Author’s response

The responses are sorted as follows:

- Response to reviewer 1
- Response to reviewer 2
- Response to editor

Response to reviewer’s comments - Reviewer 1

The text below contains our response to the reviewer´s comments and suggestions. The text in blue is the reviewer´s comments, while the black text is devoted to our remarks, explanations, etc. Yellow background indicates text, which will be added to the manuscript. The line numbering refers to the original manuscript.

The authors thank the reviewer for the helpful recommendations and suggestions.

1. (L32) This introduction is not easy to understand for someone who doesn't know anything about the study area. Caves, dam and springs mentioned should be visible on a map and maybe also on a schematic cross-section.
The reference to the overall map of the Czech Republic will be added to the Introduction with the following text:
In the Bečva river catchment (Fig. 1) in the eastern part of the Czech Republic extreme regional floods occurred in 1997 and 2010 (CHMI, 1997, 2010).
The study area is described in more details in Section 2. Not to duplicate the description, the reference to this section will be added to the introduction. In the Section 2 next to the overall map (newly Fig. 2) more detailed map with schematic cross section (newly Fig. 4) will be added.

2. (L42) Isn't it included in the hydrogeological conditions mentioned in the previous sentence?
The sentence will be deleted.

3. (L46) Sentence difficult to understand
The sentence will be improved:
... Milanovic (2018) recommends that the karst in the vicinity and wider region of the proposed dam should be carefully explored and understood.

4. (L52) "Genissiat" is the correct way to write!
The name of the dam will be corrected.

5. (L58) Not clear: do you mean monitoring the grouting?
The sentence will be modified - extended:
... detailed monitoring at the dam site and karst formations with additional grouting of permeable zones in dam foundations must be adopted ...

6. (L67) What is the goal of mentioning these studies? Is your paper dedicated to assess the impact of the dam on regional hydrogeological conditions or is your paper dedicated to know how to build a dam in a karst region?
Authors believe that both goals overlap. E.g. the layout of the dam (in our case - through-flow, lateral) may influence hydrogeological conditions at the area counting several km^2, the detailed location of the dam (possibly avoiding largest limestone outcrops) may influence water leakage from the reservoir etc. The factors mentioned may affect the concept of the numerical model.

7. (L74) Again, what is the purpose of this paragraph? There are dozens of models published, why do you cite these here? What are these specific reference useful for the focus of your paper?
The reviewer is right that numerous models exist. Authors, before deciding about the concept of the model, studied available literature sources to compare modelling approaches in relation to the site conditions, groundwater sources, and namely to the state of the knowledge about the karst and data available. The first sentence of the paragraph with general statement and groundwater hydraulics will be omitted.

8. (L82) What does it mean? What is a "poorly explored deep karstic formation" for you?
Poor exploration consists in underground channels of unknown shape and dimensions, where hydraulic characteristics cannot be directly determined (cross sections of channels, their roughness, tortuosity, branching, etc.), the layout and interconnection of single channels is unknown, in our case mostly due to significant depth of the Hranice Abyss and caves and limited access due to carbon dioxide occurrence.

9. (L83) What is exactly you aim? Why should this specific type of model be used for addressing your question?
The paragraph was modified:
The current study aims to simulate behaviour of the Hranice Karst using numerical model based on hydraulics of conduit flow in underground channels of unknown shape, dimensions and hydraulic characteristics (e.g. roughness) coupled with reservoir model simulating filling the Hranice Abyss and caves in the area. ... The final objective was to assess an impact of the proposed Skalička dam on the Hranice Karst and the source of mineral waters in the Teplice spa.

10. (L90) This introduction is not good: English is not very precise and the aim of the study, as well as the reason to select one specific type of modelling approach are not presented in a clear, concrete and concise way.
The suggestions of the reviewer will be taken into account, the text of individual paragraphs will be modified.

11. (L96) The figure is not really good. What is the position and extent of the karst region? Where is the dam project? Where are the caves, springs and Spa?
In fact Figure 2 provides most information but is not mentioned until line 104... I believe that figure 1 should be simplified and used as a small location map on figure 2.
The Fig. 1 will be simplified, the Bečva river will be depicted together with the general location of the study area. The reference will be added to the Introduction.
The Fig. 2 will be improved, the protection zone of the Teplice spa, limestone outcrops and the dam location will be depicted.

