

Review of manuscript NHESS-2013-47:

“Structural flood-protection measures referring to several European case studies”

**by A. Kryzanowski, M. Brilly, S. Rusjan, and S. Schnabl,
submitted to Natural Hazards and Earth System Sciences**

Dear Editor, dear Authors,

The article by Kryzanowski et al. handles a very interesting topic and I am convinced that it has quite some potential. I would really like to see it published. Unfortunately, at its current state, the article is not well organized and partly quite confusing, and thus needs thorough editing. Please see the specific comments below for examples. The comparison of the different structural measures established in the study sites could be further developed. I think the contribution would considerably benefit from an improved coordination of the provided information (e.g. technical data is only given for the Vienna and Bratislava case studies in Tables 1 and 2).

The English language usage throughout the manuscript can be improved, too. Because I am not a native-English speaker I was not capable to deal with all the necessary rewriting. However, I have suggested many changes in a listing entitled “technical corrections”. The authors should try to formulate short, clear and well-arranged sentences. Also, I think that the manuscript would benefit from editing by a native-English speaker.

That said, I think that the article represents a nice review of structural measures that were taken to cope with flood events in a variety of different environments. If the authors can improve the structure and organization of the individual case studies (Description – Structural measures – Experience) and add some details to the provided information (e.g. regarding past floods, the sequence of measures taken in the study areas), this manuscript should be suitable for publication in NHESS.

SPECIFIC COMMENTS:

Introduction:

P248/L12-13: You write “Severe floods in 2005 further reinforced the need for concerted action.” But you don’t mention where these floods caused damage; try to be precise throughout the text

P249/L1-4: Who/which institutions are involved in KULTURisk? I think this is information that you should necessarily give; either here or in section 2

KULTURisk – project description:

I guess section 2 (KULTURisk – project description) could be drastically shortened and easily integrated into the introduction (second paragraph). Some statements made here are repetitive (e.g. development/ improvement of the culture of risk prevention at lines 1 and 10).

P249/L12: any kind (organizational and structural) of “risk prevention measures”?

P249/L14: Does that imply an improved record keeping of past damage events/disasters?

P249/L18-20: again, this is repetitive. You mention the goals/objectives of KULTURisk (e.g. the “promotion of a culture of risk prevention”) here even though they were already address above (P249/L1 and P249/L10). Please try to be concise in the description of KULTURisk.

Case studies:

P249/L17-23: Why are case studies listed here that are not discussed in the article (e.g. Zurich, Carlisle etc.)? This is very confusing. I think it is important to very clearly and unambiguously distinguish between the KULTURisk project and the investigations described in the present paper.
If you must present all case studies, I suggest you do it in section 2, or in the introduction (cf. comment above regarding the project description). However, I do not think it is necessary.

P250/L1-4: What is the basis of your choice? I think you should add a sentence or two explaining why you picked the Danube cities (Vienna, Bratislava and Belgrade) and Barcelonnette.
At P251/L8 you mention that the Danube River flows through four European capitals. Here too, I would like to know the basis of your choice (Vienna Belgrade and Bratislava). Why is Budapest not included in your review?

For the Danube case studies (Vienna, Bratislava and Belgrade) I miss a short table, giving some basic information: (i) distance from source; (ii) catchment size for the location of the respective city; (iii) discharge data available (years, resolution); (iv) peak discharge for flood with 100y return period.

Case studies - Danube:

P251/L17-18: Give approximate information: when was Vienna founded?

