Responses to reviewer 1's comments

Ref: nhess-2017-22

We appreciate the time taken to review this paper and constructive comments were given, we have made amendment accordingly. We hope that the editor and reviewer 1 agreed with our assessment that the paper has been substantively improved.

1. however there is a lack of coherence, order and systematic data description that do not permit its evaluation by a reader. Data is missing, the presentation is not ordered and context data are included along the whole manuscript from previous articles without indicating what is new in this manuscript. The conclusion of the model, without the consideration of the data, does not permit to know if interpretations are supported by data, producing that manuscript is difficult to understand and does not have the scientific background, in this moment, for their evaluation to be published in a scientific journal.

This paper intends to introduce the research and development of a GIS-based monitoring and warning system for cover-collapse sinkholes in karst terrane in Wuhan. To achieve an early warning, first, it is to carry out monitoring works. The selection of monitoring sections and monitoring proposals is based on the study of karst geologic conditions in the study area; the choice of monitoring method is mainly based on its credibility. And then we can apply for the early warning process which is involved in the research of the early warning criteria. Therefore, the main structure of the paper is shown as figure 1:

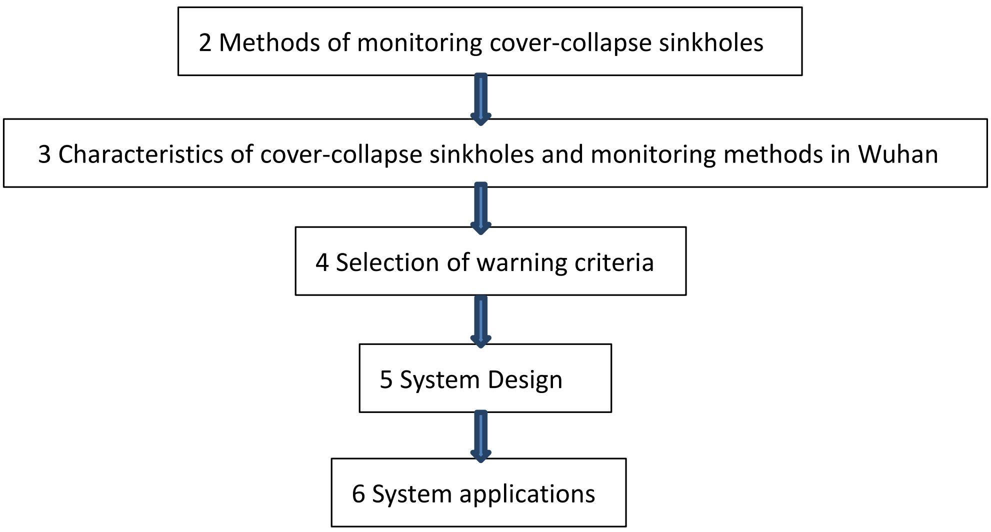

Figure 1 The main structure of the paper

The main focuses of the paper are in session 4: Selection; Session 5: System design and Session 6: System application. The analysis of karst geologic conditions in Wuhan is based on peer reviewed research. The main contributions of this research are shown in the Figures 5-15.

Based on the study of karst geologic conditions in Wuhan, this paper points out the key monitoring section and establishes the monitoring steps in session 3. In order to support the conclusions in the paper, we have amended 3.1 Characteristics of cover-collapse sinkholes; deleted session 3.1.2 Distribution of limestone; and added a new session 3.1.4 Karst collapse susceptibility distribution.

The new structure of session 3 is:

3.1.1 Geological background

It introduces the geological background in Wuhan area. The added Figure 4 shows the distribution of lithology, tectonics and ground subsidence in the monitoring area.

3.1.2 Characteristics of karst collapse in Wuhan

It introduces the characteristics of karst collapse in Wuhan, which is the basis of the study of the warning criteria in PART 4 of this paper.

3.1.3 Previous karst collapse research in Wuhan

It introduces the research work of karst collapse in Wuhan. Monitoring and early warning research is a part of the whole work.

3.1.4 Karst collapse susceptibility distribution

It introduces the karst collapse susceptibility distribution in Wuhan, which is the basis of the selection of the monitoring sections.