12. (L103) I am not sure that all these aspects of the geology are really necessary. If you think it is, you should probably add a small geological map.
The paragraph will be simplified as follows:
~~According to the regional geological classification, the area of interest is located at the junction of the Bohemian Massif and the Western Carpathians. The basic geological structure consists of Paleozoic sediments of the Sudeten Formation, on which Miocene sediments, layers of Silesian tectonic units and finally Quaternary cover are deposited (Geršl and Konečný, 2018; Il Faut, 2022).~~ In the locality, the most prominent types of Devonian limestone are those that rise to the surface in the western part of the area between the Teplice spa and the railway cut to the east from the village of Černotín. Their very easternmost outcrop is found in the locality of Kamenec in the area of the proposed reservoir (Fig. 2). At some places, the outcrops are tectonically broken and scarred. ~~The depressions of the post-Paleozoic relief are filled with the clays, claystones, sands, sandstones, gravels and siltstones that fill the Teplice Depression. Their thickness increases towards the east. These younger Tertiary sediments are also affected by dislocations from the Carpathian orogeny. From the east, the shallow shear folds of the sub-Silesian formations, mainly composed of pelitic sediments of Cretaceous and Palaeogene age, are pushed over them.~~

13. (L113) Not clear!
The sentence means that an extent of the Hranice Karst (i.e. its exact boundary) and the thickness of limestone layer have not been exactly specified until now. The more detailed explanation is in the following text, so the sentence will be omitted.

14. (L116) This was already written twice before!
The sentence in the Introduction will be deleted: ~~The location of the dam is planned in the Hranice Karst region, which contains numerous valuable natural monuments, such as the Zbrašov Aragonite Caves, the Hranice Abyss (Vysoká et al., 2019) and the Teplice spa, which exploits the mineral waters that rise from the deep karstic formations in the area.~~
The sentence in section 2.2 remains as it describes the karst formations important for the modelling.

15. (L130) Obviously there are two dam projects (or two scenarios), you should mention that somehow in the introduction, no?
What is "Section" ZAC and HA? Where are the caves?
Two dam scenarios will be newly mentioned in the Introduction: The Skalička dam is planned in two variants (through-

flow and lateral) ...
The Fig. 3 will be improved and scaled.
The term "section" will be systematically changed to "conduit". According to the suggestion of an editor, the term "chapter" will be systematically changed to "section".

16. (L147) Is this detailed description of outcrops really important and necessary?
Authors assume that the text dealing with outcrops is quite important. Based on their description the communication of surface water with water in karstic limestone was assessed and incorporated into the model.

17. (L177) Is this a fault? Why are the rock layers hardly displaced?
It is not a fault, it is the line at which the cross-section changes its direction. Fig. 3 will be improved. Moreover, new more detailed sketch - schematic cross section will be added, as suggested by the reviewer (comment No. 29).

18. (L183) What do you mean here? I believe that dams are usually built to make "water storage". The purpose of this storage may differ!
The sentence was modified: ... the water storage in the reservoir will be divided into permanent and flood control storages.

19. (L200) Chapter 2 is not bad, but some elements should have been already presented earlier in the paper introduction.
The text was modified and re-arranged according the suggestions of the reviewer, the figures were improved.

20. (L204) This is not correct! If you are interested in simulating the "water regime", you don't need spatialized models! But in your case you are probably interested to the hydraulics in space and time. Please make a better formulation of what problem you want to solve with the modelling. In your case I doubt that a dual-continuum porous-equivalent model would be very helpful.
The first sentence of the first paragraph in the section 3.1 will be modified as follows:
Various types of mathematical models can be applied for groundwater flow modelling in a karst system (Stevanovic, 2015; Hartmann et al., 2015; Kuniansky, 2016; Leins et al., 2023).
The second sentence will be deleted.
The third sentence will be changed:
Due to the deep formation of the Hranice Karst being only poorly explored, and the fact that there is practically no information about the configuration of karst channels, the modelling approach using a hypothetical pipe network that connects the caves, domes and lakes via a system of channels was applied in this study.

21. (L207) This sentence seems quite contradicting: a fully discrete pipe-flow model requires some knowledge of the existing pipes. Probably your model choice is correct, but the reason is not correctly expressed.
The first sentence of the second paragraph will be omitted.

22. (L208) not clear, why "replace"?
The sentence was omitted.

23. (L210) Does it mean that you assume that the landforms you know are all landforms existing in the system? Don't you think there could also be unknown caves?
The phreatic water level in the karst corresponds approximately to the Bečva river. At this level, lakes such as HP, ZAC, KC occur, their "visible" parts above the water level are fairly good explored, the Hranice Abyss was investigated by the underwater robot to the depth of 450 m. Other caves were not found even by geophysical methods. Water in deep canals and caves flows under pressure. Their hydraulic behaviour (resistance) is included in the aggregated resistance factor. Following sentence was added to the end of the second paragraph:
To describe hydraulic behaviour of the deep karst formations, aggregated flow resistance factor was introduced and calibrated for each channel of the pipe network using the monitoring data (see following sections).