- P251/L17-18: Again, to what age/epoch/century does the following sentence refer to?
"The Danube flowed through a wide belt of marshy meadows severely hampering the trade routes towards Bohemia and Moravia and limiting the expansion of the city."
- P251/L21: When was decision taken to control the river? The answer is given at line 25 (1869). Please minimize the repetition!
- P252/L5-8: Can you give a few details (just 1-2 sentences) on the 1897, 1899, and 1954 flood events (which was the worst flood? which areas were flooded? was there much damage?).
- P255/L2-3: I would start this description section by putting the Bratislava case study into relation with the Vienna case study (3.1.1). For example: how far downstream from Vienna is Bratislava?
Also, did the huge flood protection project in Vienna (New Danube/New Danube Island) have any influence on the occurrence and size of flood events in Bratislava?
- P255/L4: Do you mean Danube floods? ("These regions have been prone to floods for many years...")
- P255/L5-6: Does the statement "Historically the Danube floods at Bratislava most often occur in May and June." also apply for Vienna? After all, the two cities are located close to each other.
Also I think the three following sentences from line 6 to line 10 ("The flood of August 1501 [...] (1594, 1598, 1670, and 1682).") should be integrated in 3.1.1 (somewhere between lines 5 and 12 at page 252) because they apply to both the cities of Vienna and Bratislava. In any case there is a need to better coordinate the two site descriptions of Vienna and Bratislava.
- P255/L21-23: Please be accurate! When (year) were these main flood protection measures taken?
- P256/L2-5: Are the activities described here ("The structural flood mitigation measures include reconstruction of existing and construction of new flood control structures on both sides of the Danube. These flood protection structures are dams, levees, reinforced concrete protective walls, and mobile elements, and so forth") the same as described above (P255/L21-23)? When were they planned? When were they built? Specify please.
- P256/L8-9: The last sentence of this section is a bit out of context. Maybe it needs to be reformulated. What is the estimated "water level"? Do you mean the water level for a 1000 year peak flow?
- P256/L8: Reading section 3.1.1, one could infer that a runoff of 14'000 m³/s represents a flood with a 10'000 year recurrence interval in Vienna. Here it is stated that a 13'500 m³/s runoff has an estimated return period of

1000 years. Is it possible that similar discharges result in such a large difference of the return periods?

P256/L11-15: This information is required in the sub-section above (Structural measures, P255/L21-26). Why do you describe the measures taken in the sub-section above, but give the framework information here? Please adapt your text.

P257/L6-7: At the end of the first sentence, indicate the distance downstream between this case study and the former case study (Bratislava) to put them into relation.

P257/L16-17: Why are no discharge values given here (instead you mention water levels)?

P257/L5-25: The two sub-sections "Description" and "Structural measures" are not well coordinated. The latter one contains information required in the upper one (or repeats information already given in the upper one). I guess this should be revised.

P258/L1: Is the "urbanized lifted area" you mention here the same area that you describe in the sentence before (the new part of the town that was constructed in the 1960s)? Please clarify.

P258/L22-24: Which rivers are "the rivers with flash flood regime"? Sava? Danube? Please clarify!

P258/L25-26: In "Much of the area is still actually threatened by floods", which area do you mean? Do you mean the city area, the area of the Belgrade municipality? Please clarify!

Case studies - Barcelonnette:

P259/L13-24: In the sub-section below, emphasize on the contrast between the three lowland case studies along the Danube (all dealing with large-scale inundations) and this case study which is located in a mountainous environment. The contrast is large and needs a transition (just 1-2 sentences).

P260/L1-28: These four paragraphs are not well organized. It is very difficult to figure out what happened when. The authors jump from one event to the next and then back.
I suggest introducing and briefly describing the 1957 flood right after the first paragraph. Then describe the flood of 2008 and comment on the damage caused by these two flood events. After reviewing these past events you can describe the present situation and the measures planned for the future.

Also, it is difficult to keep the subsections "Structural measures" and "Experience" apart.

P260/L1-28: Is the return period of the 1957 and 2008 floods known? If so, state it in the text.

P261/L7-23: The second and third paragraphs of this sub-section are quite confusing and not well written. They should be thoroughly revised and synchronized with the "Structural measures" sub-section.

E.g. at line 12 Dutch are mentioned that were surprised by an unexpected flood scenario: have I missed something? Who are these Dutch? Were Dutch people mentioned anywhere in the MS?

P262/L1: Is the "survey" mentioned here the same as the "study" mentioned at P261/L26? Please clarify.

