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Discussions

Interactive comment on "Monitoring small reservoirs storage from satellite remote sensing in inaccessible areas" *by* Nicolas Avisse et al.

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Response to the Short Comment 1 posted by Till Francke.

The manuscript by Avisse et al. describes an elaborated approach for retrieving the storage volumes of smaller reservoirs from remote sensing. As it relies exclusively on well-available optical and DEM data, it seems a valuable contribution for the monitoring of these storages in data-scarce regions. Since the authors also emphasise the general usefulness und transferability in this regard, I'd like to encourage them to share the required source code of the algorithm, which would match the spirit of publishing in an Open-Access-journal.

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Discussion paper

We thank you for your constructive comments. We indeed think this method could be applied to other reservoirs in different parts of the world. We took your suggestion to make the code available; it will soon be possible to download it at a URL.

Further minor suggestions: - Fig. 10 suggests that the methods tends to underestimate large volumes. Especially for Karama and Tanour there seems to be a upper limit, which the predictions of the method do not exceed. This is apparently not related to the complete filling of the reservoirs, as the ground observations confirm some dynamics within these phases. Is there any explanation to that?

This is a good point. We think that this phenomenon may be caused by a very small variation of the water area for highest water levels. If the number of high-elevation pixels is small, the uncertainty on their corrected elevation (and thus the filling curve) can potentially affect the estimate of the maximum storage. This may indeed be a limitation of the method.

We will add the following sentences in the revised version of the paper (p13, l12): "For some reservoirs (i.e., Karama and Tanour), the method seems to have difficulties to predict highest storages. Indeed, if the number of high-elevation pixels is small, the uncertainty on their corrected elevation (and thus the filling curve) can potentially affect the estimate of the maximum storage. This may be a limitation of the method."

- Table 2: The values of $eps_m(V)$ for Kafrein and King Talal differ surprisingly from the impression one gets in Fig 10: In the plot, Kafrein seems to be modelled much better than King Talal. Is there any explanation for this surprising impression?

The selected error indicator does not represent well the quality of the results. This is due to the definition of $eps_m(V)$ itself. $eps_m(V)$ measures the ratio of errors compared to observed storages. Errors for Kafrein reservoir estimates are low, but the storage is also sometimes very low. This explains why the relative error is high. For King Talal, observed storages are systematically higher that estimated ones, which may explain why eps$_m$(V) tends to be so small.

Proposed correction: we would like to replace eps$_m$ with the NRMSE criteria defined as: $NRMSE = \frac{1}{Hist_{max} - Hist_{min}} \cdot \sqrt{\frac{1}{N} \sum_{i=1}^{N} \frac{(RS_i - Hist_i)^2}{N}}$ to give more weight to large errors than to smaller ones. The normalization is also done by considering (Vmax-Vmin) to consider the large range of storage variations. By using this criteria, errors vary between 10 % and 16 % for V and between 5 % and 30 % for H, and better match the impression we have when looking at the curves.

- Specifying a relative error for H (eps$_m$(H), Table 2, Fig.11) does not make sense to me: If H is water surface elevation, eps$_m$ will then depend on absolute altitude. Instead, water level (H - H$_{min}$) or absolute deviation (H$_{RS}$-H$_{HIST}$ - mean(H$_{RS}$H$_{HIST}$)) should be used.

Yes, you are right. We did not make it clear enough in the first version of the manuscript, but we did use (Hc-Hmin) to calculate the relative error. In the definition that we chose for the NRMSE, the normalization is now done using the difference between maximal and minimal values, so we do not have this issue anymore.

- The choice of the regression used for reconstructing the H-A-relationship is not explained: According to Tab. 1, "Polynomial Regression" of different order and "Local Polynomial Regression" are used. Are they selected by best fit? The respective description (p. 10, ll. 15) is quite vague, especially concerning the 3-fold repetition of the process and the exclusion of outliers.

Proposed correction: "To address the issue, a polynomial regression on observed land pixels (A > Ai, with Ai the area assumed as immersed during the satellite elevation retrieval) is used to build a "corrected elevation"-area relationship (A -> Hc(A)) **that**

best fits the data (on a least-squares sense). Values of H greater than the 80th or lower than the 20th percentile are ignored to filter potential errors and smooth the data. This step is executed three times – one for each DEM – and the better quality dataset **(i.e., the one with less dispersion and "anomalies" as defined above)** is kept. A few examples are shown in Fig. 7."

- When discerning water surfaces, water bodies with macrophyte growth remain a serious challenge. It would be interesting to discuss if the presented approach for eliminating the SLC-data gaps could also help to tackle this issues.

Macrophytes could indeed put a limitation to the detection of water bodies area. If there is no significant variation in the elevation, the 3D correction will not be as effective as with the Landsat N/A stripes to fill macrophyte-covered water areas. However, in that case the missing volume may not be significant if macrophytes do not cover a large part of the reservoir.

- The figures containing map mostly refer to a certain datum/projection. Still, this would need the specification of some units [km]; a scalebar would facilitate interpretation.

Thanks for this comment. We indeed forgot to specify that 1 unit equals 1 m. **We will add it in the legend of figures 3, 4 and 8.**

- Commonly, table captions are displayed above a table, not below it.

This is unfortunately out of our hands as we used the HESS Discussion template which defines the standards.

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