24. (L220) You model topology assumes a very direct connection between the karst objects (reservoirs in the model). Do you have any field observation proving such direct connections?
The topology and pipes are hypothetical. The hydraulic characteristics (connections, branching, tortuosity, shapes of cross sections and their areas, roughness, etc.) of the pipes and connections are expressed via aggregated resistance factors which were calibrated using data from the monitoring of water level in the reservoirs during selected flood scenarios in the Bečva river which resulted in the change of water level in the reservoirs, with some time lag (see e.g. Figs 8, 9,... old numbering).
The depth of the Hranice Karst was estimated (based on previous drilling works) to be about 1.5 to 4 km so results of more detailed direct exploration are not available.

25. (L230) What do the numbers 1, 7 and 6 mean? The legend should explain it better.

The figures were improved, new sketch (Fig. 4) was included. The numbering was introduced in Fig. 5 based on the newly added sketch (Fig. 4). The first paragraph of the section 3.2 will be modified:

The network of karst channels was replaced by a system of interconnected pressure "pipes" and open "reservoirs". The system of hypothetical "pipes" was developed based on the layout shown in Fig. 2 and on the schematic sketch of the functioning of the karst system (Fig. 4). The network diagram with the proposed interconnections of karst landforms is in Fig. 5. The water inlets to the system were localised at the limestone outcrops at the Kamenec (node 1) and at the Bečva River bend (node 7), the water outlet is represented by the Bečva river in the Teplice spa (node 6), where the springs of mineral water can be observed in the river.

The conduits A and B interconnect the sources of water (nodes 1 and 7) with the network of the deep karst channels (conduits C, D, E, F). The conduits connecting the Hranice Abyss (H) and caves at Kuče (G) are linked to these hypothetical deep channels. The most remote landform, the Zbrašov Aragonite Caves on the left bank of the Bečva river (node 10), is connected to the main branch adjacent to the Bečva River (conduits I and J).

26. (L232) The legend is incomplete. Please explain what is visible on your figure and what the reader is supposed to understand from this figure. **This comment is valid for most figures.**

The Fig. 5 (newly Fig. 2) will be improved, the schematic sketch will be attached (Fig. 4).

The caption will be improved:

Figure 5: Diagram of the conceptual model: red arrows represent water inflows to the karst aquifer; black arrows represent flow directions in karst conduits. Numbers express the computational nodes of the system, capitals denote hypothetical karst channels

27. (L233) Where is head measured? Where is discharge rate measured?

New Section 2.5 will be included, the data used are briefly described:

At the locality the monitoring of water stages and discharges in the Bečva river has been carried out since 1960 in the gauging stations in the Teplice spa and in the Bečva river bend. Occasional monitoring of water levels was carried out in lakes of HA, ZAC and KC during some months in the years 2005, 2020 and 2021. Unfortunately, the series are not complete and continuous and some data are missing in some formations due to various reasons. The measurements in the Bečva river are complete and continuous. In HA and ZAC, the measurements were quite difficult as an entrances to the caves and abyss are not public, due to the high carbon oxygen concentration the personnel must enter in the mask, at least two people are required. Therefore, it was complicated to check the measuring device and data logger and to perform remedial works in case of their outage permanently. The KC are private and the entrance could be possible only when accompanied by an owner.

The outflow discharge from the karst to the Bečva river in Teplice spa was determined using current meter, hydrometric propeller, by the acoustic Doppler current profiler and by the measurements of electric conductivity of water in the Bečva river in the spa (Il Faut 2022).

The surface areas of the lakes in the caves are specified in the Section 2.3.

28. (L294) Where? at Becva bend?

Ok, but do all these points have the same level or a steady head difference?

I am not so sure... If they don't have the same level, there must be some flow.

(L298) What is the "principal conduit"?

The section 3.4. / I. /A , B will be improved as follows:

A. Long-term monitoring of the observation wells, in the Bečva River in the Teplice spa and in its bend and in the HA, ZAC and KC indicated steady water levels with no change over time during long dry spells. Therefore, during these periods, no water flow is expected in conduits G, H, I and J. The calibration of the conduits A, B, C, D, E and F between nodes 1 and 6 was carried out under the assumption of steady state flow during relatively small discharges in the Bečva River and a discharge of 118 l/s in the conduit F at the effluent of the mineral water to the Bečva river in the spa. It was found (Il Faut 2022) that this effluent discharge practically does not change for various small water stages in the Bečva river, as the difference of water levels in the Bečva between the bend and spa does not change. At the same time no external inflows to the caves were observed during dry spells.