P262/L7: Which "plans" are you referring to? Are these plans related to the decision taken by the municipality described at P260/L5-9?

Conclusion:

Consider adding a sub-paragraph to your list in which you briefly discuss risk-communication (e.g. the interaction with the threatened population).

P262/L25-26: What kind of "further flood mitigation measures? I don't think I understand your point. If flood risk cannot completely be eliminated and some residual risk remains, then you have to elaborate strategies to deal with this residual risk. But you can't apply additional measures to further reduce the residual risk. Or can you?

Is it not conceivable to accept the residual risk? At some point prevention just gets too expensive and will never solve all problems (as you correctly state in point 3). Also, prevention is often related to ecological problems. And, if minimal residual risk is accepted by decision makers, the communication with population is essential (cf. comment above).

Reference list:

For a review article, the reference list is rather shortish. Maybe you can add a few references of articles/contributions describing the different Danube/Barcelonnette flood events mentioned in section 3.

Technical corrections:

Abstract & Keywords:

- P248/L4: change to "and the Barcelonnette area"
Barcelonnette is also misspelled at P262/L11
- P248/L4: consider changing to "were also chosen" (instead of "are also taken")

Introduction:

- P248/L12: it would be more precise to write "in August 2002."
- P248/L18-19: rephrase this sentence (syntax error)
- P248/L23: change to "the fact that floods are a natural phenomena,"
- P248/L24-26: consider changing to "In view of this, a project called «Knowledge-based approach to develop a culture of risk prevention» (KULTURisk) was launched in YYYY. It is currently ongoing and focuses specifically..."
- P248/L5: delete "solely"
- P248/L6: consider changing to "to protect agglomerations against flooding";
instead of agglomerations you could also use municipalities or cities

KULTURisk – project description:

- P250/L7: consider changing to "and others," (i.e. deleting "many")

Case studies:

- P250/L13-14: consider changing to "case studies on structural flood protection measures"
- P250/L17: if not deleted (see specific comments for this section), change to "Zürich, Switzerland; Alpine catchments (floods and landslides)"
- P250/L18: change to "Danube, several countries; trans-boundary large river (large-scale inundations)"
- P250/L19: change to "mountainous catchment" (→ minor m)
- P250/L20: change to "urban area" (→ minor u)

- P250/L21: change to "Soča-Isonzo, Slovenia and Italy; trans-boundary Alpine catchment (floods and landslides)"
- P250/L23: change to "coastal area" (→ minor c)
- P251/L1: consider changing to "in the next subsections will be oriented" instead of "in the next subsection will mainly be oriented"
- P251/L3: write "and in the Barcelonnette area" instead of "and Barcelonnette area"

Case studies - Danube:

- P251/L9: consider changing to "passes through or flows along the borders of"
- P251/L11: consider changing to "in a transnational river by"
- P251/L14: change from "to cope with flood along" to "to cope with flooding along"
- P251/L23: consider changing to "The establishment of a secure port close to the city..."
- P252/L11: consider changing to "which corresponds to the estimated peak flow discharge during the largest flood event"
- P252/L12: consider changing to "A number of flood protection studies focused on increasing"
- P252/L19: consider changing to "(the «Danube Island», see Fig. 3)."
- P252/L19-20: change to "The excess water would be directed" instead of "In such a proposal, the excess water would be directed"
- P252/L22-23: change to "Works for this project started in March 1972. It took 17 years to complete the New Danube canal and the Danube Island."
- P252/L24-26: The protection system does not have a return period, the flood does; thus, consider changing to:
"It is estimated that the Vienna flood protection system can manage flows with a return period of around 10000 years, which is one of the highest safety levels in Europe."
- P253/L7-8: consider changing to "two weirs are used to maintain the water level in the New Danube"
- P253/L10-11: consider changing to "whose discharge capacity amounts to about 5200 m³s⁻¹." instead of "which can take up to 5200 m³s⁻¹."
- P253/L17: consider deleting "accordingly"

