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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Managed aquifer recharge with reverse-osmosis desalinated seawater: modeling the spreading in groundwater using stable water isotopes" *by* Yonatan Ganot et al.

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We would like to thank anonymous referee #2 for his positive review and insightful comments. We provide below our detailed response to each comment.

Referee overview As an increased using of new water resources, understanding its effect is necessary. The desalinated seawater is a potential water resource with the increasing demands of fresh water all around the world in the modern days. This manuscript introduces a new insight of stable isotope application in water research.

An isotopic solute transport model was built to estimate the spread of the desalinated seawater in the coastal aquifer. It is not common to see applying the stable isotope method by a numerical model, considering the wide range of isotopes of the water bodies. Authors take the advantage of the conservation isotope concentration of the DSW, so that they can simplify the local water sources to groundwater into a binary system in the sight of isotopic concentration. To be honest, this manuscript is very interesting but it is really hard for me to make a comment on it. Generally, it is a useful and convincing study, but it lacks novelty on method. So my suggestion is accepted after revision.

Response to the Referee overview We are very contented that referee #2 summarized the significance of this work in its two most unique features. The extreme difference in the isotopic signature between reverse-osmosis DSW and all other sources of natural fresh water that makes the binary system approximation solid, and the data-based flow and transport model of water isotopes and its simulations. The novelty of this study was discussed in our response to referee #1 (https://doi.org/10.5194/hess-2018-341-AC1).

General comment The number and type of water samples are not clear in this manuscript. Since the rainwater and the runoff water in the setting pond are regarded as water sources to the groundwater, it should be more specific of the isotope data, especially, the runoff water.

Response to General comment We will add a detailed description of the water samples to the revised manuscript, including water sample type and number of samples. Please see more details in the following responses to the specific comments.

Comment 1 How many isotopic water samples do you have?

Response 1 We have a total of 70 isotope samples, where each sample was analyzed for ^{18}O and ^{2}H isotopes. We used 42 samples that were sampled from groundwater production wells for the model calibration (see Fig. 4c). The remaining 28 samples were sampled from several sources: (1) the DSW inlet pipe, (2) few locations inside the DSW infiltration pond, (3) runoff canal, and (4) shallow observation wells (OA and OB). We will add this information to the revised manuscript.

Comment 2 Is there any water samples of rain or runoff water in the ponds? Line 124

Response 2 We did not sample rainwater in this study and instead we used the rainwater data from Gat and Dansgaard (1972) as described in lines 152-154. We have water samples from one runoff event (δ^{18}O=–4.77‰ and δ^{2}H=–19.5‰) that was taken on January 2017 (very similar to the rain composition of δ2H=–19.9‰ line 154). Unfortunately, we have no samples from the runoff event of 2015 (line135-136) and we assumed the runoff isotope composition of 2015 is similar to 2017. This clarification will be added to the revised manuscript.

Comment 3 How did you deal with these values? The lowest and highest? For example, the lowest C_{GW} δ^{18}O=–5.43‰ δ^{2}H=–22.68‰ is this the result of one sample or the lowest values of all groundwater samples? Why? Line 121.

Response 3 We normalized the concentrations to the lowest value that was measured in the aquifer (i.e., based on one sample). Next, in section 3.2.3 (line 205) we check this assumption by normalizing the concentrations to the highest value (also based on one sample) and then compare the simulation results of these two extreme options (Fig. 6). We show that the results are almost similar (less than 1‰ difference) in the aquifer area next to the infiltration ponds. Hence, in similar isotope binary systems, a practical conclusion of this analysis will be to use an average isotope value to normalize the isotope concentrations in the aquifer. We will add this explanation to the revised manuscript.

Comment 4 Is there any soluble salt in the study area? Line 150

Response 4 There is no extensive soluble salt layer/formation according to the recent available geological data. In Ganot et al., 2018 (Table 1) it is shown that chloride con-

centrations are similar in: (1) pond water of the infiltration basin; (2) variably saturated zone (suction cups at 0.5-3 m below surface); and (3) shallow groundwater below the pond. Therefore, dissolution of chloride during infiltration is negligible. Chloride concentration of naturally infiltrating groundwater is mostly related to evapotranspiration which concentrates the rainwater with respect to the conservative chloride ion. Nevertheless, the binary system approach used in this study based on conservative water-isotope tracers is superior to both conservative and non-conservative classic tracers. This is an important insight - thank you. We will add this paragraph to the revised manuscript.

Comment 5 Do you have any data from modern rainwater? Is that too old for your study? 1972? Line 153

Response 5 The paper of Gat and Dansgaard (1972) is the most comprehensive survey published on stable isotopes of fresh water in Israel. It includes rain samples that were collected next to the Menashe MAR site and were used in this study (line 153). A more recent study (Goldsmith et al., 2017) reports similar values (δ^{18}O=–5.1‰ to –5.7; δ^{2}H=–18.6‰ to =–25.6‰) for rain samples collected at the coastal plain of Israel, but it based on fewer sampling station and with no sampling point next to Menashe MAR site. We will add this reference to the manuscript.

Comment 6 All the advantages listed in the manuscript of using the method show that it is specific lucky for this area. Can you give some descriptions to show the universal applicability?

Response 6 The advantage of using stable water isotopes for tracing reverse-osmosis desalinated water in various downstream water systems is already known from previous studies (Ganot et al., 2018; Kloppmann et al., 2008a, 2008b; Kloppmann et al., 2018; Negev et al., 2017). In this study we use this advantage in a modeling framework to predict future mixing and spreading trends of DSW in the aquifer (line 56-63). Therefore, the modeling approach presented in this study can be used in other sites (e.g., Mazariegos et al., 2017; Negev et al., 2017; Stuyfzand et al., 2017) to predict reverse-osmosis desalinated-water distribution in aquifers. As the production of DSW using reverse-osmosis is projected to increase (Hanasaki et al., 2016) and the use of MAR system widens (Hartog and Stuyfzand, 2017; Rodríguez-Escales et al., 2018) we are sure that the advantage listed in this manuscript is/will be highly relevant for more MAR hydrologists. Above seawater desalination and MAR, integrating water resources is a key for dealing with increasing water demands and droughts, hence operations of similar features are expected to develop first in semi-arid regions but also in more temperate climates. We will add these arguments to the revised manuscript.

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