B. The calibration was based on the monitoring of steady water stages at all monitoring points in the locality, i.e. the Bečva river, in the HA, ZAC and KC. The steady state conditions correspond to the period.

Following text will be added to the section 4.1:

First, the calibration of the proposed model was performed for the "steady state" (scenario I.A.) during the dry season in June and July 2019 when the discharge in the Bečva river was 4.5 m^3/s…

29. (L304) This part is difficult to understand. some sketches would be welcome.

The sketch (Fig. 4) will be added.

30. (L307) where?

The sentence will be rephrased:

A. Steady state scenario representing a discharge of Q = 25 m3/s in the Bečva River corresponding to its average discharge.

31. (L331) Do you mean here that it was verified in the field by discharge rate measurements/observations?
The word "verified" is incorrect. The sentence will be improved:
At the same time, the amount of external water flowing during and after some rainfall episodes into the HA, ZAC and KC was calculated using simplified rainfall-runoff model.

32. (L340) I am a bit disappointed by the huge differences of the resistances assessed for the respective sections. What are the corresponding diameters if you assume the same roughness?

Eq. (2) indicates that the aggregated flow resistance factor depends on local (form) losses (i.e. changes of shape and direction of the flow), the length of canals and their tortuosity, diameters, micro and macro roughness, existence of subsurface caves, sediments, etc. Therefore, it is not possible to easily determine the "pipe" diameter which may change significantly place from place. Significant variability of the resistance coefficient indicates considerable changes in the shape, length and other above mentioned factors. From Eq. (2) it can be seen, that e.g. doubling the "pipe" diameter may result in increased the coefficient 32 times, fivefold increase in "pipe" diameter (which is not uncommon in karst channels) results in the coefficient increase by more than 3 orders. Following text will be added to newly included section 4.4:
As can be seen from Eq. (2) the aggregated flow resistance factor depends on local (form) losses (i.e. changes of shape and direction of the flow), the length of canals and their tortuosity, diameter, micro and macro roughness, existence of subsurface caves, sediments, etc. Therefore, it is not possible to easily determine the "pipe" diameter which may change significantly place from place. Significant variability of the resistance coefficient indicates considerable changes in the shape, length and other above mentioned factors. From Eq. (2) it can be seen, that e.g. doubling the "pipe" diameter may result in increased the coefficient 32 times, fivefold increase in "pipe" diameter (which is not uncommon in karst channels) results in the coefficient increase by more than 3 orders.

33. (L348) I see as many vertical branches with a low resistance as horizontal ones...
The sentence will be improved:
In general, the branch channels G, H, I, J supplying the caves and the abyss have ...

34. (L368) It would be good to show the sketch of Fig 6 with heads and flow-rates in all nodes/pipes, at least for one of the scenarios.
Measured water stages and calculated flow rates for steady state calibration scenario will be added in the section 4.1 in Tab. 2.

Table 2: Discharges along individual conduits and water stages in nodes at the steady state scenario for the model calibration

Conduit	**Nodes**	***Q* [l/s]**	**Node**	**Water stage [m a.s.l.]**
A	1, 2	20	1	253.28
B	7, 2	97.8	6	243.77
C	2, 3	117.8	7	251.48
D	2, 4	117.8	8	244.37
E	4, 5	117.8	9	244.20
F	5, 6	118 *)	10	244.74
J	5, 11	0.2		

*) Measured value

35. (L385) Legends of figures are poor! There is no way to understand the paper even approximately just by looking at the figures and their legends.
Legends will be improved, some figures will be modified according to the suggestions of the reviewer.

36. (L443) The reading of this paper is difficult as names and abbreviations are not consistently used along the manuscript. (L459) This paper is quite interesting, but difficult to follow. It is difficult to understand exactly what is measured, what is assessed, and what is assumed.
The text was checked, all abbreviations were explained, the names were harmonised. Authors did their best in explaining which variables were measured and which assumed. The improvements have been marked in the text.

Response to reviewer's comments - Reviewer 2

The text below contains our response to the reviewer´s comments and suggestions. The text in blue is the reviewer´s comments, while the black text is devoted to our remarks, explanations, etc. Green background indicates text, which will be added to the manuscript. The numbering of lines, figures and tables refers to the original manuscript.

The authors thank the reviewer for the helpful recommendations and suggestions.

1. (L285) I have some principle difficulties to understand the definitions of the scenarios.

