Please find our response to Referee 1 below, and reference to each included edit.

Interactive comment on "What Does Nature Have to Do with It? Reconsidering Distinctions in International Disaster Response Frameworks in the Danube Basin" *by* Shanna N. McClain et al.

Anonymous Referee #1

Received and published: 6 January 2017

Review of "What Does Nature Have to Do with It? Reconsidering Distinctions in International Disaster Response Frameworks in the Danube Basin"

Summary

Using the example of the Danube basin and the Tisza sub-basin, the authors attempt to reflect on whether the policy distinctions made between natural and man-made disasters are a) suitable and functional, b) up to date, c) without fault. For this, the authors made a literature review and semi-structured interviews. The thematic scope of the latter remains unclear, though. They give a broad overview on the different disaster response frameworks in their study area and show that the diversity of these, combined with a lack of cooperation and ambiguity of responsibilities enhance the vulnerability of the population living in the area. However, it remains unclear in how far these problems are related to the nature vs. man-made dichotomy and why they are not simply regarded as insufficient response systems. On a more technical level, the paper lacks structure and focus and it remains unclear in how far the interviews provided considerable insight into the question of the distinction between natural vs. man-made disasters. If the authors delved more deeply on the issues of multi-hazard and trans-boundary hazards, the paper would gain focus and – so I assume – the results of the interviews could be more easily linked to the conclusions.

Scientific Significance: Does the manuscript represent a substantial contribution to the understanding of natural hazards and their consequences (new concepts, ideas, methods, or data)?

fair

Scientific Quality: Are the scientific and/or technical approaches and the applied methods valid? Are the results discussed in an appropriate and balanced way (clarity of concepts and discussion, consideration of related work, including appropriate references)?

poor

Presentation Quality: Are the scientific data, results and conclusions presented in a clear, concise, and well-structured way (number and quality of figures/tables, appropriate use of technical and English language, simplicity of the language)?

Poor due to poor structure and lack of clarity – English and number/quality of figures/tables is good, though.

Following the reviewer's comments, the paper was substantially shortened and streamlined, and citations were added.

Review Questions – summary

1. Does the paper address relevant scientific and/or technical questions within the scope of NHESS?

Yes

2. Does the paper present new data and/or novel concepts, ideas, tools, methods or results?

Trying, but in its current state is failing to do so.

3. Are these up to international standards?

unclear

4. Are the scientific methods and assumptions valid and outlined clearly?

no

5. Are the results sufficient to support the interpretations and the conclusions?

no

6.Does the author reach substantial conclusions?

They could be substantial, but they are discussed too superficially.

7. Is the description of the data used, the methods used, the experiments and calculations made, and the results obtained sufficiently complete and accurate to allow their reproduction by fellow scientists (traceability of results)?

no

8. Does the title clearly and unambiguously reflect the contents of the paper?

no – the authors rather describe the general problems of transboundary disasters and those of multi-hazards. The dichotomy between nature and man-made disasters and their respective response systems is rarely touched upon, and in those parts where it is discussed needs more reflection.

A discussion regarding the differences between hazard, vulnerability and risk was added, as well as clarification that the paper is focused solely on disaster response. A discussion on the purported differences between natural and man-made disasters was added for clarification, and since the intended focus should be on the policies for response, this was also clarified. One of the key arguments of this article is that the historic dichotomy between natural and man-made disasters is outmoded and inappropriate. Too much emphasis on the dichotomy undermines this central argument. See page 1-2 and related footnote, and page 11 and related footnote.

9. Does the abstract provide a concise, complete and unambiguous summary of the work done and the results obtained?

Partly. The paper does examine the policy frameworks in the Danube and Tisza region. If the authors focused on the general problems of the transboundary multi-hazard disaster management, this would be sufficient. The authors do not, however, discuss nature vs. man-made in detail.

The differences are discussed on page 11, again though – since the paper is focused on the differences in response, language was clarified to make this more apparent throughout the paper.

10. Are the title and the abstract pertinent, and easy to understand to a wide and diversified audience?

yes

11. Are mathematical formulae, symbols, abbreviations and units correctly defined and used? If the formulae, symbols or abbreviations are numerous, are there tables or appendixes listing them?

/

12. Is the size, quality and readability of each figure adequate to the type and quantity of data presented?

yes

13. Does the author give proper credit to previous and/or related work, and does he/she indicate clearly his/her own contribution?

From my point of view, the authors do not cite enough. I've indicated this at some points, but not always. Whenever facts, numbers, dates. . . are given, there should be a source given, just as for definitions etc. If the authors want to discuss whether the dichotomy between nature vs. man-made disasters is needed/useful, they need to cite much more literature from the social sciences, too. There (but not only there) they should find a vast body of literature dealing with nature-society-dichotomies. Furthermore, the question nature/man-made also touches considerably the issue of environ- mental determinism, an issue not discussed at all so far in this paper.

Per standard practice, we do not cite for facts, numbers, or dates that are readily available. Citations were added to paper to support argument, see page 11.

14. Are the number and quality of the references appropriate?

more references advised

References/citations were added throughout.

15. Are the references accessible by fellow scientists?
yes

16. Is the overall presentation well structured, clear and easy to understand by a wide and general audience?

It could be helpful if the authors provided a short summary of what their main points and/or what they wanted to say within the respective chapter. So far, the authors often leave the reader to draw her/his own conclusions without indicating what they – the authors – intended to conclude. Furthermore, the whole structure of the paper needs to be revised. The introduction should frame why the question is of importance, and should also give a broad literature overview. The results of the literature research – a task common to all scientific studies – has to be moved from the (supposed) results section to a section on the differences between response systems to natural and man-made disasters, respectively. The literature review should either focus on this question, or the scope of the paper needs to be changed towards the general problems of transboundary multi-hazards in the Danube region. The method (semi-structured interviews) needs to be explained in much more detail in order to be comprehensible and reproducible. Within the results section, the outcomes of the interviews need to be much more clearly linked to the research question. Within the discussion, no new literature and results should pop up.

We appreciate this comment from the reviewer, and agree that the paper's message could be sharpened. To do so, as noted above, we streamlined the paper. More specifically, the main point of the paper was clarified in the abstract and the introduction. The methodology section was substantially expanded and clarified. The interviews' insights were expanded. .

17. Is the length of the paper adequate, too long or too short?
too long – if restructured and focused it can be much shorter

As noted, the paper is now about 1,800 words shorter.

18. Is there any part of the paper (title, abstract, main text, formulae, symbols, figures and their captions, tables, list of references, appendixes) that needs to be clarified, reduced, added, combined, or eliminated? see above: literature review, methods, results, discussion need clarification, restructuring and – partly – reduction.

19. Is the technical language precise and understandable by fellow scientists?

yes

20. Is the English language of good quality, fluent, simple and easy to read and understand by a wide and diversified audience?

yes

21. Is the amount and quality of supplementary material (if any) appropriate?

/

Specific comments Major points

Introduction: Line 41: The authors start with principal questions on the benefits and consequences of distinguishing (or not) between natural and man-made disasters. Although starting with a question is "catchy", here some introductory sentences on the type of distinctions traditionally made is missing.

Clarification was provided on the distinctions among disasters. This is the same clarification as noted above in comments #8 and #9.

Lines 44-49: The line of argument needs to be sharpened: One could simply argue that we need another type of expert for this kind of disaster, i.e. an expert for cascading events. As the argument reads now (without having read any further), you seem to argue that expert knowledge in one field is not enough, but that we'll need "interdisciplinary experts". This is a common and popular demand, but nevertheless a tricky one and not as straightforward as it seems (e.g. you need to be an expert in a specific discipline in order to become a good "interdisciplinary expert"). I'd also argue that we need dichotomies in order to structure our knowledge (how else should we do it?), but that maybe the type of dichotomies need to be reconsidered. Hence, your argumentation seems to be plausible, but at a closer look is too shallow and short.

Further clarification and sharpening in regard to the need for improved holistic policies to streamline response was provided throughout the paper.

Lines 50-54: These “facts” disturb the line of argument: First, you state that dichotomies need to me eliminated (without really giving any reason for this statement), then you give some numbers of total losses, only to then switch to an example of a natech accident in your study area, and you end the latter paragraph by stating that international help was needed. Maybe my listing reveals to you, too, that you’re doing just that here: listing different facts and arguments without any coherence with regard t content. What is the problem with the fact that international support was needed? What does this have to do with your initial questions? You seem to imply that if specific experts for cascading or natech events had been in charge, then this support would not have been necessary – but you don’t say this explicitly, and most importantly: you do not argue why this would have been so. You need to exclude other factors, e.g. the lack of financial and other resources, the lack of disaster response measures – or the mere possibility that this happened because no-one ever thought something like this could happen (a core characteristic for why a disaster is a disaster*. . .*). In short: Discuss.

We have addressed this comment by further discussing and making clear the point that disaster policies have traditionally divided response between natural disasters and response to man-made disasters, explain how this has created problems in practice, and how this can be improved upon via more holistic policy approaches.

Lines 85-93: This section should reason why you structured your paper the way you did. For example, by stating “in order to understand why*. . .*, we first exemplify*. . .*” or the like. The mere structure becomes obvious by the headings.

The discussion on how the paper is structured is provided on page 4. As the reviewer indicated, the structure is made obvious by the headings.

Overview of the study area and methodology: Line 168: The numbering of the heading does not make sense. If you want to split section 2 in parts, you do need at least two parts. Either you skip this sub-heading, or you split section 2 in 2.1. study area and 2.2. methodology.

As noted, the methodology section has been substantially revamped, in part to address comments from reviewer #2.

Line 168ff: the whole section remains rather superficial. It is unclear why the authors chose a semi-structured interview (and not another method), how the chose the interviewees (criteria?), and what was the framework of themes to be explored within the semi-structured interview. Has there been an interview guide, and if so, what was in there?

