

Interactive comment on “Influence of aquifer heterogeneity on karst hydraulics and catchment delineation employing distributive modeling approaches” by S. Oehlmann et al.

Anonymous Referee #1

Received and published: 31 August 2013

The paper addresses relevant scientific questions within the scope of HESS journal, with fundamental and applied concerns about groundwater hydrology in karst environment: influence of the heterogeneity on hydraulic head distribution based on distributive modeling, and impact on the delineation of catchment area of karst springs. The paper presents the idea of improving delineation of karst spring catchment area using hybrid models introducing heterogeneity such as fault and karst conduits considering results of recent development on models taking into consideration conduits exchange with matrix and recent results of karst conduits genesis, based on the assumption that the common approaches for delineation of catchment area in porous media are of lim-

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ited use in karst systems. Such work has not yet been done, delineation of catchment area usually is based in karst system on dye tracing results, geology, geomorphology and karst features data. Regional groundwater flow modelling has been carried out using generally equivalent porous media model approach, or double continuum or hybrid model for groundwater resource management, but always with the problem of the lack of data on heterogeneity and conduits network. Substantial conclusions are reached as results of the various scenarios of modeling applied on the Gallusquelle area in South Germany reveal that the representations of heterogeneities have a large influence on the hydraulic head map and therefore on the delineation of the catchment area. Scenario 4 is the only scenario whose simulation results that may be considered as reasonable for the Gallusquelle, even if there is an underestimation of the area for the two other springs. Conclusions highlight the necessity to consider karst genesis of conduits to be implemented into hybrid and /or double continuum model and as well to integrate transport of tracer. The scientific methods used in this paper, groundwater modeling (continuum and hybrid approaches) and assumptions made on the implementation of fault and conduits are valid and clearly outlined. The results are sufficient to support the interpretations of the 4 scenarios that were modelled and as well the conclusions, based on available data and knowledge of the geology. The description of the experiments and calculations is sufficiently complete and precise, and it will allow their reproduction of the approach by fellow scientists on other case studies. The authors of the paper give proper credit to related work; their own new original contribution could be more clearly indicate, considering that this is the first time that such work considering the input of results of modeling can be used for the delineation of catchment area. The title of the paper clearly reflects the contents of the paper. The abstract provides a concise and complete summary of the main work carried out and the main approach used and obtained results. The overall presentation of the paper is well structured and clearly. The English language is fluent and precise. The mathematical formulae, symbols, abbreviations, units are correctly defined and used. The number and quality of references are appropriate. Some parts of the paper should be clarified?

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No reduction, combination or elimination are required. In the introduction, in the first paragraph, lines 10 to 13, it is necessary to add that hydraulic lines contour are used as well. In the second chapter, Methods and approach, in the first paragraph, lines 27 to 29, it is necessary to give details on the basic module. At the end of the paragraph, lines 2 of the page 4, default hydrogeology tools are not they the hydrologic tools used to delineate surface catchment area based on topographic lines ? The four scenarios are clearly described. In the chapter 3, Field site, prefer the term of hydraulic conductivity instead of solubility in the line 17. In the chapter 4, Model design and calibration, it is necessary to clarify and to modify the figure 4, where was implemented the conduits network based on the geometry of dry valleys, specifically on z, at which depth. On figure 4, the position of the conduits network used in the scenario 3 and 4 has to be represented. In the first paragraph of the page 9, line 6, it is necessary to add the reference of the figure 2 and to modify this figure adding the location of the 20 observatory borewells (instead of measuring stations - wording). On the chapter 5, concerning results and discussion, Figure 5a, hydraulic head contour map from Sauter (1992) is used as reference. Hydraulic head contour maps obtained for the 4 scenarios are presented in the figure 5. Additional graphical representation of difference between observed and simulated data should be provided, and not only the RSE in the table 1, even if a visually observation show the main differences, using GIS tools. As said above, the location of the observatory borewells and the instant values used to draw the hydraulic head contour map have to be added to the figure 5a. In the figure 5b to 5e, it could be good to add the contour of the delineation of the catchment area of the Gallusquelle based on the figure 5a, in order to have a better visualisation of differences. In addition, it is necessary to discuss the modeling approach considering uniform recharge and steady state flow equations; are they a limitation or not ? In the conclusion, it is necessary to develop a little bit more the additional value of the results of the modeling regarding the delineation of the catchment area of the Gallusquelle, using modelling in comparison to more conventional way using hydraulic head contour map and dye tracing connections, and the uncertainty of the results. In addition, it is necessary to discuss as well more

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in details the suggestion of using input of karst genesis simulation and to add some references about it. The question of minimum data to have to be able to carry out such modeling approach for the delineation of catchment area may be also discussed in one or two sentences.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 10, 9027, 2013.

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