2. Figure 1. A geological sketch is needed in order to locate the study area, a continental view can help for the location against only China surface.

Thank you for your comments, we have inserted Figure 1, to show the location of the research area in China; we have replaced Figure 4 Limestone distribution bands in Wuhan with geological map of karst monitoring area in Wuhan city on page 6.

3. At figure 2 and 3, I assume that authors should have permission from both journals to include photographs from the cited manuscript, I suggest to editorial team to confirm this subject about the figure rights.

Figures 2 and 3 have been replaced by using the Research Group's pictures in page 3.

4. The cities referenced where sinkholes has been identified should be included in the map from Fig. 1.

The sinkholes pit layer was added in the replaced Figure 4 on page 6.

5. The text from page 4 (paragraph from line 15) "so by contrasting cross-sectional maps of the same traverse collected regularly over time by GPR, it is possible to estimate underground soil movement, and this helps to monitor the cave in terms of its formation and development, and thus enables prediction of cover-collapse sinkholes." Requires some references where this subject has been previously applied.

GPR was employed to monitor Zhemu village in Guilin city, Guangxi by Li et al.(Li et al. (2005) (page 26, L29). This has been made clear on page 27, L14; and on page 4, L4.

6. On the other hand, the evaluation of GPR in order to analyze karstic underground features should require to include, at least, some example of the obtained results and the compared evaluation of the same profiles during time to identify the changes related to the GPR record (besides the underground characteristics, soil state can also produce changes in the radargrams).

Figure 2 shows the results of the Maotangang 1 # GPR monitoring profile in 2010 in Wuhan, Hubei Province. There are two anomalous reflection signals areas: (1) at the mileage of 170-180m and depth of 17.5m; (2) at the mileage of 240-255m and depth of 15m. Figure 3 shows the results of the same area in 2011. The comparison results show that the change at the second exception area is not obvious, but not the first one. It is indicated that the tendency of the depth developed to the surface is not exist. The found can be used as the evidence for the karst ground subsidence warning. Since the paper focused on the early warning system, so Figure 2 and Figure 3 did not included in the paper.