The methods section has been expanded, the use of semi-structured interviews has been explained, along with detail on how individuals interviewer were selected, please see methodology section.

Lines 191ff (table 1): Currently, the table does not provide much information. It could be interesting, for example, how many experts from international, national, ... have been interviewed. Plus, change the order: International, national, regional. Ah no, I only realize now that you imply a different understanding of "regional" - this is somewhat confusing. Plus, I am not quite sure why the EC is not listed within international (just as the ICPDR, which even has "International" in its name)? Maybe you should then write supranational instead of regional? Or, yet another possibility: global, international, national. Non-state actors could also be distinguished in global, international, and national
(or at least it should be clarified which type of non-state actors).

Additional clarification has been provided regarding table 1 (now table 3).

Distinctions between natural disasters and man-made accidents in policy frameworks: Lines 211f: I do not understand the meaning of “traditionally” in this sentence. Does this imply that non-traditionally the approaches do not shape monitoring and response methods? Plus, some source(s) should be given for this statement.

The word “traditionally” was removed..

Lines 223f: I do not understand what you want to imply with this sentence. Here, again, you simply place a statement without source, and more importantly, without saying what you want to say with it. Currently, this sentence is a mere filler.

This sentence has been removed.

Lines 224ff: This is not the definition of disaster, but the definition of a natural event. In order to be a disaster, people have to be involved. Plus, if you give a definition, you should also cite the source for the given definition. If you give a correct (in the sense of well-accepted) definition of natural disaster, it might also become easier to discuss whether the distinction of natural vs. man-made makes sense. After all, it might also be seen as a decision of individuals or the society to take some risks – hence, is the disaster (not the event itself!) man-made or natural?

Citations have been added.

Line 229: “some natural events”? Why only some? And other natural events are disasters per se? Plus, you’re not sticking to your initial definition of natural disaster.

Please see page 12, this was clarified.

Line 230ff: They only become a function of where people reside? In opposite to what? Has this ever been different, i.e. something has been a disaster without any impact on individuals or society? I do not think so.

Clarification has been provided, please see page 12.

Lines 238-256: The paragraph is well argued. However, the conclusion of the argumentation is still missing. As a consequence, the authors leave the reader to assume what they want to state. For example, I assume that your statement is that natural disasters become a disaster due to societal circumstances and conditions. Because of this, you might want to state, the term "natural disaster" is misleading, which could b e a first hint that the distinction between man-made and natural is not useful. But as I said, this I what I assume – you keep the reader in suspense.

We followed the reviewer's suggestion, and new language was included. Please see pages 13-15.

Line 264: How do disasters multiply or become more complex? This, again, is a mere statement without any source or argumentation given. Why should disasters be more complex nowadays than in previous times? Do they multiply, or is this a question of awareness and/or mass media and/or statistical bias? There are so many questions and uncertainties attached to this statement that it needs source and discussion, the latter especially if – as I think it is – the statement is important for your line of argumentation. Please be also aware of the difference between complex and complicated. As your focus is on dichotomies and differences, I think you should be especially clear with respect to your wording.

The definition (and further elaboration) of cascading and complex events has been provided on page 2.

Lines 273ff: So what you meant by "complex" in the previous paragraph actually means the degree of uncertainty of knowledge of cause and effect? In fact, I do not quite understand why you include this aspect here and what you want to tell the reader with it. How does it relate to what was previously said? Over wide parts you employ an "additive style of writing", i.e. adding several arguments without clarifying how these arguments relate to each other.

Please see page 2.

Lines 221-279 (section 3.1.): I do not quite think that you give the "rationale for different treatment" of natural and man-made disasters. The rationale could be stated in two or three sentences of what you wrote and seems to center around liability. Plus, not only natural hazards but also man-made hazards are a function of where people live, but you do not discuss this. In fact, you leave the reader rather puzzled with respect to what you really want to say. What you do in this chapter is discussing different terms (e.g. moral hazard and vulnerability (although one could ask if especially the latter should be discussed in the context of man-made hazards, too?)). Honestly, I do not quite get your point, and I still do not know the "rationale" behind the distinction of natural and man-made hazards – apart of the question of liability. The mentioning of climate change at the end of this section further adds to this confusion. Maybe if you change the heading of this section, so that it reflects the discussion of the difficulties in distinguishing between “natural” and “man-made” with respect to disasters, the section would gain focus.

We agree with the reviewer. The section has been renamed, and language has been clarified. Please see new title and new language.

Lines 284-286: Before stating how the fragmented nature of disaster response has emerged, you should explain in how far the disaster response has been fragmented so far.

This was provided in lines 270-303, section 3.2 “Dimensions for Different Treatment”.

Lines 288: Why do you refer to chemical accident response programs only? Here, you assume that the reader knows all or sufficiently enough about response programs to man-made hazards. In order to provide the reader with the knowledge that (s)he needs for understanding your argumentation, you need to give an overview of the respective response programs. Are natech accidents included in industrial and nuclear etc. response programs?

Language clarified to denote absence of “natechs” in disaster response frameworks, please see page 7.

Lines 280-322: I’m afraid I’m totally lost – I do not understand what you want to state within this section. Maybe repetition and clarity would help: The principle of “First, state what you’re going to state, then state what you’re stating, and the state what you’ve just stated” might be useful here and in other parts of your paper. You need to be much more explicit about your take-home-message in every section of your paper, as well as in your paper as a whole.

Disaster frameworks in the Danube and Tisza: Line 331: Heading should be changed to “Introduction to disaster response programmes (? If that is what is meant?) in the Danube and Tisza region/basin/. . .”

Heading changed, as suggested.

Line 353ff (Table 2): It remains unclear what classifies as disaster here. Is it classified by each individual country, or is there a definition of the EC that is utilized here? Or is your above "definition" used, meaning that any event is a disaster? Sometimes, you add "natech" to an event, but it remains unclear why it is classified as such.

Note has been added to clarify references to natech accidents, see Table 4.

Line 355: Heading 4.2. is misleading – it is a sub-section of the Danube and Tisza but the heading reads as if response frameworks in general are treated. Without having read the section so far: If you do discuss the response frameworks in general, then this section has to be moved further to the beginning of the paper, since all your argumentation is based on the differences in these frameworks. However, to this point of the paper, you have not given any information on how they do in fact differ. If you discuss the response frameworks with respect to the Danube and Tisza region, say so in the heading. However, the first sentences of the sub-chapter suggest that the first is the case, so that this section will have to be moved. Another possibility is to split this section and to move the general part to the first parts of the paper, and to keep the Danube-specific section here (with an appropriate heading). In particular, the heading should stress the differences between response frameworks for natural and man-made disasters, respectively, and not the differences of frameworks in general.

Line 389ff: This is a little bit confusing for the reader: The focus of your paper is – or should be – the problems arising from the dichotomy of response frameworks for natural and man-made hazards, respectively. Your discussion, however, centers on general problems of disaster response frameworks such as the different treatment of sudden-onset and slow-onset disasters. This is a major issue, but minor with respect to your main question, and thus misleading for the reader who starts to lose track.

Please see page 14, where this has been clarified/explained.

(in the following, I left my initial comments to transport my confusion while reading. It was not at all obvious to me that I was reading the results-section) Lines 409ff: These are already results and do not belong in this section.

Lines 470ff: see above – these are results. Lines 493ff: see above, results.

Lines 506ff: see above, results. Lines 539ff: results?

Lines 589ff: results? I start to realize only now that this seems to be supposed to be the result section. It seems that the authors employed an inductive way of reasoning, and this is reflected in the structure of the paper, which results in some difficulties for the reader. Deduction, however, is part of "normal science" and is thus what the reader would expect and – in fact – needs in order to follow the argumentation. Hence the authors need to rearrange the content of the paper, so that the results of the literature review – which, actually, is part of every scientific study and thus is not really a "result" but rather prerequisite for any study – need to be given first. This is then the framework in which the detailed results of the interviews can be set. Hence, your paper needs a profound restructuring.

Questioning the distinction Line 612: Do you really believe that vulnerability can be avoided? How should this be possible?

We agree with the reviewer. The sentence was rewritten to be clearer - vulnerability can be reduced, see page 27.

Line 613ff: What do you mean by "proper"? Disaster is characterized by something unexpected happening – how can this be "properly" avoided? Again, this is a mere statement that would need discussion.

The word "proper" has been removed.

Line 616: There is ample literature on the question whether natural hazards can be considered natural hazards. Maybe this literature should be reflected, too – the discussions go much further and deeper than is currently the case in this paper.

We thank the reviewer for this helpful comment. Please see page 12, hazard and disaster are now discussed and defined.

Line 616ff: It still remains unclear what difference it would make to simply name natural hazards not natural, but complex hazards or maybe even man-made. The key is to consider all potential causes and triggers of disasters, regardless of them being natural or man-made. Hence, the problem is not the distinction, but the problem is the insufficient knowledge regarding causes and triggers – and maybe also: that new technologies bring with them new hazards and risks, which can often only be known in retrospective. Instead of propagating a higher level of security by avoiding the distinction between man-made vs. natural you could also come to the conclusion that "proper protection" is impossible. With your argumentation you presume that things would change for the better just because of naming it differently. This is clearly not the case. In a nutshell, so far you simply argue for taking more causes and triggers into account, in other words: for a better understanding of the hazardous processes. Everybody would agree on that – but what is the new finding? And how does this relate to the interviews you've made? The results you've mentioned so far do not at all relate to your initial question.

We agree we could have sharpened the argument and clarified our point. Please see the reworked section 5.

Line 631: Why "for this reason"? As you wrote before, this accounts for every type of hazard, not only natech! Highly populated areas mean higher risks (not hazards!).