Scenarios' description was upgraded. Following text will be added at the beginning of the Section 3.4:

Prior the simulations the model was calibrated using the measured water levels in the Bečva river and lakes in HA, ZAC and KC.
Presently hydrological extreme floods in the Bečva River temporarily influence the groundwater regime in the area including the karst system. However, experience shows that in few weeks the groundwater system returns back to the pre-flood conditions. Therefore, the main concern is associated with a permanent increase of the water level in planned reservoir that is represented by the levels 259 m a.s.l. in case of lateral reservoir (variant III.) and 261 m a.s.l. in case of through-flow variant (variant IV.). For each reservoir variant two scenarios were investigated, namely at the average discharge in the Bečva river counting about 25 m3/s (III.A., IV.A.) and during the flood with return period 20 years with the discharge about 660 m3/s (III.B., IV.B). For these scenarios the results were compared with corresponding reference variants (II.A., II.B.).

2. (L365) Is it correct that scenario II.A is similar to the steady state calibration? Then, what is the meaning of this scenario?

Yes, in principal they are similar. However, the discharge and water stages in the Bečva river and water stages in HA, ZAC, KC used at the calibration scenario (I.A.) correspond to measured values, in the reference variant II.A. water stages in the Bečva river correspond to 25 m3/s and water stages in HA, ZAC and JC are the result of the calculation. Variant IA. served for the calibration of hydraulic characteristics in channels A, B, C, D, E and F while the variant II.A. is a reference one for comparison with results of scenarios that include an impact of the dam. Following text will be added to the Section 4.2:

Compared to the calibration scenario I.A. the water level in the Bečva River in the reference scenario II.A. is rather higher due to higher discharge in the Bečva river. This results in higher water level in monitored lakes while the outflow discharge via the conduit F practically does not change.

3. (L390) The boundary conditions of the scenarios III.A and IV.A, which seems steady state simulations are not clear.

The boundary conditions in these variants represent steady state at no flood period. Results of these scenarios, when compared with the reference variant (II.A), enable the assessment of the impact of two spatial variants (lateral - III.A., through-flow - IV.A.), namely changes of water levels (pressures) and discharges in the karst formations such as ZAC and HA. Text will be added - see suggestion No. 5.

4. (L365) How can the relation to the discharge of 25 m^3/s be understood?

The discharge 25 m3/s approximately corresponds to the average discharge in the Bečva river.

Explanations will be added to the Section 4.2:

The scenario II.A. corresponds to no flood period with constant average discharge of Q = 25 m3/s in the Bečva River.

5. (L388-L439) What is the difference in boundary conditions between scenario III.A and III.B (and IV.A and IV.B)? How are they related to different discharges?

The difference is related to different type of the dam (lateral, through-flow). The main difference is that in case of the through-flow scheme the Bečva river bend outcrop (which is considered as main source of groundwater in the karst) is inside of the dam reservoir and changes of water level in the reservoir directly influence the pressure and discharges in the karst. In case of lateral dam only certain water communication via Kamenec outcrop is possible while the Bečva river bend is outside of the reservoir. Following text will be added to the Section 4.3:

This scenario represents steady state situation with the discharge of 25 m3/s in the Bečva River and with reservoir permanent water level (259.00 m a.s.l.) so only Kamenec infiltration zone may be affected by the reservoir.

This scenario represents steady state situation with the discharge of 25 m3/s in the Bečva River and with reservoir permanent water level (261.00 m a.s.l.) which affects both Kamenec and the Bečva river bend infiltration zones.

6. (L340) The calibrated values of the resistance coefficients are varying over several orders of magnitude. A discussion on the physical meaning and the sensitivity of the single values is missing, even if a very simple modeling approach is applied.

Following text will be added into the new Section 4.4 Discussion.

As can be seen from Tab. 3 the calibrated values of the coefficient of aggregated resistance are varying over several orders of magnitude. Eq. (2) indicates that the aggregated flow resistance factor depends on local (form) losses (i.e. changes of shape and direction of the flow), the length of canals and their tortuosity, diameters, micro and macro roughness, existence of subsurface caves, sediments, etc. Significant variability of the resistance coefficient indicates considerable changes in the shape, length and other above mentioned factors. From Eq. (2) it can be seen, that e.g. doubling the "pipe" diameter may result in increased the coefficient about 30 times, fivefold increase in "pipe" diameter (which is not uncommon in karst channels) results in the coefficient increase by more than 3 orders.

7. (L362) No data from ZAC are presented in Fig. 10 without further explanation.

