

# ***Interactive comment on “Stable isotope investigation of groundwater recharge in the Carpathian Mountains, East-Central Europe” by Carmen-Andreea Bădăluță et al.***

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We would like thank the referee for the fast response and to the recommendations and we are grateful for the comments on how it can be further improved. We provide below a point by point response to the reviewer’s comments/suggestions.

Comment 1: According to the title the main focus of the manuscript (MS) is the study of the groundwater recharge. The authors took samples from dug wells for characterizing the shallowest groundwater, but the sampling method they applied was not appropriate. They simple took grab samples 30-50 cm below the surface of the water in the dug wells. Water in a dug well is in direct contact with the atmosphere, and so it may

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evaporate easily, which modify both chemistry and isotopic characteristics. Looking at the groundwater data on Figure 3 we can easily recognize that several water samples suffered evaporation effect (they are far below the Local Meteoric Water Lines). Actually the slope of the trend line of groundwater samples has got the lowest value, which is another indication for evaporation effect. This entire means that the collected groundwater samples are not representative of the shallowest groundwater. The proper way of taking representative sample of groundwater from dug well involves the removal all the water from the well and the newly infiltrated water can be used for sampling.

Response 1: We have used the standard strategy of collecting water from dug wells (Hunt et al. 2005). Further, we have removed the GMWL given the very similar stable isotope values in the samples, which translate into a line that is unrepresentative. While the “cloud” of groundwater data might suggest evaporated samples, this is not the case here. The d-excess values of the groundwater samples is usually between 9 and 10, close to the average of precipitation, with only 5 out of 88 being lower than 9 (and 3 from the same well), thus indicating extremely limited (or absent) evaporation.

Comment 2: If we want to determine whether the shallowest groundwater is locally infiltrated or it was infiltrated at a higher elevation area, minimum we need a conceptual groundwater flow model. This is completely missing from the manuscript. Having been identified the local recharge areas we can characterize the isotopic composition of the locally infiltrated water. On the local, intermediate or regional discharge areas the locally infiltrated water necessarily mixes with the discharging groundwater. Once we know the characteristics of the locally infiltrated water, we can study this mixing process.

Response 2: We have switched both the approach and the general organization of the text. . We fully agree that the title and the general organization of the text do not clearly lead to the idea enounced in the title. We attempted a recharge study, the hypothesis being that we would be able to 1) disentangle between various moisture sources and tracks feeding precipitation in the study area and analyze their controlling

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factors, 2) track how precipitation water feeds local aquifers and 3) analyze the relationship between precipitation, river and ground waters; the overall aim being to provide policymakers a first tool to be used (and improved) to assess groundwater resources.

Comment 3: Major part of the manuscript deals with precipitation including its isotopic characteristics. But: stable isotope time series are discontinuous for both stations, Rarău and Suceava, see Table 1. In case of Rarău there are long periods with no data, e.g. from December 2012 to April 2013, or from June 2014 to December 2014, or from September 2015 to May 2016. The situation for the Suceava station is far better, but there are several months (actually 10) without any data. I hardly believe that there was no precipitation for so long periods of time (the MS doesn't mention any reason for lack of data). This entire means that the precipitation isotope data theoretically don't describe well the local precipitation. This data set can be used for calculating the first approximation of the LMWLs, but inadequate for calculating the multiannual means of delta values.

Response 3: The lack of samples from the Suceava station is due to the extremely low amounts of rainfall in the relevant months, while at the Rarău station the lack of most samples is due to possible evaporation of the samples after collection (they were stored at room temperature for more than two weeks and we have decided not to include them in the study).

Comment 4: Not having representative groundwater samples, neither proper mean delta values of local precipitation the "Stable isotope investigation of groundwater recharge" is hopeless, or at least inappropriate.

Response 4: We agree on the inappropriateness of the title. As discussed above, we have changed the general approach and structure of the text, and hence the title was changed to - Moisture sources, transport and hydrological processes in Carpathian Mountains, Central East Europe.

Comment 5: HYSPLIT: I am not experienced in this field, so I have discussed this part

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with two of my colleagues, who are applying this method in their research work. They have confirmed my feeling that modelling at only one level (500mb) is not enough. Modelling at three levels is the most common situation in these kinds of publications (recently). Furthermore, the specific humidity along the trajectory was not determined, so the source region of the air mass was determined, but not the source region of the vapor!

Response 5: We have modeled the HYSPLIT-based trajectories at three levels (500, 1000 and 1500 m AGL), however, the differences were negligible, with little to know impact on the results. We have plotted the trajectories at 1000 m AGL and used these for calculating the sources. Now, the sources. The model was run for days with significant precipitation (>3 mm) in order to minimize the effect of sub-cloud evaporation of raindrops on the stable isotope composition of meteoric water. For each trajectory, we have acquired hourly atmospheric pressure, potential and environmental temperature, precipitation and relative humidity. Along every trajectory we have calculated (using HYSPLIT output data) the specific humidity using standard equations (Baldini et al., 2010, Krklec et al., 2014, Sodemann et al., 2008). Further, we have derived the moisture uptake using the specific humidity following Sodemann et al. (2008) and Krkelec et al. (2014). Interestingly, a good correlation was found between the source region of the air masses and the source region of the vapor for moisture derived from both the three “wett” sources (Atlantic Ocean, Mediterranean and Black Sea) and the dry continental one. Further, in the case of local trajectories, during summer, locally evaporated water was more important in terms of amount and stable isotope composition than that from the source region of the air masses. However, in winter, the stable isotope composition of the moisture was more conservative, “preserving” the original signal.

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