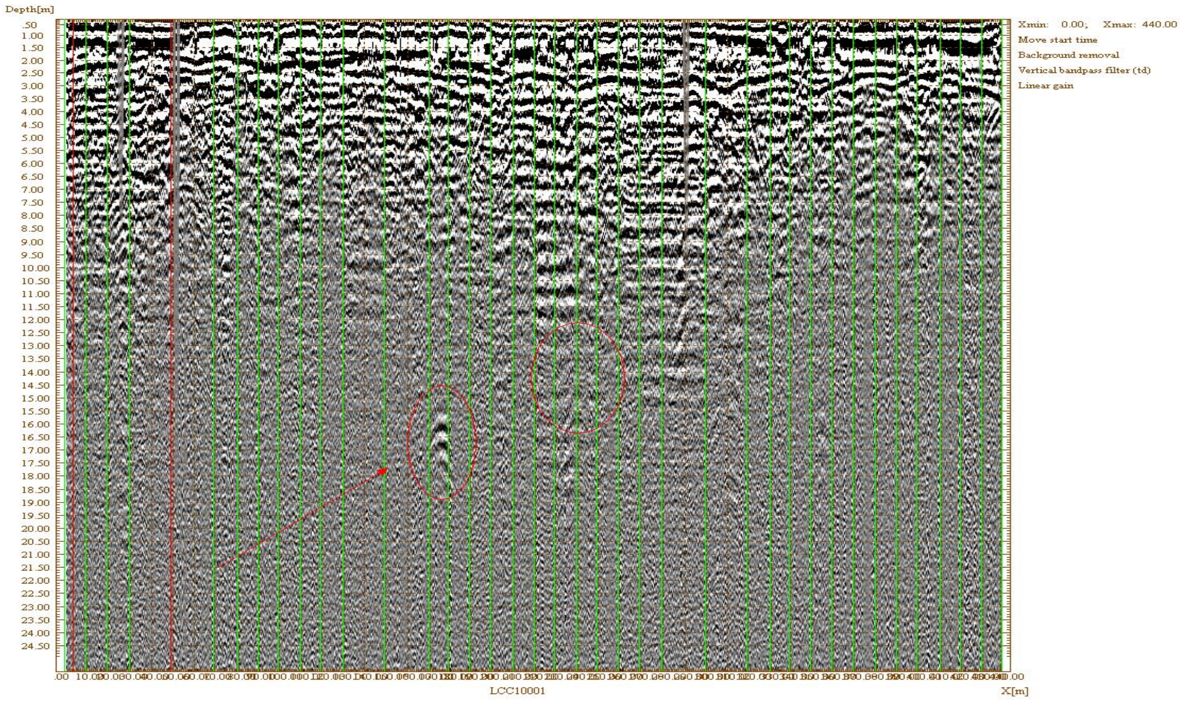

Figure 2 The results of Maotang 1 # GPR Monitoring Profile in 2010

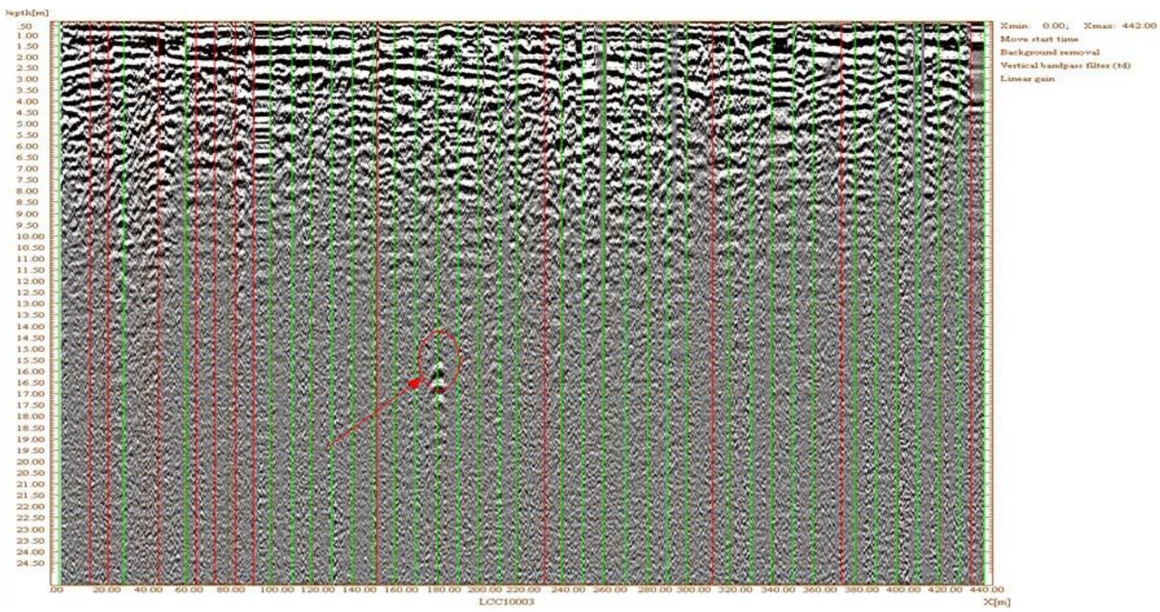

Figure 3 The results of Maotang 1 # GPR Monitoring Profile in 2011.

7. About the dynamic underground water level monitoring is difficult to understand as a generalization that collapse are produced by the pressure increase or the term "the cover layer will be damaged", this subject requires explanation.

Lei et al. (1993) tested the karst ground subsidence model in the Yangzi River first terrace in Wuchang District where the paper studied area. The result shows that the mechanism of karst ground subsidence is mainly seepage deformation where is a dual structured covering layer of soil – the clayey is on the top of the sandy soil. The saturated sandy soil located above the karst cavity is easily moved and formed the creep flow failure as long as the karst cavity water level decreases; and the damage will soon extend to the surface of the sandy soil, so that the upper clayey forms a cover layer. When the strength of the cover layer is not strong enough, the karst collapses occurred and the collapse process is shown in Figure 4.