- P253/L17-20: I would consider rephrasing this sentence. It is mainly the Danube Island that is kept free from constructions, and not the canal itself.
- P253/L21: delete "surface" or even delete "surface area"
- P253/L23: consider changing to "The flood protection project was implemented"
- P253/L27: Please clarify the difference highlighted below:
4 years (P253/L27) + 15 years (P254/L1) = 19 years
P252/L22: "it took 17yr to complete [...]"
- P254/L2: consider changing to "since in the 1990s, a hydropower plant..."
- P254/L3: delete "led to" at the end of the line
- P254/L5-6: consider changing to "...within the city, and led to ecological improvement."
- P254/L7: change to "The project allowed for the transformation of..."
- P254/L16: consider changing to "...such as the introduction of a new subway line,"
- P254/L18-19: consider writing "on the left side of the Danube" instead of "on the other side of the Danube"
- P254/L24: use "would become" instead of "will become"
- P255/L4-5: write "storm rainfall events" instead of "storm rainfalls events"
- P255/L6-7: change to "The flood of 1501 can be considered the highest flood..."
- P255/L6-7: add a bracket → "(1594, 1598, 1670, and 1682)."
- P255/18-19: Simplify as follows "Since 1920, there have been two such floods, they occurred in July 1954 and in August 2002."
- P255/L23-26: Poor phrasing, repetitive; consider changing, e.g.:
"These measures were established to address gaps in the existing Danube flood protection system and to cope with under protected areas on Slovak territory in general and the Bratislava area specifically."
- P256/L4-5: consider changing to "These structures include dams, levees..."
- P256/L7: consider changing to "All these structures are designed for a peak flow in Bratislava corresponding to..."
- P256/L14-15: I would change the text as follows:
"... while the construction started in 2007 and was completed in December 2010. The objectives of the project «Bratislava – Flood protection» are listed below; they were all completely achieved."

- P257/L3: delete "were completely achieved" (cf. comment above)
- P257/L7: add reference to Figure 2 → "... and the Sava Rivers (Fig. 2)."
- P257/L11: consider changing to "of the area" (instead "of this area")
- P257/L12: Because it is a new paragraph, it would probably be good here to state again that you are speaking of "the left side of the Sava (?) River bank" (instead of referring to "the area" again)
- P257/L12-13: change to "the government of the Federal People Republic of Yugoslavia.
- P257/L15-16: The sentence "The layer of excavated sand from the Danube main channel..." seems a little out of context here and difficult to understand. When was sand excavated and why?
- P257/L19: consider starting the sentence as follows "Subsequently, a study was..."
- P257/L23: use "km²" instead of "square kilometers"
- P257/L23: delete "Serbia", it has been mentioned before and is obvious here
- P258/L4: consider writing "most of the urban flood protection" (instead of "the largest volume of urban flood protection")
- P258/L9: do you mean "only 3.5km of levees have been built and approximately 1.6 km of Sava River banks was regulated"?
- P258/L11: change to "Nowadays, flood control along the Danube and..."
- P258/L15-18: some information in this paragraph is repetitive (cf. P257/L16-17; consider rephrasing
- P258/L21: use "significant decrease" instead of "significant reduction"
- P259/L1: do you mean "the potential risk of flooding still exists"?
- P259/L4: the comment on maintenance is repetitive (cf. P258/L20); I suggest you delete it here
- P259/L7-12: this could be concisely rewritten as follows: "...a new implementation of the flood-protection system of the city of Belgrade has to be proposed as soon as possible. The level of flood-protection should be increased to provide security against floods with a 200 year return period. Eventually, the goal should be to assure protection against 1000 year floods. The latter can be achieved with the combination of fixed facilities with prefabricated or mobile elements (Kreibich and Thieken, 2009)."