Please see clarification of language in paragraphs and in footnote on page 12.

Line 651: Are we in the discussion section now or still within results section? Here, you suddenly bring new results (as well as new literature) – if this was supposed to be the discussion section, no new information should be given, but only previous information be discussed.

Line 677: Section 6 suddenly brings up multi-hazard approaches, without them being mentioned beforehand. Actually I have more or less expected the paper to start with multi-hazard approaches, as natech would classify as such. Here, at the end and in the way you present this information, it is not included in the previous discussion, but suddenly opens up a new discussion that leaves the reader rather helpless: How does this relate to the previous sections? Why does this come up now? How does it relate to "multilevel disaster response", yet another issue that is new and non-discussed?

Multi-hazard approaches are suggested in the introduction, per the reviewer's suggestion.

Minor points - See comments within the attached pdf

All minor points in attached document have been corrected throughout.

Please also note the supplement to this comment:
http://www.nat-hazards-earth-syst-sci-discuss.net/nhess-2016-307/nhess-2016-307-RC1-supplement.pdf

Please find our response to how we incorporated Referee #2's suggestions listed below.

Interactive comment on "What Does Nature Have to Do with It? Reconsidering Distinctions in International Disaster Response Frameworks in the Danube Basin" *by* Shanna N. McClain et al.

Anonymous Referee #2

Received and published: 19 March 2017

Review of NHESSD 2016-307 (What does nature have to do with it? – Reconsidering distinctions in international disaster response frameworks in the Danube basin) by McClain et al.

The distinction made between natural hazards and man-made disasters is not so clear to me since the policy and therefore institutional framework needed for risk management is interrelated.

Clarification regarding the focus of this paper -dichotomies between response to natural disasters versus response to man-made disasters, and the need for improved frameworks for response – was provided throughout the paper, but especially on page 2, and in the corresponding footnote found on page 2. Since the paper is not focused on disaster/risk management, but on how organizations/institutions respond to disaster in a fragmented manner, this point was clarified as well.

In the introduction the authors argue that the dichotomy between both disaster types – even if historically grown – is to be eliminated also because of the effects of anthropogenic climate change. I encourage the authors to not overemphasize the man-made effects on climate here since also the natural climate change together with the socio-economic development in the case study regions call for more tailored risk management options. Maybe the introduction would gain in conciseness if the argumentation string will be streamlined and some additional references (apart from these of international organizations) are consulted. Even by searching quickly Science Direct, some sources caught my eyes and with respect to the mentioned natech disasters some studies are available.

Additional references were provided using the Kappes et al. paper suggested by the reviewer. Argument in regard to the focus of the paper – disaster response (not management), and how institutions respond to each type of disaster based on a fragmented system of legal frameworks – was clarified on page 2. Overall, the paper was streamlined to ensure the focus was clear throughout.

In their overview on the case studies I am missing some Citations (there should be more than ICPDR available), also with respect to the historical flood risk management activities in the region, and I kindly would like to suggest to also show rivers Danube and Tisza in Figure 1.

The map has been updated to include the rivers as requested.

In the method section some clarification is needed in order to better follow the arguments.
To give an example, the authors conducted 71 interviews and an overview is given in Table 1. In Table 1, however, it remains unclear what exactly the numbers in brackets show: Either “multiple interviews conducted at each level of governance”, which should then sum up to 71, or “a reference to the interview citations in the text”, as indicated in the Table footnote. Moreover, the method section is quite short (only two paragraphs) and does neither describe the secondary data analysis nor the sources for this analysis. An additional Table could help here. Some additional information is needed on the method itself, why semi-structured interviews were chosen and which criteria were used. Finally, if there is a section 2.1 there should also be a section 2.2 in the text (could be linked to section 2 so that 2.1 is the overview on the case studies and 2.2 is the method description).

The methodology section has been considerably expanded to address this comment. See pages 8-11

In section 3.1, more citations are needed to underpin the statements made; for flood risk in Europe there are some sources available showing the historical development of risk management beyond the simple classification of disasters being seen as “acts of good” and technical approaches. Moreover, in this section the wording is a bit confusing since the authors are addressing dynamics in exposure (population and assets) but are talking about vulnerability (which even from a societal point of view is more than just exposure). There have been some articles in the targeted journal (NHESS) on this topic which may serve as guidelines for re-writing this section. So I suggest to first make a clear distinction between hazard, vulnerability and risk and second between different management options for technical and natural disasters (and here I suggest to only focus on the disaster type studied and not on all types of disasters since the management of earthquake risk in Danube countries is highly different from managing flood risk. The same for moral hazard: also here we do have excellent examples published in NHESS on the associated issues (insurance etc.). Of course the authors are free to choose any other sources, but this will help to streamline the chapter and to make it more concise, also with respect to the hypotheses and statements the article is at the moment missing over larger parts.

Citations from Kappes et al. were added, as well as distinctions requested regarding hazard, vulnerability and risk on page 11, and in corresponding footnote found on page 11.

With respect to section 4 (Disaster frameworks. . .) I suggest to shorten the introduction and to integrate the material in the overall introduction of the paper. This would help to increase the accessibility of the text, and to streamline the string of argumentation (which is the different treatment of natech and natural hazards in both of the catchments?).
The different treatment is, moreover, also a result from the different legal situations in the affected (EU) countries, as such it remains a bit unclear to me how the current top-down approaches are interwoven. It may be good to re-write this section in a way to mirror (a) the overall UN activities which are somehow legally binding, and (b) the regulations spanning from EU level to individual countries and below (some regions may have specific rules and also a specific institutional setting, such as e.g. the water associations in some of the Austrian federal states (see for example Thaler et al. (2016; 2016) for some in-depth discussions). I also assume that potential reasons identified for a lower level of integration in terms of flood management on river basin level as opposed to bilateral levels are connected to funds availability as well as potentially a lack of political will, while Tisza states focus on preserving their national sovereignty. Did this also result from the interviews?

The top down approach follows the chain of various laws governing response to natural and/or man-made disasters (which are often delineated by disaster type) from UN to EU to basin level (via the Danube Convention of the ICPDR) – table 1 was added to reflect this. Discussion of funding constraints is provided on pages 21-23. The EU WFD stipulates management at the basin level and activities are funded through annual support from each Danube member state.

An additional Figure with all the regulations (in terms of boxes and arrows) would also help to clarify the diversity here.

Table was added to reflect the legal mechanisms governing response to natural and man-made disasters.

Section 5 could then be better connected to section 4, and here I also would like to raise the question whether it is really a dichotomy or a “question of distinction” between natech and natural hazards (both of them of course could be cascading, see for example the discussion in Kappes et al. (2012)).

The title of this section is “Questioning the Distinction” because the argument is not about whether natech accidents or natural disasters can be cascading – they both can be, as the review mentioned. However, the question is – do we need multiple organizations piecemealing strategies for responding based on whether the disaster is natural or technological in origin, particularly when natural disasters are often recognized as anthropogenic in nature – and when disasters are more often including a natech element to them (which requires (unnecessarily) fragmented response by numerous agencies). Please see clarified language in section 5.

To summarise, I kindly would like to suggest to

- Streamline the paper in terms of avoiding repetition, - To clearly discuss definitions on hazard, vulnerability and risk in the very beginning, - To clearly state the hypotheses in the introduction, - And then to smoothly develop a set of arguments why the current management is suboptimal and where you identified necessary changes. This should be clearly linked (or more prominently stated) to the interview results.

The paper was considerably shortened and streamlined, per both reviewers’ suggestions. Clarification was provided in the introduction, see page 2.

I encourage the authors to undertake the necessary improvements and I definitely believe that then the paper becomes acceptable for publication in a journal such as NHESS.

References relevant to the paper, and recommended by the reviewer were added to the paper.

References mentioned in the text

Kappes, M., Keiler, M., von Elverfeldt, K., and Glade, T.: Challenges of analyzing multihazard risk: a review, Natural Hazards, 64, 1925-1958, 2012.
Thaler, T., and Hartmann, T.: Justice and flood risk management: reflecting on different approaches to distribute and allocate flood risk management in Europe, Natural Hazards, 83, 129-147, 2016.
Thaler, T., Priest, S., and Fuchs, S.: Evolving interregional co-operation in flood risk management: distances and types of partnership approaches in Austria, Regional Environmental Change, 16, 841-853, 2016.
Interactive comment on Nat. Hazards Earth Syst. Sci. Discuss., doi:10.5194/nhess-2016-307, 2016.

What Does Nature Have to Do with It?
Reconsidering Distinctions in International Disaster Response Frameworks in the Danube Basin

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Abstract

This article examines the policy and institutional frameworks for response to natural and man-made disasters occurring in the Danube basin and the Tisza sub-basin. Response to these types of incidents has historically been managed separately, as has the monitoring of these types of incidents. ~~Given policy distinctions in response to natural and man-made disasters,~~W ~~w~~e discuss whether the policy distinctions in response to natural and man-made disasters remain functional given recent international trends toward holistic response to both ~~natural and man-made~~kinds of disasters. We suggest that these distinctions are counterproductive, outdated, and ultimately flawed, a conclude by reflecting on the lessons learned and ~~conclude~~ by proposing an integrated

framework for disaster response in the Danube basin and Tisza sub-basin~~and conclude with a reflection of the lessons learned, and propose an integrated framework in the Danube basin and Tisza sub-basin~~.

