Answers to Review 2 – https://doi.org/10.5194/hess-2021-322-RC2 **(Dec 2021)**

Thank you very much for your review, insightful comments and helpful recommendations.
Please allow us to address your general and specific comments in the following.

General Comments

1. **Introduction (too long)**

This comment was also made by Reviewer No. 1 and we changed, reorganised and shortened our Ch.1 Introduction accordingly.

2.

3. **Quantitative aspect of RC attribution**

Also this was already found in review 1 as a main shortcoming of our manuscript. We adapted our manuscript thoroughly, changed Table 3 and added more precise descriptions and explanations of our work.

4.

5. **Societal issues**

We slightly adapted and added to our manuscript (Section 1.3)

6.

7. **Climate change & emphasis on applicability to many major resources of the Mediterranean region**

We added a short mentioning of climate change under Ch. 6 (end of first sentence; third sentence).

Specific Comments

8. **Again: Length of Ch. 1 Introduction**

As in 1. Above.

9. **Discussion of application to other peri-Mediterranean sites (soil, crops, geology…)**

8 lines of text were added to Ch. 6 Conclusions (sentence 3 ff.)

10. **Again (and as in Review 1): Quantification of RC-values (% figures)**

As noted before, major changes were made in the manuscript. The methodology was explained more precisely and the text and Table 3 in the Ch. 4 Results were changed.
And more specifically on your remark: "This point [*percentage value*], which makes it possible to quantify the recharge areas and to propose a detailed map, is not explicit at all." Major changes were made in Ch. 3 Methodology.- The quantification is now better explained and stated more explicitly in several of its sections (for example 3.2.). We explain, where the quantitative RC figures come from (soil models in the first article of the series) and how they were used for other formations under the Soil Group, as well as attributed to the other groups (and their different formations). Please note, as already discussed in our answer to Review 1: In all but one formation, we used the exact values of RC as modelled at the representative soil measurement sites (for 5 different formations) – see first article (Messerschmid *et al.*, 2020). The one exception (l-UBK formation), where we introduced a new RC (composite value of two modelled RC-values), is now highlighted an explained in both text and table 3.

11. **The role of slope in recharge and its role in our Basin Classification Framework**

This is a valuable comment, thank you. In principle you are right and indeed, also relief (slopes) plays an important role. But in our specific case we opted for not singling it out as a distinct Group of our

Basin Classification Framework (BCF). It was however included as one of the relevant factors in our analysis on land forms (LU/LC Group).
More specifically: The matter of slopes - especially terraced slopes and their role in soil infiltration and percolation - had been dealt with in the first article. For this purpose, their nature and distribution were observed in the field, and their typical appearance and prevalence was attributed accordingly to the different lithostratigraphic formations that crop out in Wadi Natuf (together with the typical soil thickness cover over each such formation). The results were discussed and presented in the first article; see our "matrix" in Table D1, Annex D in Messerschmid *et al.* (2020). In this new manuscript (under review), this matrix is mentioned 4 times in the Methodology and another time in the Discussion. In the new article under review, this correlation is also mentioned in the text and shown in the photographs in Fig. 3.
Please allow us to go into more detail on this point (see discussion at the end of this file).