There were no data available in ZAC for this period. The measurements in ZAC are complicated due to high CO2 concentrations close to the lakes inside the caves. Therefore, measuring device and dataloggers are not easily accessible and controllable, entrance is possible only with masks and with the guide as there is not public access into the caves. Following text will be added to the Section 2.5:

At the locality the monitoring of water stages and discharges in the Bečva river has been carried out since 1960 in the gauging stations in the Teplice spa and in the Bečva river bend. Occasional monitoring of water levels was carried out in lakes of HA, ZAC and KC during some months in the years 2005, 2020 and 2021. Unfortunately, the series are not complete and continuous and some data are missing in some formations due to various reasons. The measurements in the Bečva river are complete and continuous. In HA and ZAC, the measurements were quite difficult as an entrances to the caves and abyss are not public, due to the high carbon oxygen concentration the personnel must enter in the mask, at least two people are required. Therefore, it was complicated to check the measuring device and data logger and to perform remedial works in case of their outage permanently. The KC are private and the entrance could be possible only when accompanied by an owner.

The outflow discharge from the karst to the Bečva river in Teplice spa was determined using current meter, hydrometric propeller, by the acoustic Doppler current profiler and by the measurements of electric conductivity of water in the Bečva river in the spa (Il Faut 2022).

The surface areas of the lakes in the caves are specified in the Section 2.3.

Moreover, short explanation will be added to the Section 4.1

Unfortunately for available flood scenarios in the years 2005, 2020 and 2021 there were not complete data for monitored lakes in HA, ZAC and KC. Therefore, one calibration and two verification scenarios were used to determine the aggregated roughness coefficients in conduits G, H, I.

8. (L435 - L480) The results of the scenarios III and IV seems not to be correct. The simulated period is too short. The maximum level at ZAC was not reached.

The maximum in ZAC is reached shortly before the end of the simulation (see table A below). The total time of the simulation was 246 hours. The calculated maximum water levels at ZAC and corresponding times as well as the water level at the last time steps are shown in table A below. This is shown to prove that the maximum at ZAC was reached before the end of the simulation. As the decrease of water level is quite small (see Tab. A), it is not clearly visible in Figs. The longer simulations showed that the more significant (visible) decrease in ZAC occurs after 350 h. Therefore, in all figures the simulation time corresponds to 246 hours, at which in all scenarios the maximum water levels have been reached.

Table A. The calculated water level at ZAC for selected time reached for scenario III and IV.

Scenario	Time and water level at ZAC	Time and water level at ZAC
III.B (Fig. 14)	238 h. – 246.63 m a.s.l.	246 h. – 246.61 m a.s.l.
IV.B (Fig. 16)	238 h. – 246.68 m a.s.l.	246 h. – 246.66 m a.s.l.

Following text was added to the Section 4.4 Discussion:

Time dependent reference and simulation scenarios were solved with time step 1 hour, the simulation period was 246 hours. During this time maximum water level was reached at all landforms, namely HA, ZAC and KC.

9. (L410, 440) Fig. 14 seems to be identical to Fig 12. Due to the difference in time variant boundary conditions different result are expected.

There is a very small difference between results of these two scenarios (see table B below with the summary of results). Therefore, we concluded that the effect of the dam is practically negligible.

Table B. Summary of results reached for scenarios used in Fig. 12 and Fig. 14

Location	Fig. 12 - maximum calculated water level	Fig. 14 - maximum calculated water level
HA	246.60	246.61
KC	246.89	246.92
ZAC	246.63	246.63

10. (L438) For IV.B the inflow boundaries are constantly on a high level. Therefore, no falling water tables should in the caves. A description of the scenario results with respect to the system behavior is largely missing.

The scenario IV.B. represents the situation when the water level in the reservoir does not change in time, but there is flood situation in the Bečva river (return period 20 years). Even if the water level in the reservoir is stagnant, interconnected system is influenced by temporarily increased water levels in the Bečva river both in the ned (inflow to the system) and in the spa where water springs out of the karst.

11. (L443) Furthermore, a detailed discussion of the usability and shortcomings of the applied modeling approach could be expected in the 'conclusions'.

New section 4.4 Discussion will be added with the following text:

The model presented was used for the assessment of the effect of the permanent increase of water level in the Skalička reservoir in two variants. The model calibration was carried out using rather incomplete monitoring data namely due to complicated accessibility into HA, ZAC and KC. Moreover, for the complete model calibration monitoring during flood situation in the Bečva river is necessary. Therefore, the model calibration and verification was carried out for three periods when temporary increase in the Bečva river was identified, namely during the March/April 2005, October 2020 and February 2021.

During the model calibration and verification, fairly good agreement of measured and calculated water levels in HA and ZAC were obtained. In case of less explored KC the verification provided rather worse agreement, in KC the only one data series measured in 2021 was available.

Following text was added to the Conclusions:

Based on calibration and verification results the applicability of simplified hydraulic model is justified, especially if the knowledge about the deep karst formation is very poor. In contrary to purely regression models (Vysoká et al. 2019) the model proposed is physically based, pipe and reservoir hydraulics is incorporated into the solution.