Keywords: International Disaster Response Frameworks; Natural Disasters; Man-made Accidents; Industrial Accidents; Natech Accidents; Danube River basin; Tisza River Sub-basin

1 Introduction

What are the benefits of maintaining the distinction between natural and man-made disasters? What are the consequences of eliminating this distinction? When a disaster occurs, local and national capacities for disaster response can be overwhelmed, often triggering a request for external, international assistance. The actors engaged in disaster response[1] have historically been determined by the nature of the disaster (i.e., natural disaster, industrial accidents, nuclear accidents, marine oil spills) and legal frameworks typically divide response between natural ~~disasters~~ and ~~response to~~ man-made disasters. However, there is ~~; but with~~ growing recognition that anthropogenic climate change and other human activities such as land use change are ~~is~~

[1] While disaster response is considered part of the disaster management cycle, disaster management includes the application of policies and actions regarding disaster risk (i.e., prevention, preparedness and mitigation, response, and recovery). Each have their own set of policy frameworks, actors and mechanisms for implementation. This paper focuses on the disaster response phase specifically, and on the policy frameworks and actors related to requesting and receiving assistance immediately following a disaster, and the legal mechanisms by which responders are deployed.

driving more ~~extreme,~~extreme and sometimes cascading events. Cascading events ~~(e.g.,~~refer to ~~the phenomen~~cases ~~on associated with events~~ in which a primary threat is followed by a sequence of secondary or additional hazards~~,~~ ~~Pescaroli and Alexander, 2015).where the effects of disasters are multiplied, or where they are composite, or concurrent)~~ that require complex and often overlapping types of response (Pescaroli and Alexander, 2015). Thus,~~,~~ the question of eliminating ~~this~~ the natural/man-made dichotomy is brought to the forefront. ~~The complexity of disaster events increases with cascading events, both temporally and spatially, due to the interaction of multiple hazards, threats, and vulnerabilities — thus, creating challenges in response fragmented response frameworks since the main impact from a disaster event can be from its subsidiary events and not necessarily from the triggering event (Pescaroli and Alexander, 2015).~~

In Europe, natural and man-made disasters combined caused total losses of US$ 13 billion in 2015 of which only US$ 6 billion were insured; the predominant losses came from flood events (Swiss Re, 2016). Flooding and pollution are considered to be the primary transboundary pressures of the Danube River basin; however, a number of other man-made accidents occurred in the region (ICPDR, 2015a).

Specifically, i~~I~~n 2000, the Baia Mare and Baia Borsa mine-tailing pond failures mobilized approximately 100,000 m³ of metal-contaminated water into the Tisza River, eventually polluting the Danube River and Black Sea. Since the industrial accidents occurred originally as a result of significant rainfall and flooding, these events are an example of what are commonly referred to as natech accidents, technological accidents triggered by natural disasters. In 2010, an industrial accident occurred in the Hungarian portion of the Danube River when a dam containing alkaline red sludge collapsed, releasing 1.5 million m³ of sludge into the surrounding land (approximately 4000 hectares) and waterways (including Kolontár, Torna

Creek, and the Danube River), killing 10 people and injuring several hundred more (ICPDR, 2010). In 2014, following Cyclone Tamara, over 1,000 landslide events occurred in Serbia as well as significant flooding, resulting in damage to properties and infrastructure and the inundation of agricultural land. Due to concern over possible breaches in infrastructure to mine tailing dams in the surrounding area, and the harmful effects to human health, technical experts investigated mining sites and provided recommendations for local evacuations (NERC, 2014). In all three disasters, the need for disaster response exceeded the capacity of national actors; therefore, international response involved the United Nations, the European Commission, and various other international organizations.

While international humanitarian law is generally well defined, the law of international disaster response is still incomplete (Fisher, 2008). Historically, a distinction has been drawn between the scope of response to natural disasters and man-made disasters; however, this distinction is absent from the 2015 Sendai Framework for Disaster Risk Reduction, which adopts a multi-hazard risk approach providing management tools for disasters that are both natural and man-made (UNISDR, 2015). The European Union's disaster response framework is also holistic and includes natural and man-made disasters, and some multilateral sub-regional agreements are also taking similar approaches, such as those adopted by the Association of South East Asian Nations (ASEAN) and the Baltic Sea Economic Cooperation (BSEC). Adopting a multi-hazard, or all-hazards, approach to disaster response allows for recognition of all conditions, natural or man-made, that have the potential to cause injury, illness or death; damage to or loss of infrastructure and property; or social, economic and environmental functional degradation (Kappes, Keiler, von Elverfeldt and Glade, 2012).

With international policies starting to shift toward more holistic frameworks of response that incorporate both natural and man-made disasters, this article explores what this trend will mean for regional institutions in the Danube basin and Tisza sub-basin, whose policy frameworks for monitoring and response continue to distinguish between types of disasters, and resultantly have separate policy response options depending on the type of disaster.

This article begins with an overview of the study area and a description of the methodology. Next is a discussion of the distinctions between natural disasters and industrial accidents – how and why they have been treated differently and how recent developments in international law and practice are raising questions about the merits of these distinctions. It is followed by an examination of the international frameworks governing disaster response in the Danube basin and Tisza sub-basin. Subsequently, the differences in how natural disasters and industrial accidents are monitored, and how they are responded to, are explored. The article discusses the transition of international policies toward more holistic frameworks for response, and concludes with a reflection of how this might affect the Danube basin and Tisza sub-basin.

2 Overview of study area and methodology

The Danube River basin covers more than 800,000 km² – over 10 percent of continental Europe – and flows through the territories of 19 countries with nearly 80 million people residing within the basin. Today, 14 of the 19 countries, plus the EU, have committed to transboundary cooperation in protecting the Danube via the Danube River Protection Convention (DRPC), and work jointly toward the sustainable management of the Danube basin and the implementation of both the European Union's Water Framework Directive (WFD) and Floods Directive (EU FD) (ICPDR 2015a).

Among the tributaries of the Danube River, the Tisza sub-basin has the largest catchment area, and covers approximately 160,000 km^2 (20 percent of the Danube basin's area), with approximately 14 million people (Fig. 1). There exists a distinct socio-economic contrast in the basin between western and former socialist countries, and since the end of communism in the late 1980s, the central and lower Danube has experienced a rapid shift to free market democracy within the context of increased globalization, privatization, and deregulation. This has led to rural decline as well as increased poverty, unemployment, and depopulation (WWF, 2003). ~~Additionally, as a result of the continuing conflict in Syria and neighboring states, countries in the Danube and throughout Europe are experiencing a significant increase in population from refugees, displaced persons, and other migrants who are escaping persecution, conflict, and poverty, and are settling in empty buildings, hotels, or refugee camps that have become ad hoc~~

shelters (UNHCR, 2016)

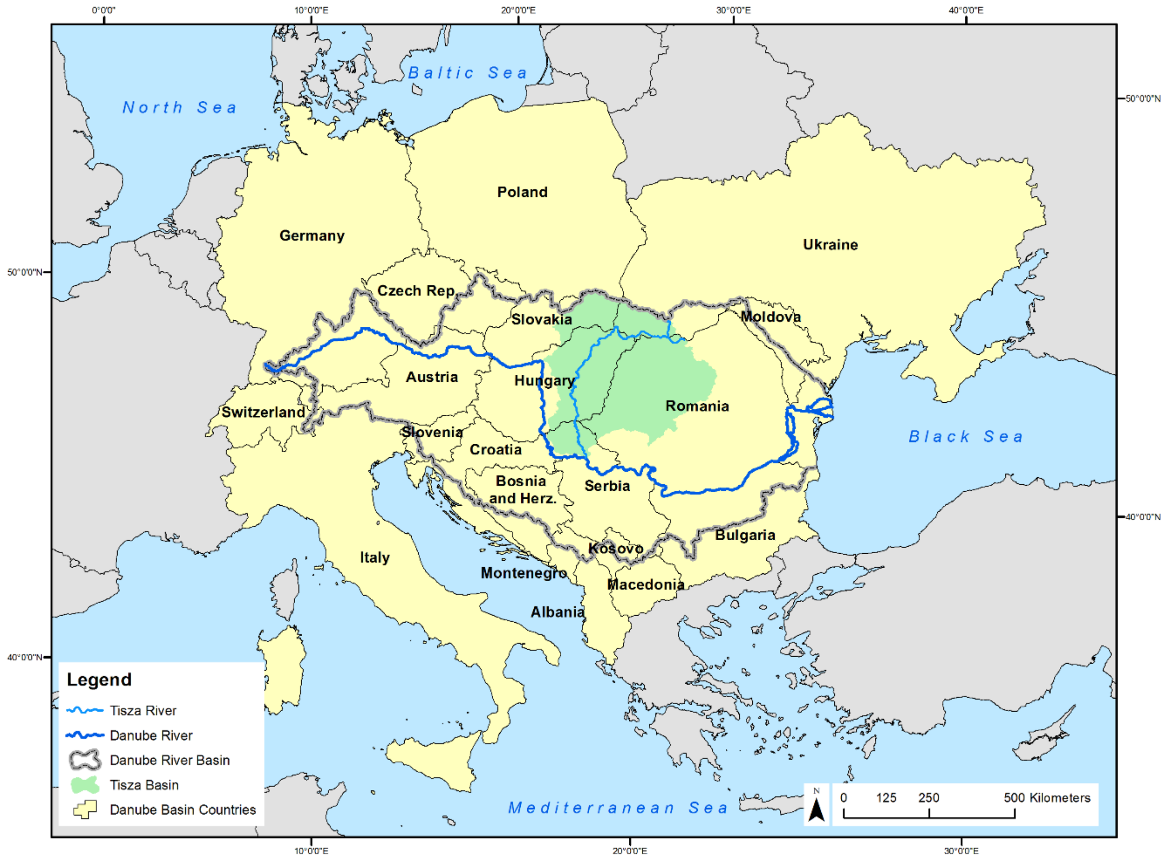

Fig. 1 Map of Danube River basin and Tisza River sub-basin.

