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Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "Classification of Karst Springs For Flash Flood-Prone Areas in Western Turkey" *by* M. Demiroglu

M. Demiroglu

demiroglum@itu.edu.tr

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RESPONSES TO REVIEWER 2

I am deeply thankful for your contribution, time and important guidance. I am happy particularly that I have got very constructive, encouraging and positive comments for which I have prepared a list of "responses to comments" as follows:

1.There are different types of karst aquifers in Mediterranen areas. You cannot consider that all karst aquifers in the Mediterranea area have similar recharge behaviour. In term of percentage of infiltration in Mediterranean karst aquifer, you can consider the following articles (and relative references): Bonacci O. (2001) - Monthly and annual effective infiltration coefficient in Dinaric karst: example of the Gradole karst spring catchment. Hydrological Sciences Journal, 46(2), 287–300. Fiorillo F., Pagnozzi M.,

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Ventafridda G. (2015) - A model to simulate a recharge processes in karst massifs - Hydrol. Process. 29, 2301–2314. Besides, about Mediterranean area, the Author could find some recent srticles in a recent Special Issue "Mediterranean Karst Hydrogeology" published in Environmental Earth Sciences (Springer), 2015, volume 74, 5-295.

Response: This part doesn't infer that karst aquifers in the Mediterranean area have similar recharge behavior. Examples were given to show the high infiltration rate of karst terrains and to support following statement: "In karst regions, point infiltration and sudden rainfalls are correspondingly effective. Studies indicate that less than 5% of annual effective rainfall becomes groundwater recharge, whereas recharge to karst aquifers is in excess of 80% of effective rainfall" (Williams et al., 2007). Therefore, the "Mediterranean region" is removed from the sentence in Page 2 Line 35 as "Therefore, it can be mentioned that higher recharge in limestones is due to point infiltration coming from the well-developed karstic structures." The special issue of Environmental Earth Sciences were checked and foloowing references were properly cited and included in the paper:

Bakalowicz, M. (2015) Karst and karst groundwater resources in the Mediterranean, Environ Earth Sci., 74:5-14. Fiorillo F., Petitta M, Preziosi E, Rusi S, Esposito L, Tallin M. (2015b) Long-term trend and fluctuations of karst spring discharge in a Mediterranean area (central-southern Italy), Environ Earth Sci., 74:153-172. Günay G., Güner N., Törk K. (2015) Turkish karst aquifers. Environ Earth Sci., 74:217-226.

To improve the paper the following sentences and references were also added (Page 2, Lines 15-18): "The annual effective infiltration coefficients of the Gradole catchment in Croatia were given between 0.356 and 0.763 (Bonacci, 2001), The infiltration ratio between 0.6 and 0.9 of total precipitation were given for the mountainous karst regions in Switzerland (Malard et al., 2016).

(Page 2, Lines 29-37): Despite a year in which cumulative precipitation increases, the total amount of recharge into groundwater may be less in aquifers dominated by

diffused flow (Williams and Lee, 2007). This research reinforces the hypothesis that aquifers controlled by conduit permeability will have higher recharge and discharge rates unlike the aquifers dominated by diffused flow. Vertically oriented karst structures collect and transport very fast water from the surface into the underground fluvial system. Practically all rainfall quickly penetrates the karst underground system where it fills karst voids of different dimensions, and at the same time flows under the effect of gravity. (Bonacci, 2006). Therefore, it can be mentioned that higher recharge in limestones is due to point infiltration coming from the well-developed karstic structures. However, it should be mentioned that an accurate and reliable estimation of recharge into karst aquifers is difficult because of its heterogeneity (Bonacci, 2001, Fiorillo et al., 2015).“

2. Spring hydrographs are missing (also taken from literature); they can to support these statements.

Response: Spring hydrographs are partially available for springs studied here. For the sake of a consistent analysis, the hydrographs are not included in the text. Instead, coefficient of variation calculated for discharge was used as an indicator to support the statement (revised as follows): High discharge rates (Qmax/Qmin), rapid change in temperature and chemical composition reveal turbulence flow conditions in developed karstic structures with low storages (Aydin, 2005; Demiroglu, 2008). Low variations of the measurements in both wet and dry seasons point fracture and matrix permeability dominated by diffused controlled groundwater flow with low or high storage, and conduit permeability with high storage.

However, in order to respond the comment in a more proper way to satisfy the reviewer, a representtaive hydrograph was provided together with explanation below (Page 7, Line 7) :

S8 is a particular spring chosen a representative. “As an example, S8 (the SubasÄś spring) has three discharge points. Hydrograph of SubaşÄś springs S8 (Fig. 4) reflects

a correlation between monthly cumulative precipitation and discharge unlike the montly precipitation which does not replace such a correlation. Annual precipitation could influence the discharge of the following hydrological year (Fiorillo 2009, 2015b). This reterdation time in aquifers controlled by diffusive infiltration is longer than that in the point infiltration controlled aquifers. However, it is observed in Fig. 4 that the SubaşÄś spring discharge (64 l/s) in March 2002 suddenly rised to 173 l/s in April after a heavy precipitation of 88,3 mm in April. The total precipitation in April has been recorded as 88,3 mm more than twice compared to the average (43,98 mm) of total precipitation in April calculated for the long term from 1925 to 2005. This is shows that the vadose zone (developed fossil karstic structures) is activated after heavy rains and carries the surge to surface water and to deep aquifer. Therefore, spring S8 (SubaşÄś) is classified as having high response capability to heavy precipitation. “

3. 3. Conclusion are missing Response: Conclusions were listed as suggested. Page 7 line 40-42, Page 8 line 1-17 5. Conclusions

Following concluding remarks are drawn based on analysis and discussion of the data compiled for the karst springs in the study area:

1. Measurements compiled for the study considered reinforces that the recharge of karst aquifers dominated by conduit permeability can increase by heavy rains becoming more frequent than before with possible changes in the climate.

2. Karst aquifers, which are deeply fractured, mostly allocthonous in origin, located on the steeper parts of the land and bordered by impervious rocks can transfer the considerable amount of water from different hydrological drainage basins to flood areas.

3. In this study, an approach considering groundwater temperature, physico-chemical properties and discharge rates of springs in addition to lithological and structural features is used to determine the storage and flow conditions of the aquifers. However, due to heterogeneity, each karst aquifer is site-specific and needs detailed multi-method measurements and co-operation between hydrology and hydrogeology to reach more

reliable estimates.

4. This approach offers a valuable tool for the identification of flood-prone areas in large regions provided that representative and organized data sampling is available at least twice in wet and dry seasons.

4. Legend is missing in the geological cross-section. Response: Legend was checked and added.

5. Section trace on the map is missing Response: Section trace was added on the map

6. Qmax is less than Qmin? Response: Table 4 was corrected

Sincerely yours,

Muhterem DemiroÄ§lu

Please also note the supplement to this comment:
http://www.nat-hazards-earth-syst-sci-discuss.net/nhess-2016-6/nhess-2016-6-AC3-supplement.pdf

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