For further refinement of the model extensive hydrogeological survey is need and more extensive long-term parallel monitoring data should be provided in all karst phenomena in the area. The model indicated that additional places of surface water inflows to the karst system exist and should be systematically measured. These are namely inflows to the caves and abyss.

12. (L195) Finally, the descriptions have several depths of detail. For instance, the technical sketch of the dam is not of importance for this manuscript.

The cross section of the dam was originally attached as relevant reservoir water levels were depicted. New sketch (newly Fig. 4) will be added showing the water levels in the reservoir, the original Fig. 4 and paragraph describing the dam body will be omitted.

Response to editor’s comments

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The authors thank the editor for the helpful recommendations and suggestions.

1. Notwithstanding the interest for the article, there are some issues that need to be worked and better explained, starting from the feasibility to apply such a methodology in karst areas, and the amount of data needed to properly implement it. This should be in some way clarified.;
New Section 2.5 will be included, the data used are briefly described:
At the locality the monitoring of water stages and discharges in the Bečva river has been carried out since 1960 in the gauging stations in the Teplice spa and in the Bečva river bend. Occasional monitoring of water levels was carried out in lakes of HA, ZAC and KC during some months in the years 2005, 2020 and 2021. Unfortunately, the series are not complete and continuous and some data are missing in some formations due to various reasons. The measurements in the Bečva river are complete and continuous. In HA and ZAC, the measurements were quite difficult as an entrances to the caves and abyss are not public, due to the high carbon oxygen concentration the personnel must enter in the mask, at least two people are required. Therefore, it was complicated to check the measuring device and data logger and to perform remedial works in case of their outage permanently. The KC are private and the entrance could be possible only when accompanied by an owner.
The outflow discharge from the karst to the Bečva river in Teplice spa was determined using current meter, hydrometric propeller, by the acoustic Doppler current profiler and by the measurements of electric conductivity of water in the Bečva river in the spa (Il Faut 2022).
The surface areas of the lakes in the caves are specified in the Section 2.3.

2. (L23) Further, given the main topics of the journal NHESS (natural hazards) I would have expected more information provided on the floods that hit the area. Were they flash floods linked to concentrate rainfall, or were they another type of flood phenomenon? This also may have implications on the overall hydraulic functioning of the area, and provide further indication for a better application of the model.
The first sentence in the Introduction will be improved:
In the Bečva river catchment (Fig. 1) in the eastern part of the Czech Republic extreme regional floods occurred in 1997 and 2010 (CHMI, 1997, 2010).
Two references to the flood reports (CHMI 1997, 2010) were added.

3. (L97) Figure 1: a graphic scale is needed in the figure. Further, what is CUZK? You should explain the acronym, or put a specific reference.
The figure 1 is modified according to the suggestion of the referee 1, the scale and reference to CUZK were added.

4. Lines 110 and following:
Authors give for granted that readers are familiar with hypogene karst. As for NHESS audience, I am not sure this is the case. Therefore, some explanation, and a few references about hypogene karst, starting from the pioneering work by Klimchouk (2007) should be provided.
Following explanation will be added:
The Hranice Karst is hypogenic karst at which confined karst water flow is upward (Klimchouk, 2009). The Hranice Karst in the area of Devonian limestone ...

The reference to Klimchouk and other authors was added.

5. Line 113:
Authors are probably referring here to the limits of the catchment area. I do not think "boundaries of the karst" is right, since it gives the idea you are just referring to the surface boundary of soluble rocks, not necessarily corresponding to the actual limits of the hydrogeological catchment. Please correct the sentence.

The text was not accurate; the sentence was improved:
For the protection of the Teplice spa and valuable mineral springs the protection zone was declared (Fig. 1) based on ...

6. (L118) Breathing spots: please clarify what you mean by this, it is a term unfamiliar to me.
The “breathing spots” are the sites on a karst landscape surface, across which air is exchanged between the external atmosphere and an underground cavity. Following explanation was added to the page 5:
... "breathing spots" (the sites on a karst landscape surface, across which air is exchanged between the external atmosphere and an underground cavities), ...

7: Is the vertical scale as the horizontal one?
The vertical and horizontal scales are the same. The information will be added to the caption of the figure: ...vertical and horizontal scales are the same.

8. Figure 4: the figure lacks a graphic scale.
Based on the suggestion of the referee 1, the figure will be omitted. Improved Fig. 2 and sketch in Fig. 4 will be added.

9. (L6) There is discrepancy here between title and text. I suggest using the term hazards and not risks, since risk includes also socio-economical issues that are not dealt within this article
The text will be improved, "risk" will be substituted by "hazard".

10. (L23) No references available for these flood events?
Two references added.