The headwaters of the Danube are located in the Black Forest of Germany. After leaving the Bla Eastern Europe to the Black Sea in eastern Romania (Fig. 1; ICPDR, 2009a). International measures regulating the Danube were first undertaken in 1882 for flood protection and navigation. Dams were constructed within the upper Danube basin for flood mitigation, hydroelectric power generation, and regulation of river levels for navigation. The operation of these dams for these services has been attributed with altering the flow regime of this segment of river and consequently varying the ecological disturbance regime within the river and on the floodplain resulting is substantial changes in the riverine ecosystem (ICPDR. 2009a). The flow regulation provided by the dams and the construction of levees has allowed for the conversion of floodplains and riverine wetlands into area suitable for agricultural and urban development. Today only 12 small reaches (<1 km in length) of the Upper Danube ~~relatively~~ remain relatively untransformed (Schneider, 2010). In the Middle and Lower Danube, the river bed has been dredged repeatedly to maintain a navigable river channel. Along these segments of the Danube River, levees and dams mitigate or prevent inundation of over 72 percent of the floodplain. The substantial reduction in~~s~~ Danube's connection with its floodplain combined with wastewater discharge from agricultural and industrial sources, and increasing levels of pollutants along these river segments have substantially altered or damaged riverine ecosystem and reduced resiliency of urban and rural communities to large floods which exceed the protection level of their flood mitigation measures (Schneider, 2010; UNECE, 2011). The degree of industrial development and amount of pollution created by the industrial sector varies among Danube countries. In general, pulp and paper industries represent the largest contributors of pollution, followed by chemical, textile, and food industries (ICPDR 2009a).

The Tisza headwaters are located in the Carpathian Mountains in Ukraine. From these headwaters the Tisza River flows southwest across central portions of the great Hungarian Plain into the Danube River in Serbia (Fig. 1; ICPDR, 2008a). ~~Precipitation within the Tisza basin is generally concentrated in the Carpathian mountains within the upper portion of the watershed.~~ I~~The i~~ntense, concentrated ~~ity of the~~ rainfall and the steep terrain coupled with deforestation and channelization of many streams ~~within this portion of the Tisza watershed,~~ result~~s~~ in some of the most sudden and high-energy flooding in Europe~~. Flood levels along the upper reaches of the Tisza can range up to 12 m deep within as little as 24-36 hours~~ (Nagy et al., 2010). The sudden water level rises coupled with the high energy of the flows often threaten human lives and result in substantial damage to infrastructure and croplands (ICPDR, 2008a).

While industrial production has dropped drastically in the Tisza since the 1990s, there remain a variety of industries that contribute to the economy of the region, and the legacy of heavily concentrated industrial activities continues to threaten the surrounding ecosystems. The main industrial regions of the Tisza are located in Romania and Hungary, where the potential for ~~greatest~~ flood damage and losses is also greatest. Chemical and petrochemical industries (including oil refinery, storage and transport) are important for both Hungary and Ukraine, and the cellulose and paper, textile, and furniture industries are also present predominantly in the upper portion of the Tisza in Slovakia, Romania, and Ukraine (ICPDR, 2011). ~~Beyond the threat of mobilizing hazardous materials from industrial activities directly into the Danube or Tisza Rivers, the risks posed from industrial accidents to the surrounding communities, particularly with increasing urbanization, is of growing concern.~~

Mining activities, and the accidental spills of chemical substances, have affected the aquatic environment and water quality within the Tisza sub-basin since the 2000 Baia Mare and Baia Borsa natech accidents (JEU, 2000). Natech accidents present significant challenges, as natural events can trigger multiple and simultaneous accidents in one installation, or depending on the impact of the natural hazard, in several hazardous facilities at the same time (Krausmann and Baranzini, 2012). Furthermore, natechs present additional difficulties ~~to already fragmented disaster response activities,~~ as they remain absent from disaster response frameworks (Krausmann, Cruz, and Salzano, 2017). A 2009 assessment identified more than 92 potential sources for industrial and waste deposits; however, the list does not include abandoned mine sites and their mine tailing dams – only those from currently operational mines (ICPDR, 2015a).

Therefore, the potential risk of accidental pollution could be substantially higher (ICPDR, 2015a).

~~2.1~~ Methodology

The ~~analysis~~ examination of policy and institutional frameworks for monitoring and responding to natural disasters and man-made accidents in the Danube ~~River basin~~ and Tisza ~~River sub-basin~~ ~~was conducted~~occurred through a combination of primary and secondary data collection and analysis. The primary data ~~collection and analysis~~ consisted of semi-structured interviews, while the secondary data ~~analysis~~ included analysis of the legally binding mechanisms in the region, including conventions and directives (Table 1), of bilateral agreements (Table 2), and a literature review of peer-reviewed publications and white papers, providing for ~~and~~ an analysis of international laws, policies, and institutions within the Danube basin and Tisza sub-basin regarding the provision of disaster response. Semi-structured interviews were conducted over an eight-month period from January to August 2013. This format of interviews was chosen so that the pre-determined set of interview questions could be expanded through the natural course of conversation and allow for a more thorough understanding of what was initially queried – in particular, each expert interviewed was provided with the freedom to express their personal views in their own terms.

Table 1. List of legally binding mechanisms for Danube basin and Tisza sub-basin.

Governing Body	**Convention**	**Type of Instrument**	**Description of Instrument**
UN Economic Commission for Europe	Industrial Accidents Convention	Legally binding for parties to convention.	Determines actions of request for assistance and response for industrial accidents

			specifically.
European Commission	Water Framework Directive	Legally binding for EU member states, and though Danube Convention.	Sets basin-level management of water quality and quantity.
European Commission	Floods Directive	Legally binding for EU member states, and though Danube Convention.	Requires action regarding flood mapping at the basin level.
European Commission	Seveso Directives	Legally binding for EU member states.	Requires corporations to list possible risk of industrial accident, and develop preparedness plans.
European Commission	Civil Protection Mechanism Directive	Legally binding for EU member states,	First EU-wide law to include multiple-hazards in disaster risk strategies.
International Commission for the Protection of the Danube River (ICPDR)	Danube River Protection Convention	Legally binding for Danube member states.	Provides integrated framework for all Danube countries to participate in basin-level management, regardless of EU affiliation.

Table 2. List of bilateral agreements within countries in the Danube basin and Tisza sub-basin.

Countries	**Transboundary Watercourses**	**Disasters / Emergencies**
Austria – Czech Republic	1967*	1994 (Floods Only)
Austria – Germany	1987	1991 (Floods Only)
Austria – Hungary	1956	1959 (Floods Only)
Austria – Slovakia	1967*	1994 (Floods Only)
Austria – Slovenia	1956***	1956* (Floods Only)

Bosnia and Herzegovina – Croatia	1996	1996 (Natural/Manmade Disasters)
Bosnia and Herzegovina – Serbia and Montenegro**	-	2011 (Flood EWS)
Bulgaria – Romania	2004	2004 (Floods Only)
Bulgaria – Serbia	Draft	Draft (Floods Only)
Croatia – Hungary	1994	1994 (Floods Only)
Croatia – Serbia	-	-
Croatia – Slovenia	No Date	1977*** (Coastal Pollution)
Czech Republic – Slovakia	1999	-
Hungary – Romania	1986	2003 (Floods Only)
Hungary – Slovakia	1956*	2014 (Floods Only)
Hungary – Slovenia	1994	1994 (Floods Only)
Hungary – Ukraine	1997	1998 (Floods Only)
Moldova – Romania	2010	2010 (Floods Only)
Moldova – Ukraine	1994	-
Serbia and Montenegro – Hungary	1955**	1955*
Serbia and Montenegro – Romania	1955**	Under Discussion
Ukraine – Romania	1997	1952*** (Floods Only)
Ukraine – Slovakia	1995	2000 (Floods Only)

* Agreement formed with Czechoslovak Socialist Republic
** Agreement formed with Yugoslavia
***Agreement formed with Union of Soviet Socialist Republics
- No Information Available

Seventy-one interviews were conducted in various locations throughout Europe. The interviews took place with experts ~~working within~~in the International Commission for the Protection of the Danube River, ~~within~~ the expert groups of the International Commission for the Protection of the Danube River (i.e., Tisza group, river basin management, flood protection, and accident prevention and control), with respondents working at the national ministries, water management directorates, and non-governmental organizations in the Tisza and Danube countries, as well as with experts ~~working within~~ in the European Commission~~,~~ and the United Nations ~~involved in the Danube basin and Tisza sub-basin~~. Those interviewed were chosen based on their knowledge of and work within the Danube River basin and Tisza sub-basin. Given public roles, the interviews are intentionally left anonymous to ensure candidness in the responses ~~(Table 1)~~. Thus, only the kind of organization the experts work for is identified - the numbers appearing in brackets in the table below refer to the interview citations in text; ~~reflect~~ multiple interviews were conducted within~~at~~ each level of governance indicated (Table ~~1~~3). The questions focused on how Danube basin and Tisza sub-basin policies and laws were implemented in practice, as well as the perceptions of the experts regarding the frameworks and implementation of disaster monitoring and response throughout the Danube basin and Tisza sub-basin.[2]

Table ~~1~~3. Organizations from which experts were drawn for interviews.

