Hydrol. Earth Syst. Sci. Discuss.,
https://doi.org/10.5194/hess-2018-86-AC2, 2018

Hydrology and Earth System Sciences
Discussions
Open Access
EGU

Interactive comment on "Unraveling the hydrological budget of isolated and seasonally contrasted sub-tropical lakes" *by* Chloé Poulin et al.

Chloé Poulin et al.

poulin@cerege.fr

Received and published: 21 August 2018

We thank the reviewer for his work on our manuscript, and for his detailed prescriptions. The reviewer criticized the lack of clear presentation of our objectives, and the structure of the manuscript that he considers difficult to follow. He also did not understand in what purpose we used stable isotopes, and to what extent our study was different from previous ones on remote areas. He has specific recommendations. First, he suggests re-writing the introduction section in order to clarify the research question and the objectives. He also recommends developing the theoretical background of the stable isotope method and adding more references. Finally, he proposes to develop

Printer-friendly version

Discussion paper

the Materials and Methods section by moving all the section 5.1 in this section, and to clarify our use of Lake Ihotry from Madagascar as a test of our method. We understand how several paragraphs can be considered as misplaced, thus precluding a good understanding of our study. We will be ready to work on improving the text following his recommendations.

We agree with the reviewer that several previous studies were able to determine the hydrological budget of tropical lakes, even when difficult to reach, and that some of them also used satellite altimetry data. However, all these studies dealt with relatively small basins, and where based in general on extensive data sets and continuous monitoring. For instance, Liebe et al. (2005) and Rodrigues et al. (2012) (cited in the paper), estimated small reservoir storage capacity with altimetry data. Gal et al. (2016) calculated a hydrological budget with altimetry data, but with regular water height measurements (data we do not have in our study). Alternative methods such as the Thornthwaite-Mather procedure (Steenhuis and Van der Molen, 1986; Collick et al., 2009) are also efficient for estimating water budgets in remote areas, but require precise precipitation data, which remains unavailable in many areas. By contrast, we want to emphasize the huge surfaces of the catchments of the two lakes Iro and Fitri (195 000 and 96 000 km2), with only one meteorological station. It is thus impossible to interpolate data at this scale. Standard hydrogeological approaches are thus highly unconstrained in such a case, and isotopes may help to obtain a first order hydrologic budget. Calculating the mean evaporation/inflow ratio of a lake from a simple mass balance equation has been already applied in a number of studies (Gat, 1978; Gibson et al., 1993; Gibson, 2002; Yi et al., 2008). However, the seasonal variation of isotopic composition was generally not discussed in studies despite very few available data over a year (Mayr et al., 2007; Yuan et al., 2011; Brooks et al., 2014). This may induce large error on the results, especially in catchments with seasonal climate contrast (Gibson, 2002).

In our manuscript, we describe a simple method to circumvent this difficulty, by combining isotopes with altimetry data in order to assess uncertainties on the influx and

Printer-friendly version

Discussion paper

outflux calculation. This approach requires only point data collected during the dry season, and is thus most appropriate for isolated tropical lakes with difficult access during the wet season. Recently, Cui et al. (2018) reviewed a number of case-studies where detailed hydrographic and isotopic monitoring were obtained on different lakes under various climates, in order to identify the most representative period for sampling during the seasonal cycle in each case, in the hope of obtaining a representative long term perspective on the lake water balance. We see our study as fully complementary to this approach.

We also take good note that introducing lake Ihotry from Madagascar only in the discussion was too late, and thus confusing. We used our results previously published on this lake as a benchmark test of our method, and did not want to place those results on the same line as the new data produced on the Chadian lakes during this study. However, the reviewer is right that this should be introduced and explained earlier in the paper.

We are willing to take into account all the reviewers recommendations to clarify our manuscript. We will re-write the introduction section in order to better put forward our research questions and objectives, and better develop the theoretical background of our use of the stable isotopes method. We will develop the Material and Method section to clarify our use of Lake Ihotry from Madagascar. In this section, we will also move all the section 5.1 to explain our scientific approach, in order to facilitate understanding of the discussion section.