The paper concluded that the mechanism of soil damage caused by the decline of karst water level is the soil seepage deformation (or subsurface erosion). In the model test, the soil damage critical hydraulic gradient is 12.89 for the single structured clayey covering layer of soil, and 2.03 for the dual structured covering layer of soil (the clayey is on the top of the sandy soil). When evaluating the risk of karst collapse in the study area, it can be done by comparing the maximum permeability hydraulic gradient (J) which is calculated from the pore water lever in the study area with the critical hydraulic gradient (Jc). When J > Jc, there are collapse risks.

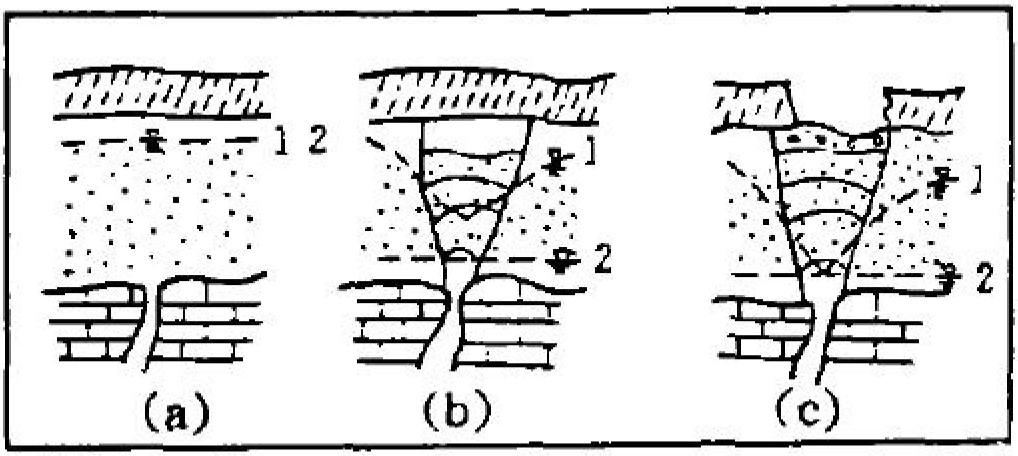

Figure 4 The collapse formation process in the dual structured covering layer of soil

1 the pore water level 2 the karst water level

The amended part shows in the Line 13 to Linw22 in the page 10.

8. About chapter 3.1.1. a geological map, section, borehole distribution or a cross-section should help in the interpretation of the context where the later analysis is carried out. If cross-section is included, the location of the water level should be also interesting to be included.

The information was included in the newly replaced Figure 4 on page 6.

9. Figure 4 also could require permissions from the journal from where it comes from, the aspect of the figure is not clear and besides the bands of carbonatic rocks, other geological subjects are required to be included. Moreover the bands are assumed to be limestones bands and not karstic bands as are referenced in the figure. Authors indicate that no evidences of karstic processes are in some of them. Moreover the reference to the structural setting, fold axis for example, requires being included in the figure.

The new Figure 4 shows the results of the study on karst geologic conditions in monitoring area, mainly demonstrates the section of karst ground subsidence in Wuhan. In the newly added geological map of the study area, the lithology, geologic structure, and the distribution of sinkhole pits are included.

10. The quality of fig. 5 is not evident, as there is not information that permits to contextualize it, moreover this does not make reference to risk, if there were anything evaluated in this figure should be hazard, peligrosity or susceptibility (not risk distribution).

The research team used the AHP Method to evaluate the karst collapse susceptibility in Wuhan. Figure 5 is one of the consensuses on the risk of karst ground subsidence research in Wuhan. The purpose of putting in this paper is to illustrate the degree of the karst ground subsidence susceptibility in Wuhan. It is the susceptibility partition, not the risk partition. We are sorry the lack of grasp of the word, resulting in ambiguity.

11. At figure group IV is incorrectly written and there is no sense about what "no suscetibility" means. The rest of the manuscript include description of what is presented to be done, with the considerations of the conclusions but there are not a data integration, comparison or discussion different than the general description. I think that what is presented can be of interest for the community but further work is needed including presentation, description and discussion of data. In this moment is more a general report of what to do, what can be expected and some results without the possibility to be evaluated by readers. In this sense, I suggest to modify significantly the manuscript before further revision.

The term"no susceptibility" has been replaced with "non-Karst area" because the karst collapse is not exist in non-Karst area.