International	United Nations, United Nations Economic Commission for Europe, and United Nations Environment Programme (UNEP)/UN Office for the Coordination of Humanitarian Affairs (OCHA) Joint Environment Unit [1]
Regional	European Commission [2]
	International Commission for the Protection of the Danube River (ICPDR) and Expert Groups (Tisza Group, River Basin Management, Flood Protection, and Accident Prevention and Control) [3]
National	National Ministries of Environment, Rural Development, Interior, Environment Agency [4]
	Water Directorates [5]
Non-State Actors	NGOs [6]

***** Numbers in brackets refer to interview citations in text.

3 Distinctions between natural disasters and man-made accidents in policy frameworks

~~Traditionally~~ T~~t~~he approaches used for describing, limiting, and categorizing disasters fundamentally shape~~s~~ the methods for monitoring and responding to disasters. They determine

[2] Questions relevant to international frameworks for disaster response included: (1) What are the respective roles in multilevel governance in regard to response for natural and man-made disasters? (2) To what extent are natural and man-made disasters included in policy frameworks for response; in what context and at what level, and what is the language being used? (3) What gaps exist between policies and practice in regard to response for natural and man-made disasters? (4) What constraints or opportunities exist in including policies for response to natural and man-made disasters; which type would be most effective and at what level?

the solutions utilized, the resources allocated, and the governance frameworks selected by categorizing the types of disaster into that which is natural or man-made. It is therefore important to ~~understand~~recognize the etiology of disaster in order to understand why the distinctions among the various types of disasters still remain. These are discussed below.

3.1 Rationale for different treatment between natural and man-made disasters

~~The manner in which disasters are framed by society has evolved over time, still the role of human responsibility features prominently in disaster narratives.~~ Natural ~~disasters~~ hazards are naturally occurring physical phenomena, which can include earthquakes, landslides, tsunamis, volcanoes, and floods. Disasters disrupt individuals and communities at various scales due to hazardous events interacting with conditions of exposure, vulnerability, and risk – leading to human, material, economic and environmental losses and impacts.[3] Natural disasters have historically been characterized either (1) as a direct form of punishment from God for the sins of humanity, or (2) in more recent history~~more recently~~ as an "act of God" that removed humans from culpability (Rozario, 2007). ~~The framing of natural disasters continues to shift, and some natural events – earthquakes, hurricanes, tsunamis – only become disasters as they impact and interact with individuals and communities.~~ The consequences of natural disasters become a function of where people reside~~ – along coastlines, in floodplains, in vicinity of fault lines, and within mountainous regions –~~ and their overall vulnerability, including aging infrastructure and a function of their ability to monitor and prepare for these events (Peel and Fisher, 2016). Vulnerability within and between populations can vary, and occurs for multiple reasons – social

[3] Exposure is understood as people, infrastructure and housing, production capacities and other human assets located in hazard-prone areas. Vulnerability is defined as a set of physical, social, economic and environmental factors or processes that increase the susceptibility of an individual, a community, assets or systems to the impacts of hazards. Disaster risk is the potential loss of life, injury, or damaged assets occurring to an individual or community as a function of hazard, exposure and vulnerability (UNISDR, 2015).

inequalities, community demographics (e.g., age and poverty), lack of access to health care, and limited access to jobs or to lifelines (e.g., emergency response, goods, services) (Cutter and Emrich, 2006). While building in disaster-prone areas is not the sole responsibility of individuals, they do share responsibility for investing in the risk involved. The existence of moral hazard[4] can increase the amount of damage from disaster and reduce the capacity of insurance to cover disaster loss; this occurs due to individuals acting irresponsibly and because of those who erroneously believe there is coverage for any loss incurred (Smith, 2013). For example, offering insurance encourages people to build and live in flood-prone areas, in spite of the known risks – if insurance were not available, the household would absorb the entirety of the risk and prospective buyers would most likely choose to reside elsewhere. Additionally, as seen with some large disasters such as Hurricane Katrina, losses suffered by policyholders can be several times larger than collected premiums, consuming insurers' capital and, if the losses are severe enough, not only jeopardize claim payments, but also cause insurance companies to declare bankruptcy before covering any – or only some – insured losses (Nekoul and Drexler, 2016). For example, while the total economic loss incurred during Hurricane Katrina is assessed at approximately US$ 125 billion, insured losses covered an estimated US$ 45 billion, however, only an estimated US$ 2 million in insurance claims were paid (Munich Re, 2005). Moral hazard can also exist in disaster preparedness and response activities when actors believe they are sufficiently prepared to respond to any event or crises. During Hurricane Katrina, despite emergency preparations, preexisting social vulnerabilities and the collective failure to adequately

[4] For purposes of this paper and described by Munich Re (2007), moral hazard is a lack of incentive by an individual to guard or protect against risk (or to enter into a situation of risk), knowing that they are protected from risk through insurance, which results in higher insurance loss claims. Examples provided are assured compensation for flood damage, leading to increased building in flood-prone areas and assured compensation for crop losses in drought-prone areas that encourage farmers to grow more compensated crops instead of planting alternative crops or adopting alternative land uses.

~~respond to the emergency made response inadequate for the type of complex emergency relief needed (Cutter and Emrich, 2006).~~

Industrial accidents and other man-made accidents are traditionally ~~considered~~ governed and responded to separately from natural disasters. The role of human agency features even more prominently in these events, due to potential moral or legal obligations to mitigate risk (e.g., preparedness, insurance, disaster aid). Man-made disasters suggest potential moral and legal obligations to both aid the victims of the disaster in a response capacity in the period immediately following the disaster, as well as to compensate those who are harmed during their long-term recovery (Verchick, 2012). The liability is only effective if a polluter can be identified or liability can be assigned. As disasters continue to multiply, cascade ~~become more complex~~, and their costs mount, responsibility for the disaster also becomes more complex. For example, in assigning liability to the 2010 red sludge spill in Hungary, early reports from the Hungarian Prime Minister Victor Orbán indicated that the breach was likely due to human error, and that "there was no sign the disaster was caused by natural causes, therefore it must be caused by people" (Dunai, 2010). In ongoing efforts to determine human negligence, it was determined that flooding and subsidence led to structural breaches in the reservoir containing the alumina, yet it remained difficult to prove whether officials at the MAL alumina facility knew of the weakened infrastructure (NDGDM, 2010).

The degree of uncertainty related to the amount of damage and probability of occurrence is very high with disasters, particularly those influenced by climate change (Greiving et al., 2012; Munich Re, 2016). Liability can be more difficult to calculate and assign in these cases, in part because disaster loss agencies (i.e., Munich Re, Swiss Re), are often accounting for specific losses from flooding and sudden-onset disasters that are more easily quantified, whereas the impact of slow-onset, or “silent”, disasters ~~related to climate change~~ can be more difficult to quantify ~~since they occur slowly over time~~ (IFRC, 2013). Therefore, due to numerous anthropogenic influences on these events ~~(including anthropogenic effects of climate change/slow-onset events)~~, it is misleading to continue the differentiation in terminology between “natural” versus “man-made” disasters, and the frameworks that govern mechanisms for disaster response.

3.2 Dimensions for different treatment

Increased frequency of major disasters, legal barriers to disaster response, and the absence of unified response ~~to both natural disasters and man-made accidents~~ have led to increased attention at a variety of levels for more integrated international frameworks ~~for disaster response~~ (IFRC, 2007). The fragmented nature of disaster response has emerged from the need to address specific types of disasters, in specific regions, or response modalities. Furthermore, while natural disasters and industrial and nuclear accidents have established frameworks for response, natech accidents are often missing from chemical accident response programs (OECD, 2015). Natech accidents can lead to the release of toxic substances, fires, or explosions and result in injuries and fatalities; therefore, the lack of consideration for natech response mechanisms, planning tools or response programs can be an external risk source for chemical and nuclear facilities (Krausmann and Baranzini, 2012). Some international instruments, such as the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency and the Convention on Early Notification of a Nuclear Accident apply only to specific types of disaster. While the Nuclear Accidents Conventions were adopted almost immediately following the Chernobyl nuclear accident, there still remains no similar overarching global framework for notification or assistance in response to industrial accidents, or for environmental emergencies more broadly (Bruch et al., 2016). Other disaster frameworks, like the Tampere Convention, apply only to a single sector or area of relief (such e.g., as the provision of importing telecommunication resources following disasters caused by nature or human activity, or whether occurring suddenly or as the result of complex, long-term processes). ConverselyHowever, the ability to provide disaster response for natural disasters is quite broad and is included in a number of international frameworks. A question of applicability of agreements arises, however, when a complex disaster occurs and multiple institutions have a mandate for response, but it is unclear which institution should take the lead in responding or coordinating response efforts (Bruch et al., 2016). During the Lebanon crisis in 2006, international assistance was requested in response to the bombing of fuel storage tanks at a power station, and over 70 countries and organizations responded – it was unclear who should take lead, and the need for coordination was reflected among response efforts (Nijenhuis, 2014).

An additional difficulty challenge with fragmented disaster response frameworks lies in the types of international actors engaged in natural disasters and man-made accident response. Generally, there is a failure to include non-state actors, the private sector, or individuals in response efforts to disasters (IFRC, 2007). The Tampere Convention and the sub-regional Black Sea Economic Cooperation (BSEC) and Association of South East Asian Nations (ASEAN) agreements are exceptions. With the Tampere Convention, for example, the decision to offer assistance, the type of assistance provided, and the terms of assistance are up to the discretion of the non-state actors offering assistance (Bruch et al., 2016). Given the increasing role of private funds in disaster response and relief operations, considering the includingsion of these actors in disaster frameworks can be beneficial. Oftentimes, there is the assumption that assets and personnel are provided as a favor to an affected state government, where when in reality they

~~might are normally be expected to reimburse costs and manage how assistance is carried out (Bruch et al., 2016). However, efforts are increasingly being made to clarify the respective roles of actors and institutions in regard to disaster response, and more recently laws are changing in favor of including broader terminology to comprise both natural and man-made disasters (IFRC, 2007).~~

4 Disaster frameworks in the Danube basin and Tisza sub-basin

Response to natural and man-made disasters, including natech accidents, is governed by a range of global, regional and national laws, policies, and soft-law instruments. In the Danube basin and Tisza sub-basin this includes the Industrial Accidents Convention and the Seveso Directive, the Water Framework Directive and the Floods Directive, as well as treaties and policies developed at the level of the Danube and Tisza. ~~Here~~As such, natural and man-made disasters continue to be treated as distinct and separate issues, where monitoring and response are managed independently.