Brooks, J. R., Gibson, J. J., Birks, S. J., Weber, M. H., Rodecap, K. D. and Stoddard, J. L.: Stable isotope estimates of evaporationâĂŕ: inflow and water residence time for lakes across the United States as a tool for national lake water quality assessments, Limnology and Oceanography, 59(6), 2150–2165, doi:10.4319/lo.2014.59.6.2150, 2014.

Collick, A. S., Easton, Z. M., Ashagrie, T., Biruk, B., Tilahun, S., Adgo, E., Awu-

lachew, S. B., Zeleke, G. and Steenhuis, T. S.: A simple semi-distributed water balance model for the Ethiopian highlands, Hydrological Processes, (23), 3718–3727, doi:10.1002/hyp.7517, 2009.

Cui, J., Tian, L. and Gibson, J. J.: When to conduct an isotopic survey for lake water balance evaluation in highly seasonal climates, Hydrological Processes, 32(3), 379–387, doi:10.1002/hyp.11420, 2018.

Gal, L., Grippa, M., Hiernaux, P., Peugeot, C., Mougin, E. and Kergoat, L.: Changes in lakes water volume and runoff over ungauged Sahelian watersheds, Journal of Hydrology, 540, 1176–1188, doi:10.1016/j.jhydrol.2016.07.035, 2016.

Gat, J. R.: Isotope hydrology of inland sabkhas in the Bardawil area, Sinai, Limnology and Oceanography, 23(5), 841–850, 1978.

Gibson, J. J.: Short-term evaporation and water budget comparisons in shallow Arctic lakes using non-steady isotope mass balance, Journal of Hydrology, 264(1), 242–261, 2002.

Gibson, J. J., Edwards, T. W. D., Bursey, G. G. and Prowse, T. D.: Estimating Evaporation Using Stable Isotopes: Quantitative Results and Sensitivity Analysis for Two Catchments in Northern Canada, Hydrology Research, 24(2–3), 79–94, 1993.

Liebe, J., Van de Giesen, N. and Andreini, M.: Estimation of small reservoir storage capacities in a semi-arid environment, Physics and Chemistry of the Earth, Parts A/B/C, 30(6), 448–454, doi:10.1016/j.pce.2005.06.011, 2005.

Mayr, C., Lücke, A., Stichler, W., Trimborn, P., Ercolano, B., Oliva, G., Ohlendorf, C., Soto, J., Fey, M., Haberzettl, T., Janssen, S., Schäbitz, F., Schleser, G. H., Wille, M. and Zolitschka, B.: Precipitation origin and evaporation of lakes in semi-arid Patagonia (Argentina) inferred from stable isotopes (δ18O, δ2H), Journal of Hydrology, 334(1–2), 53–63, doi:10.1016/j.jhydrol.2006.09.025, 2007.

Rodrigues, L. N., Sano, E. E., Steenhuis, T. S. and Passo, D. P.: Estimation of Small

Reservoir Storage Capacities with Remote Sensing in the Brazilian Savannah Region, Water Resources Management, 26(4), 873–882, doi:10.1007/s11269-011-9941-8, 2012.

Steenhuis, T. S. and Van der Molen, W. H.: The Thornthwaite-Mather procedure as a simple engineering method to predict recharge, Journal of Hydrology, 84(3–4), 221–229, 1986.

Yi, Y., Brock, B. E., Falcone, M. D., Wolfe, B. B. and Edwards, T. W. D.: A coupled isotope tracer method to characterize input water to lakes, Journal of Hydrology, 350(1–2), 1–13, doi:10.1016/j.jhydrol.2007.11.008, 2008.

Yuan, F., Sheng, Y., Yao, T., Fan, C., Li, J., Zhao, H. and Lei, Y.: Evaporative enrichment of oxygen-18 and deuterium in lake waters on the Tibetan Plateau, Journal of Paleolimnology, 46(2), 291–307, doi:10.1007/s10933-011-9540-y, 2011.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., https://doi.org/10.5194/hess-2018-86, 2018.

Printer-friendly version

Discussion paper