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Comment on nhess-2021-376

Anonymous Referee #2

Referee comment on "First application of the Integrated Karst Aquifer Vulnerability (IKAV) method – potential and actual vulnerability in Yucatán, Mexico" by Miguel Moreno-Gómez et al., Nat. Hazards Earth Syst. Sci. Discuss.,
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The manuscript presents a new and interesting approach to groundwater vulnerability assessment. The potential vulnerability (IKAV-P) is an intrinsic vulnerability method with a similar concept to existing ones (DRASTIC, EPIK, and others). The actual vulnerability (IKAV-A) is designed to be a specific vulnerability method (considering vulnerability to specific contaminant) using numerical modelling. The authors put much effort into implementing different vulnerability assessment methods, applying statistical analysis, contaminant transport modelling and others.

Broad comments

One of the authors' goals was to reduce the subjectivity of the vulnerability assessment process (abstract, last sentence). However, the process of preparing IKAV-P map does not differ significantly from other PCSM methods with weighting parameters. Moreover, some parameters are excluded (e.g. Slope) because of low variability, and this approach does not reduce the subjectivity. The final vulnerability map doesn't have to have significant differences particularly if the input parameters do not differ spatially. Therefore, specific parameters should be included in the vulnerability assessment process, particularly if two areas are compared (for example, with different terrain morphology). It is interesting that the precipitation (or infiltration) parameter is not included in the assessment process, although the A1 (Appendix) shows a significant range (458-1566 mm) which could be of significant impact (as previously shown by PI, COP and other European approach methods). In the bottom line, it should be emphasized that the proposed IKAV method is suitable only for Yucatan and other similar karst environments and not for complex karst systems with allogenic recharge.

Specific comments

Line 14. Theoretical models that consider contaminant characteristics exist (specific vulnerability, COST 620 report) but are rarely used.

Line 18. Hazard and risk mapping should be mentioned if the anthropogenic impact is introduced into vulnerability assessment.

Figure 1. The title should mention that this figure corresponds to PCSM vulnerability assessment methods.

Line 63. It is better to put "in some regions" because the reference Parise et al. 2004 refer only to karst in Albania.

Line 71. Add karst areas where the project "Development of an integrated methodology to estimate groundwater vulnerability to pollution in karst areas" was carried out.

The Study area lacks in description of Quaternary, Neogen and Paleogene units.

Figure 2. Legend does not contain the dark grey geology unit in Tobasco state. It is better to put a blue colour for seas around Mexico on the small map.

Line 93. The four hydrogeological regions are not presented in figure 2 (although presented on other maps).

Line 97. Reference [29] is unclear.

Line 151. The use of an extensive number of parameters can complicate the process but could be necessary to characterize and evaluate specific karst features.

Line 165. A homogenous layer could be important for groundwater vulnerability, particularly when vulnerability maps of two areas are compared.

Line 180. If several pollutants are representative for one area, does it mean that the several IKAV-A maps are to be produced?

Chapter 4.1. (IKAV-P). Describe why vegetation and precipitation factors are not used in the IKAV-P assessment (although the precipitation is used in IKAV-A method through recharge)?

Line 229. Table 1. If ranges are based on parameters values from the field analyzed with the natural breaks method, then Table 1 presents ranges and ratings only for the Yucatan region. This should be clearly stated in the Table title to avoid using these particular ranges in other study areas.

Line 264. Are initial NO_3 concentrations of 80 mg/l introduced for all pollution source areas presented in figure 7, including smaller towns? Are contaminant loads continuous?

Figure 10 (a, b, c). Which time step represents the modelling plume output?

Figure 10d. Wells classified according to IKAV-A vulnerability represent vulnerability which depends on the artificial impact, and therefore this classification represents a risk to contamination. Instead of using source vulnerability, it is better to use actual vulnerability. On the other hand, source vulnerability includes vulnerability assessment through the unsaturated and saturated zones in the groundwater source catchment and could be high without anthropogenic impact. Therefore, it should not be misunderstood with actual vulnerability.

Line 323. The presented comparison of IKAV-P with IVAKY and other European methods shows a high spatial correlation with the IVAKY vulnerability map, but it does not mean that IVAKY or IKAV-P maps provide better results than other methods.

Conclusion. Considering the previous comments, it should be emphasized that the prosed IKAV method is designed and suitable for Yucatan and other similar karst environments.