~~4.1 Introduction to Danube basin and Tisza sub-basin~~

In 1994, the Danube countries developed the Danube River Protection Convention (DRPC), a legally binding instrument that ensures ~~to ensure~~ sustainable management of the Danube River. Through the International Commission for the Protection of the Danube River (ICPDR), the DRPC requested the ICPDR to coordinate the activities of the EU Water Framework Directive (WFD) and EU Floods Directive among the Danube member states. The WFD and Floods Directive are legally binding to members of the European Union, but through the DRPC become legally binding to all Danube member states, regardless of EU member status. ~~among the EU member states~~. The WFD combines the monitoring and assessment of ~~surface and groundwater~~water quality in the basin, and the Floods Directive instructs national authorities to establish flood risk management plans by 2015, linking the objectives of the WFD and the risk to these objectives from flooding or coastal erosion through the Floods Directive, and integrating them into basin level activities via the ICPDR. However, because not all countries of the Danube are EU member states, not all measures and outcomes of the WFD and Floods Directive are implemented equally among the basin countries.

The Danube ~~basin~~ and the Tisza ~~sub-basin~~ have experienced numerous natural and man-made disasters, including natech accidents (e.g., Baia Mare Cyanide Spill, Hungarian Chemical Accident, and recent Serbian landslides) (European Commission, 2016). These are tallied in Table ~~2~~4. However, the frameworks for disaster response at the levels of the United Nations, the European Union, and those utilized by the ICPDR ~~and implemented at the national level by the Danube countries,~~ are restricted to particular types of disaster – monitoring and response to flooding is the most advanced throughout the basin, while pollution is monitored, but does not have the same frameworks for response. Additionally, there remain a variety of natural and man-made disasters that ~~occur throughout the basin~~ that are not integrated into any type of basin monitoring or response framework, including fire, and drought~~, and other types of predictive climate modeling~~.

Table 4. Natural and man-made disasters in the Danube basin, reported by country, 2000-2012

~~**Table 2.** Natural and man-made disasters in the Danube basin, reported by country (2000-2012,). (Adapted from European Commission, 2016.)~~

2000	Mine tailing failure/cyanide and heavy metal pollution (natech)	Romania, Hungary, Bulgaria, Macedonia
	Landslide/avalanche	Austria, Slovenia
	Extreme temp./drought	Bulgaria, Croatia, Slovenia
	Flooding	Croatia, Hungary, Romania, Slovenia
	Severe ice storms	Moldova, Ukraine
	Wildfires	Croatia, Slovakia
	Factory fire	Slovenia

2001	Mining accident (natech)	Slovenia
	Flooding	Croatia, Hungary, Romania, Slovakia, Ukraine
2002	Industrial fire at waste dump	Slovenia
2003	Mining accident (natech)	Slovenia
	Extreme temp./drought	Austria, Croatia, Germany, Slovenia, Bosnia and Herzegovina
	Flash floods/severe storms	Hungary
	Wildfires	Slovenia
2004	Drinking water pollution (natech)	Hungary
	Dam failure	Romania
	Earthquake	Slovenia
	Flooding/severe storms	Hungary, Slovakia
	Drought	Bosnia and Herzegovina
2005	Landslides	Slovenia
	Flooding/Severe Storms	All Danube Countries, except Ukraine
2006	Avian (H5N1) flu pandemic	Hungary, Romania, Slovenia
	Aircraft accident	Hungary
	Earthquake	Hungary
	Extreme Temp.	Bulgaria
	Wildfires	Slovenia
2007	Wildfires/forest fires	Bulgaria, Croatia
	Hurricane	Germany
	Extreme temp./drought	Austria, Bulgaria, Croatia, Hungary, Romania, Slovakia, Bosnia and Herzegovina, Montenegro, Serbia, Moldova
	Flash floods/severe storms	Bulgaria, Germany, Hungary, Romania, Slovenia, Montenegro, Serbia, Ukraine
2008	Transportation accident	Croatia
	Extreme temp.	Bulgaria
	Forest fires	Bulgaria
	Flash floods/severe storms	Hungary
	Flooding	Romania, Slovakia, Slovenia, Serbia, Moldova, Ukraine
2009	Swine (H1N1) flu pandemic	All Danube Countries
	Ice storms/blizzard	Croatia, Romania, Bosnia and Herzegovina, Ukraine
2010	Chemical accident (natech)	Hungary
	Earthquake	Serbia

2012	Ice storms/blizzards	Bulgaria, Hungary, Romania, Montenegro, Serbia, Moldova, Ukraine
	Extreme temp./drought	Moldova

-Note that economic losses, deaths and displacements are not reported to either European Commission or ICPDR.
- Where indicated, natech accidents occurred because of initial flood event that led to subsidiary release of chemicals/pollutants.
-Adapted from European Commission, 2016.

4.~~2~~ 1 How disasters are treated differently within response frameworks

~~In the absence of a centralized institution for disaster response, the development of a large and diverse international disaster relief community has occurred. Initially, the large-scale relief work after natural disasters was undertaken by the Red Cross movement at the end of the 19th century, but eventually the disaster relief community expanded capacity and function to include a variety of disaster assistance activities and involve other international initiatives and organizations (IFRC, 2007). The United Nations (UN) began humanitarian work shortly after World War II with agencies such as the United Nations High Commission for Refugees (UNHCR), and predecessor agencies such as the United Nations Office for the Coordination of Humanitarian Affairs (UN OCHA) are now regularly engaged in disaster response and relief (IFRC, 2007).~~

Numerous frameworks for response to natural disasters exist (Table ~~3~~1). Apart from natural disasters, the United Nations Economic Commission for Europe's (UNECE) Industrial Accident Convention applies to land-based, non-military, and non-radiological industrial accidents (UNECE, 2009). Through the convention, response for industrial accidents is provided through bilateral or multilateral arrangements. If no prior agreements exist, an affected country can request assistance from other parties through mutual assistance agreements. However, in these situations, it is the responsibility of the requesting country to cover all costs, unless otherwise agreed upon among the responding countries (UNECE, 2009). ~~One example is the 2002 UN General Assembly Resolution 57/150 on "Strengthening Effectiveness and~~

Coordination of Urban Search and Rescue Assistance" (UN, 2003). While non-binding, the resolution highlights the importance of national responsibility to victims of natural disasters within country borders, but in the event that an incident exceeds country capacity, Urban Search and Rescue (USAR) assistance through the International Search and Rescue Advisory Group (INSARAG) can supplement local rescuers, and the coordination of these resources, particularly following earthquakes or other events leading to structural collapse (INSARAG, 2016).

Table 3. List of legally binding mechanisms for Danube basin and Tisza sub-basin.

Table 3. List of legally binding mechanisms for Danube basin and Tisza sub-basin.

Governing Body	**Convention**	**Type of Instrument**	**Description of Instrument**
UN Economic Commission for Europe	Industrial Accidents Convention	Legally binding for parties to convention.	Determines actions of request for assistance and response for industrial accidents specifically.
European Commission	Water Framework Directive	Legally binding for EU member states, and though Danube Convention.	Sets basin-level management of water quality and quantity.
European Commission	Floods Directive	Legally binding for EU member states, and though Danube Convention.	Requires action regarding flood mapping at the basin level.
European Commission	Seveso Directives	Legally binding for EU member states.	Requires corporations to list possible risk of industrial accident, and develop preparedness plans.
European Commission	Civil Protection Mechanism Directive	Legally binding for EU member	First EU-wide law to include

		~~states,~~	~~multiple hazards in disaster risk strategies.~~
~~International Commission for the Protection of the Danube River (ICPDR)~~	~~Danube River Protection Convention~~	~~Legally binding for Danube member states.~~	~~Provides integrated framework for all Danube countries to participate in basin-level management, regardless of EU affiliation.~~

~~Apart from natural disasters, the United Nations Economic Commission for Europe's (UNECE) Industrial Accident Convention applies to land-based, non-military, and non-radiological industrial accidents (UNECE, 2009). Through the convention, response for industrial accidents is provided through bilateral or multilateral arrangements developed in advance among the parties. If no prior agreements exist, an affected country can request assistance from other parties through mutual assistance agreements. However, in these situations, it is the responsibility of the requesting country to cover all costs incurred for disaster response, unless otherwise agreed upon among the responding countries (UNECE, 2009).~~ Flooding in the Danube in 2013 and 2014 caused approximately €15 billion in damage (Table ~~4~~5~~3~~), and while the economic cost from industrial and other man-made accidents are not monitored or reported in the same manner (Table ~~2~~4), such accidents have occurred quite frequently and make apparent the need for improved agreements on bilateral or multilateral relief (ICPDR 2015b).

