Supplement of Hydrol. Earth Syst. Sci., 27, 2189–2204, 2023
https://doi.org/10.5194/hess-27-2189-2023-supplement

Hydrology and Earth System Sciences
Open Access
EGU

Supplement of

Hydrological regime of Sahelian small waterbodies from combined Sentinel-2 MSI and Sentinel-3 Synthetic Aperture Radar Altimeter data

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1 Evaluation of satellite derived A-H curve using in situ data

For lakes Seguenega and Bam (Table 1), volume-height (V-H) curves were provided by the Direction Générale des Ressources en Eau (DGRE) via l'Institut International de l'Eau et de l'Environnement (2IE). For Lake Bam, we also have in situ data obtained by Pouyaud (1975). Since our method produces A-H data, to compare in situ and satellite results we need to estimate volume. We have calculated volumes from our A-H curves using the integration method (Abileah et al., 2011) and we have compared the results to pyramidal and cylinder methods (Abileah et al., 2011; Taub, 2000). All methods gave similar results. The maximum of average differences in the volumes obtained were of 633 m^3 (Lake Bam) and 263 m^3 (Lake Seguenega) which is for both smaller than 0.01 % of the volume.

Satellite data document lake variations from a starting value of height and volume, corresponding to the minimum water area detected in the time series, that are unknown. To match the V-H estimates with in situ data, we need to determine the volume corresponding to this minimum. In that purpose, we have matched the minimum water area, A_0, of our time series to the in situ water areas to estimate H_0 and V_0 corresponding to our starting point. Water areas from in situ V-H curves are given by the derivative of V(H) with respect to H. In situ V-H data are then compared to satellite derived V-H (Fig. S1a). Both curves agree very well for these two lakes. For Lake Bam, the agreement is good for both the DGRE and Pouyaud (1975) data.

2 Evaluation of errors on water heights

For each in situ V-H pair, the corresponding satellite V-H is extracted and statistics are calculated for matching in situ and satellite water heights (Fig. S1b). Bias is –0.070 m for Seguenega and –0.006 m for Bam and RMSE is 0.073 m for Seguenega and 0.015 m for Bam. For data from Pouyaud (1975) the bias is –0.035 m and the RMSE is 0.035 m but only two matching data are available. The comparison of water heights derived from satellites and in situ V-H data provides an evaluation of our method as a whole, which combines altimetry with surface areas from Sentinel-2. It differs from classical altimetry height evaluation, since it is affected by noise/error in water area estimations. Overall the construction of the A-H curve and the removal of outliers smooths out noise/error in altimetry and areas estimation. That makes the final RMSE values found when comparing to in situ data smaller than values found in the literature when altimetry data are directly compared to in situ heights.

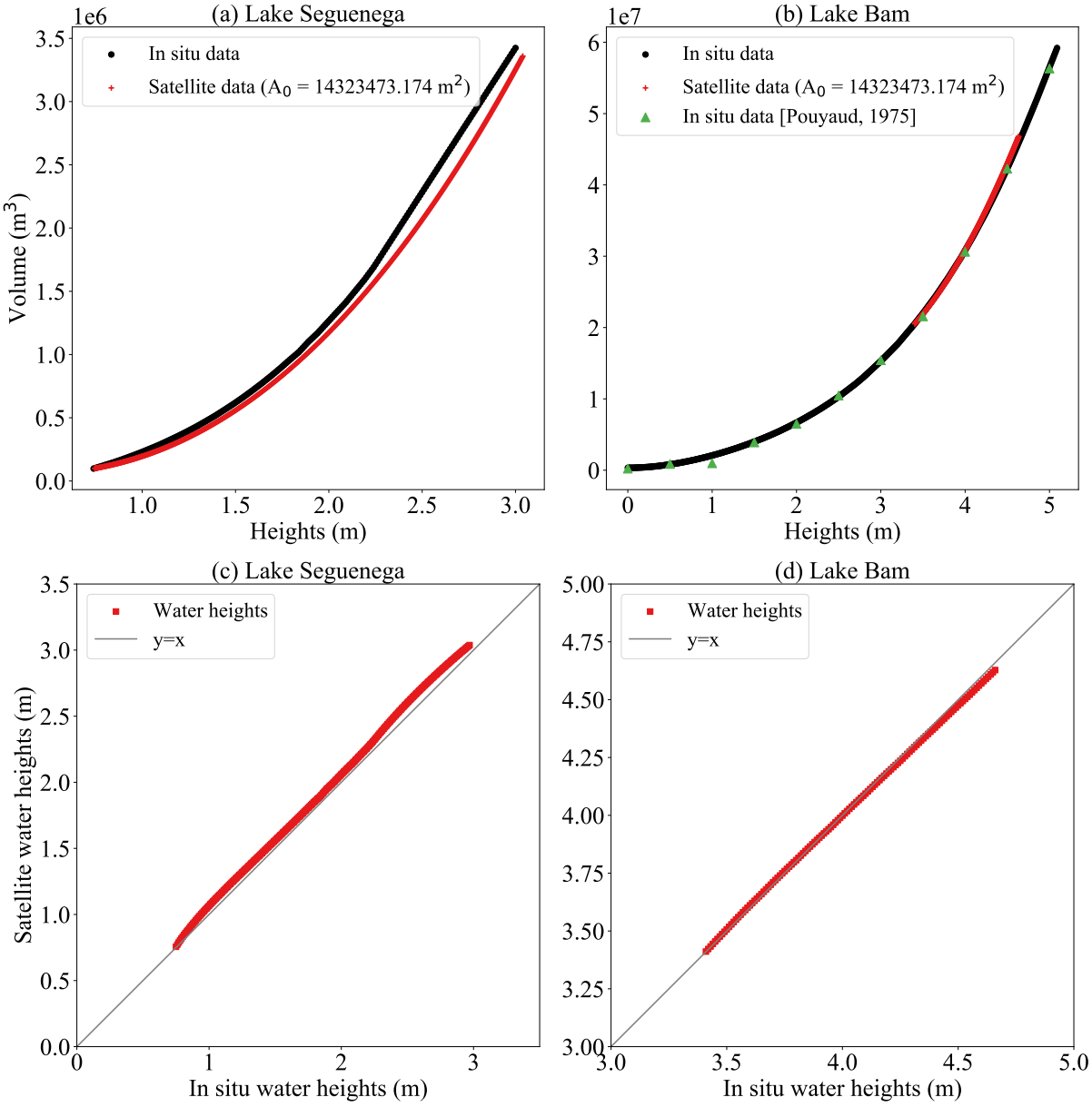

Figure S1. Satellite and in situ data comparison over Lakes Seguenega (left) and Bam (right). (a) and (b) represent water volume-height curve from in situ (black) and satellite (red) data. For the Lake Bam in situ data from Pouyaud (1975) are also reported (green). (c) and (d) represent satellite derived water heights compared to in situ water heights .

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