid regions. Furthermore, reservoir siltation mapping can be performed repeatedly, and thus repeated sediment yield trends over time can be derived. There are several studies that report sediment yield estimates based on reservoir siltation surveys, however, information on the uncertainties involved in these measurements is not frequently reported.

In October 2019 and March 2020, we conducted reservoir siltation surveys of eight mid-size (~ 10 mio m³ water storage capacity), filled and dried-out reservoirs in South Africa. The water-filled reservoirs were surveyed using single beam, single frequency echosounders mounted to a boat. The dried-out reservoirs were surveyed using differential GNSS and a Terrestrial Laser-Scanner (TLS) with a scanning range of up to 1 km deployed at multiple scanning positions.

In this contribution we present survey results, report on the issues encountered during the surveys and the uncertainties observed in the results. For the water-filled reservoirs we derived depth measurement uncertainties from the survey leg intersection points. Here, the mean measurement error is in the order of 0.1 m ($p= 0.05$). When this uncertainty of the volume estimation is applied to the water storage capacity of the dams, the resulting uncertainties are in the order of a few percent, only. However, if this volume estimation uncertainty refers to the volume of the sediment at the bottom of the reservoirs, the relative error is can be in the order of a few ten percent. From this we conclude, that depending on the sediment inflow, it may take several decades before a repeated survey can establish a meaningful trend in sediment yield from the catchment beyond the measurement uncertainties involved.