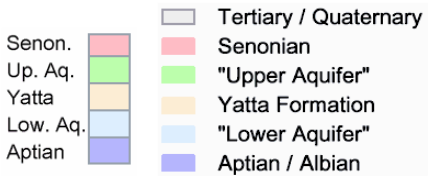
Technical corrections

12. Colours in Figure 1 and 2

The colours were adapted and unified

13. Colours in Table 1

Please note that the colours in Table 1, in our opinion, should not be the same as in Figures 1 and 2. The figures are area-specific maps of the different formation outcrops in the area - grouped as main regional aquifers and aquitards: Upper Aquitard (Senonian) / Upper Aquifer / Middle Aquitard (Yatta) / Lower Aquifer / Bottom Aquiclude (Aptian). By contrast, Table 1 not only lists the Regional hydrostratigraphy but also the much more refined local hydro-stratigraphic divisions, which do not appear in the Figures. We would find it difficult to apply this regional colour code to the local fine-stratigraphy. In addition, the main purpose of this column is to portray the general conceptual differentiation between formations of different aquifer potential (major / minor / good / poor /local and none), which applies to all aquifers/aquitards worldwide. Our purpose here is that and to which extent the regional stratigraphy subdivides into a more refined pattern on the local scale. Using a rather chronostratigraphic colour code for the different formations (and sub-formations) would rather create some distraction from the main purpose, at least in our view. Last not least, as opposed to the figures, HESS journal may well choose to print the Tables on in different tones of shaded grey. The colours in this table may therefore have to be adapted anyway under the final layout.



New, unified colour code for both figures (Fig. 1 & 2)

Clemens Messerschmid, Amjad Aliewi, Dec 2021

Additional discussion on the role of slopes:

In general, many different types of physical characteristics can be used under our approach. As so often, the "art" here is how to keep it as simple as possible[1] while yet simultaneously as differentiated (complicated) as necessary.

The Research Hypothesis in my PhD-Thesis was that: "*recharge is controlled not only by 'outer' meteorological variations in rainfall (and evaporation), but also and especially by land-intrinsic physical features, such as bedrock lithology, soils and land forms (which encompass **relief**, soil, natural vegetation, land use and land cover)*" (freidok.uni-freiburg.de/data/174560, p. 36, section 1.5).

In principle, any number of different land forms or other, typical characteristics can and should be accounted for when creating a specific, intrinsic basin classification framework (BCF). The selection and choice, which set of parameters is best used cannot be decided upon in general. Rather, it is intrinsic to the particular study area at hand (see PUB recommendations). Based on the unique nature of each study area, a specific set of "best", most appropriate physical characteristics has to be picked from a large – in principle, *infinite* - number of possible factors. The researcher should ask: Which land features best express and represent the typical hydrological processes of recharge in the area? Which patterns are most pronounced? But also practically: Which features are easiest and most practical to determine, group and classify under field conditions? Etc.

As a matter of fact, at early stages of our work (and field work), we pondered over the question, whether to single out relief forms such as slopes (their steepness or dip, slope forms, exposition etc.), as an individual group for our BCF. But it soon became clear that in our study area, a rather confusing mix of different degrees of slope dipping, slope types, etc. was likely to emerge. (The amount of work did not seem to justify the amount of work necessary.) In addition, we checked but could not find a pronounced correlation between exposition of slopes and typical vegetation (e.g. north-growing plants vs. south-exposed vegetation…). Therefore we did not use slopes as an additional separate group. However, in other areas, slopes (or more generally: relief forms) may well be indicated as promising grouping factor. It should also be noted here, that the separation and attribution of different features to distinct groups in the BCF does not aim at completeness. Under empirical approaches such as ours, the aim should not be a most exhaustive number of parameter sets (as in Radulovič, 2012). Rather, and in line with PUB, a few, simple and easy to handle sets of land forms should be targeted and selected. The main question should be, whether they do faithfully represent the major processes of recharge in the respective catchment.

Nonetheless, as shown above, we did account for slopes (and terraces) in our matrix of typical soil depths. So, to a certain extent, their spatial distribution was accounted for and included in our analysis, though not singled-out as a separate group in the BCF.

Having said that, you are right in principle and we do encourage other researchers to pay attention to typical slope patterns, both, in their field observations and when approaching and setting up their site-specific BCFs for spatial recharge analysis.

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[1] „*In sum, many authors of PUB emphasized an increasing realization of the* need for simplification *in hydrological models and a common framework for hydrological modelling, such as Sivakumar et al. (2015), Grayson and Blöschl (2000); Woods (2002); Sivapalan et al. (2003b); McDonnell and Woods (2004); Sivakumar (2004b, 2008a); Wagener et al. (2007); Young and Ratto (2009) and Olden et al. (2012).*" (PhD-Thesis, p. 29)