11. (L44) , as for several other engineering projects (Parise et al., 2015, 2018)
The text modified according the suggestion of the editor.
The reference added.

12. (L47) To what author are you referring here? Milanovic? If so, it would be better to write "The latter author...."
The text will be modified according the suggestion of the editor.

13. (L60) , and many problems have been described during the construction and after such engineering works (Palma et al., 2012; Golian et al., 2021)
The sentence will be modified:
... workshops and seminars, and many problems have been described during the construction and after the completion of such engineering works (Palma et al., 2012; Stevanovic, 2015; Milanovic and Stevanovic, 2018; Golian et al., 2021).

The references added.

14. (L97) A graphic scale is needed in this figure
The figure will be modified, the scale will be added to the figure.

15. (L104) What do you mean here? Probably not the correct term
At the locality of Kamenec (local name) outcrops of limestone reach the terrain, therefore the concern of the seepage of the water from the reservoir to the karstic system exists. Following sentence will be added:
Concern exists about the seepage of the water from the reservoir to the karstic system.

16. (L110) You give for granted that readers are familiar with hypogene karst. As for NHESS audience, I am not sure this is the case. Therefore, some explanation, and a few references about hypogene karst, starting from Klimchouk (2007) should be provided.
Following explanation was added:
The Hranice Karst is hypogenic karst at which confined karst water flow is upward (Klimchouk, 2009). The Hranice Karst in the area of Devonian limestone ...
The reference to Klimchouk and other authors was added.

17. (L113) You are probably referring here to the limits of the catchment area. I do not think "boundaries of the karst" is right. Please correct the sentence
The text is not accurate, the sentence will be improved:
For the protection of the Teplice spa and valuable mineral springs the protection zone was declared based on ...

18. (L118) Again, you need to clarify what you need by "breathing spots"

The “breathing spots” are the sites on a karst landscape surface, across which air is exchanged between the external

atmosphere and an underground cavity. Following explanation will be added to the text:
... "breathing spots" (the sites on a karst landscape surface, across which air is exchanged between the external atmosphere and an underground cavities), ...

19. (L130) What is this? What does the acronym mean? CUZK
Reference (CUZK, 2024) added.

20. (L187) Is the vertical scale as the horizontal one?
Yes, both scales are the same. The information will be added to the figure caption.

21. (L195) A scale is needed
Original Fig. 4 will be omitted according to the suggestion of the reviewer 2, the longitudinal sketch will be included instead as Fig. 4.

22. (L203) Please have also a look at Stevanovic, 2015, and the individual chapters therein. Further, other interesting references might be Kresic (2013), Hartmann et al.(2014) and Leins et al. (2023).
References to these papers will be incorporated into the text.

23. (L446) This is quite a strong assumption in karst. Do you believe that, after dam construction, no flood problem will be registered?
The sentence will be rephrased and following text will be added to at the beginning of section 3.4:
Prior the simulations the model was calibrated using the measured water levels in the Bečva river and lakes in HA, ZAC and KC.
Presently hydrological extreme floods in the Bečva River temporarily influence the groundwater regime in the area including the karst system. However, experience shows that in few weeks after the flood the groundwater system returns back to the pre-flood conditions. Therefore, the main concern is associated with a permanent increase of the water level in planned reservoir that is represented by the levels 259 m a.s.l. in case of lateral reservoir (variant III.) and 261 m a.s.l. in case of through-flow variant (variant IV.). For each reservoir variant two scenarios were investigated, namely at the average discharge in the Bečva river counting about 25 m^3/s (III.A., IV.A.) and during the theoretical flood with return period 20 years with the discharge about 660 m3/s (III.B., IV.B). For these scenarios the results were compared with corresponding reference variants (II.A., II.B.).

24. (L464) Add references.
Following text will be added to Introduction, together with corresponding references in the end of the manuscript:
Parise et al. (2018) generally summarize current knowledge about karst areas, including karst geology, geomorphology and speleogenesis, karst hydrogeology, karst modeling, and karst hazards and management. Numerous authors deal with the karst environment which is characterized by distinctive landforms related to dissolution and a dominant subsurface drainage which brings risks for the planning, construction and operation of engineering works (Gutierrez et al. 2014; Parise et al. 2015). Klimchouk (2007) provides an overview of the principal environments, main processes and manifestations of hypogenic speleogenesis. He states that elementary patterns typical for hypogenic caves are network mazes, spongework mazes, irregular chambers and passage clusters. Palmer (1991) presents various types of cave systems that can gradually form in the karst area under the action of water. The process of the formation and expansion of cave systems usually takes more than 10 ths. years which significantly exceeds the live cycle of dams.