Case studies - Barcelonnette:

- P259/L16: add a reference to Figure 6 at the end of the sentence
- P259/L17: "km²" instead of "km⁻²"
- P259/L19: add a reference to Figure 7 at the end of the sentence
- P259/L20-21: consider changing to "natural hazard processes" instead of "natural hazards"
- P259/L22: delete the sentence "Figures 6 and 7 show a map of the study area." (cf. comments above for Figs 6 and 7)
- P259/L22-24: consider changing and simplifying as follows to "Because records of hazards covering the period from 1850–2006 show that the area is mainly affected by floods (Weber, 1994), the emphasis of this case study will be devoted to the flash flood problem."
- P260/L2: change to "The Barcelonnette basin has an elongated form which makes it highly ..."
- P260/L6: "happens again" instead of "happen again"
- L260/L6-9: simplify as follows: "the municipality has decided to take the following measures: increase the dike height by 1.5 m in some areas, renovate sections of the river banks, reinforce the concrete embankments, build sheet piles at the "shoreline of scouring", and increase the height of the embankment of the bridges."
Please specify when this was decided by the municipality!
- P260/L11-15: There is something wrong with the syntax of the long sentence that starts at line 11; please rephrase. Try to write in short and concise sentences.
- P260/L1-28: spell dyke/dike consistently throughout the text
- P260/L15: "These actions" instead of "This actions"
- P260/L22: be consistent with units, use the same units throughout the article (here 0.6 m instead of 600 mm)
- P260/L22: change to "Also important to note is that the construction of check dams along the tributaries is a continuous process. Every year new infrastructure is being built to reduce the..."
- P260/L28: write "is to find a solution to..."
- P261/L4: change to "...the risk of flood events, such as the 2008 flood..."
- P261/L20-23: Just one example of three poorly written sentences; consider changing to "Therefore, a flood event of that size or greater may have an even worse

impact on the current Barcelonnette population since more people reside in the area. Moreover, the 1957 flood occurred more than 50 years ago and thus may not be remembered by many residents and may be unknown to recent settlers.

P262/L1-2: consider changing to "...respondents had been directly affected by a flood event, the majority of them..."

P262/L4: consider changing to "While the municipality is enthusiastic to implement..."

Conclusions:

P262/L10: consider changing to "in three cities along the Danube (Vienna, Bratislava, and Belgrade) and the Barcelonnette..."

P262/L11: consider changing to "These cities were also selected as case studies..."

P262/L16-19: this point is a bit confusing, change to
"In the cities of Vienna and Belgrade the construction of flood-protection systems started in the 1970s, but could not be finalized yet. Because local communities usually cannot afford the costs resulting from large mitigation projects, significant investments by governments are required."
However (!), at P254/L15 you mention the "completion of the project", which is contradictory to the statement you make in Point 1 of the conclusions. Was the "New Danube" project ever finalized or not?

P262/L20-21: consider changing to "The level of protection in the city of Vienna is assured against floods with a recurrence interval of 10'000 years."

P262/L22: write "level of protection" (instead "level of this protection")

Specific comments on figures and tables

Figure 1:

- In my opinion you should only indicate the location of the case studies discussed in the present study. As many of the KULTURisk case studies are not further described, it's rather confusing to see them on this overview.

Figure 4:

- What does the inset of this figure show? It's unclear.
- How are Fig. 4 and Fig. 5 related? What structures are planned along the "flood protection lines"?

Figure 5:

- Put a reference to Table 2 in the caption: "Various structural flood protection measures in the city of Bratislava (cf. Table 2); ..."

Figure 6:

- The black dots seem to represent towns/cities. Is the city within the case study Barcelonnette? And what does the white dot represent? What do the names in *italics* represent?

Figure 6/7:

- Do you need both figures?

Table 1 and 2:

- I think the two tables should be better coordinated (e.g. why is there no information on the design flood for Bratislava)
- Furthermore I think the reader would benefit from information on the Belgrade flood protection system/measures.

Table 2:

- Put a reference to Figure 5 in the caption: "Technical data of the flood protection measures taken in the city of Bratislava (cf. Fig. 5)."