Table 5. Estimated human and economic loss in Danube per flood event, 2002-2014

~~**Table 43.** Estimated human and economic loss in Danube per flood event (2002-2014) (Adapted from ICPDR, 2008b and ICPDR, 2015b).~~

Flood Year	# Deaths or # Displaced	Economic Losses €
2002	N/A	N/A
2006	N/A	> €6 billion

2010	35 deaths	€2 billion
2013	9 deaths	€2.4 billion
2014	79 deaths; 137,000 displaced	€4 billion

*N/A – Data not available
-Adapted from ICPDR, 2008b and ICPDR, 2015b

The facilitation of international disaster response can be inadequate if mobilization is untimely, or fails to include sufficient financial support. Response frameworks may neglect or place disproportionate attention on certain types of disasters, which could become more problematic with growing concerns over climate change and increased urbanization. ~~For example, there is visible delayed response for sudden-onset disasters such as the 2005 Indian Ocean tsunami and the 2010 Haiti earthquake which received the majority of funding support within one to three months of the initial request, compared to the slow-onset drought events of the 2011 appeals by Kenya and Somalia where funding was not provided until nearly 7-12 months after the initial request (GHA, 2013). In 2005, nearly three quarters of all UN contributions for natural disasters arrived within a month of their appeal; the comparable figure for complex emergencies was only seven percent (IFRC, 2007).~~

~~While differences exist among slow-onset and sudden-onset disasters, they can create cumulative impacts to the community that increase vulnerability and lead to larger disasters in the future – precipitation deficiencies in soil and water lead to drought and when combined with high temperatures and dry conditions, this can lead to wildfires (e.g., extreme fire hazard situations in the eastern US and south-east Australia) (Smith, 2013).~~

~~The growing size and diversity of international responders to disasters can have ramifications for the facilitation, coordination, and quality of response efforts (IFRC, 2007).~~

Diverse systems of response are implemented among the Danube basin countries due to the variety of disasters experienced. Some utilize a single Civil Protection Mechanism, while others rely on multiple parties among Ministries of the Interior, Ministries of Rural Development, Water Directorates, and a variety of additional local protection committees [4, 5]. Interviews indicated that not all responders/parties are sufficiently trained, and many lack managerial or technical capacity to manage specific disasters appropriately [4]. There is also large compartmentalization of tasks at lower levels – both regional and local – where integration among the various types of disaster, as well as increased cooperation is needed [2, 3]. Other than the fact that these diverse actors are providing certain types of disaster assistance, there is nothing uniting them – no international or regional disaster response system. Given the increased frequency of natural and man-made disasters and the growing number of actors involved in disaster response efforts, ensuring effectiveness of aid should not detract from response and assistance (IFRC, 2007).

Besides the diverse ensemble of international organizations with a mandate and capacity for responding to natural disasters and/or specific types of technological or industrial accidents, there are also agencies experienced in particular types of international disasters, but which may not necessarily have the mandate or capacity for response. In 1994, the United Nations Environment Programme (UNEP) and the UN Department of Humanitarian Affairs (DHA, the predecessor of OCHA), developed an administrative arrangement through an exchange of letters (Bruch et al., 2016). The arrangement relies on the environmental mandates of UNEP and the humanitarian mandates of the DHA. Through UNEP's Governing Council Decision UNEP/GC.26/15 on "Strengthening International Cooperation on the Environmental Aspects of Emergency Response and Preparedness", the Joint UNEP/UN OCHA Environment Unit (JEU) plays a leading role in facilitating coordination among international organizations in the event of natural and man-made disasters, including natech accidents, which are more broadly termed environmental emergencies (UNEP, 2011). The JEU has a number of existing agreements and interface procedures in place with these organizations, in order to facilitate response~~, particularly because there is a lack of familiarity among UN member states regarding existing regional and international systems for response to the various types of disasters, as well as the coordination between them~~. For example, the JEU facilitated international agreements and interface procedures to aid with response between UN Disaster Assessment and Coordination (UNDAC) and the EU Civil Protection Mechanism to the 2014 Serbian landslides following Cyclone Tamara (NERC, 2014). During the 2000 Baia Mare natech accident in the Tisza River sub-basin, sixteen experts from seven countries deployed for response to the natech accident, and the JEU assisted to coordinate response efforts among UNDAC, the European Commission, the Military Civil Defence Unit, the World Health Organization, and a variety of other actors (JEU, 2000).

At the regional level, the European Union's Civil Protection Mechanism (EU CPM) is an instrument for disaster response that protects people, the environment, property, and cultural heritage in the event of natural or man-made disasters, occurring within or outside of the European Community (European Commission, 2016). Disasters are monitored internationally through the Emergency Response Coordination Centre (ERCC) in cooperation with the JEU and with participating states.

The European Union's Seveso Directives (I enacted in 1982, II enacted in 1996, and III enacted in 2012) are some of the earliest pieces of legislation to address disaster risk (European Community, 1982; European Community, 1996; European Community, 2012). The various iterations of the Directive govern the establishments where dangerous substances are present, and require the establishments to classify and report the amounts, types, and locations of dangerous substances present. The majority of the Directives' focus is on notification requirements and accident prevention~~, including notification to the public due to the increased~~

~~risk by natural disasters associated with the location of the establishment and associated risks from natech accidents~~ (European Union, 2012). The responsibility for response under the Directives falls on the ~~establishment~~ industries for developing preparedness response measures in advance of an accident, and notifying the competent authority in case of a major accident (European Union, 2012). However, a 2012 study by the European Commission indicated that industry in nearly half of the EU countries is believed to insufficiently consider natech risks in their preparedness response measures (Krausmann and Baranzini, 2012).

The EU Floods Directive provides a framework for addressing risk from natural disasters, specifically floods. While inspired not only by the damaging effects of floods, but also by increasing flood risks as a result of climate change, the main objective of the Directive is to require member states to assess and manage risks of flooding ~~within their territories~~ and to develop flood risk management plans. Though the plans are restricted to areas considered at high risk of floods, these are not integrated into other types of plans and maps available – such as the Inventory of Potential Accidental Risk Spots in the Danube[5] – nor are they used for developing preparedness response measures in advance of an accident or natural disaster, such as in the case of the Seveso Directive. Though the Flood Directive was expected to reduce flood risk, interviewees voiced disappointment regarding the limitations of integrating disaster risk more broadly, particularly in relation to water quality and accidental pollution [3]. These present as policy limitations to the Water Framework Directive and Flood Directive, as neither of the two directives require the integration of disaster risk of both floods and accidental pollution.

[5] Pursuant to the 2001 Baia Mare natech accident in Romania, the ICPDR conducted a qualitative evaluation of the hazardous locations in the Danube catchment area, with reference to location of possible water pollution. The report of Inventory of Potential Accidental Risk Spots was released in 2001, and has not been updated since (ICPDR, 2001; ICPDR, 2015a).

The European Union also developed a set of macro-regional strategies for the Adriatic and Ionian, Alpine, Baltic Sea, and Danube regions (European Commission, 2010). While the intent ~~from the EU~~ was to not provide new EU funding, these integrated frameworks are supported by EU Structural and Investment Funds in order to address common challenges faced in each defined area~~ in order to strengthen cooperation and achieve greater economic, social, and territorial cohesion~~. In the Danube Strategy, risks from floods and industrial accidents are reflected as having substantially negative transnational impacts, and are listed as requiring preventive and disaster management measures that are implemented jointly, with the understanding that work undertaken in isolation in one place (e.g., to build levees) displaces the problem and places neighboring regions at greater risk of flooding (European Commission, 2010). Other man-made disasters are integrated in the discussion of risks, as well as the need to account for climate change by taking a regional focus at the basin level (European Commission, 2010, p. 8). In a 2015 European Commission Communication report~~ following implementation of the Danube Strategy~~, several limitations were highlighted, including: the need to improve efforts to reduce the Danube region's risk of exposure to major floods and accidental hazardous material releases; limited political commitment, funding, and capacity among countries and institutions in the Danube; lack of staff, funding, and expertise impeding participation, particularly in lesser-developed areas of Danube – the report also acknowledged that these challenges are more acute in non-EU countries (EPRS, 2015). The limitations in funding, technical expertise, and capacity were confirmed in interviews with experts at various levels, who also noted how this leads to uneven implementation of EU Directives within the basin that can create pockets of vulnerability to both flood risk and risks from industrial accidents [2, 3, 4].

While the Danube Strategy does not provide a framework for response to natural and man-made disasters, it does highlight the EU's continued support for managing multi-hazard response at multiple levels, particularly through Priority Area 5 "To Manage Environmental Risks". Specifically, it requests that the countries "strengthen operational cooperation among emergency response authorities in the Danube countries and improve the interoperability for risks that are common to an important number of countries in the region (i.e., floods and risks of other natural and man-made disasters)", and advises that each country's civil protection mechanism have an ~~updated~~ understanding of neighboring country's systems so that response teams can function smoothly in case of emergencies ~~involving bilateral, European, or international response~~ (EUSDR, 2015). Experts also expressed the need for formal agreements with specific language on integrated mapping of complex disasters, as well as provisions addressing response to both natural and man-made disasters, particularly if additional grants could be given from the EU to support these activities [2, 3, 4, 5]. Some interviewees reflected that the regional Strategy depended on stronger countries helping the weaker ones, but limitations with funding and capacity are difficult to overcome [2]. In the 2015 Annual Report on implementation of the Danube Strategy produced by the Danube countries, all projects focused on implementation of the Floods Directive. The only mention of industrial accidents was to reflect the failure to include an updated Inventory of Potential Accidental Risk Spots along the Danube, which is also discussed in the 2015 Danube River Basin Management Plan (DRBMP) (EUSDR, 2015; ICPDR, 2015b). Given past issues with mine tailing collapses and other pollution disasters associated with flooding, the 2015 DRBMP acknowledged the need to update the Inventory of Potential Accidental Risk Spots promptly (ICPDR, 2015b). Unfortunately, this recommendation from the 2015 DRBMP, and initially expressed in first Danube River Basin Management Plan of 2009, has yet to be realized.

Through the 1994 Danube River Protection Convention, Article 17 provides for mutual assistance "where a critical situation of riverine conditions should arise". While "critical situation" is not defined, Article 17 indicates that the ICPDR will elaborate procedures for mutual assistance including, the facilities and services to be rendered by the contracting party, the facilitation of border-crossing formalities, arrangements for compensation, and methods of reimbursement (ICPDR, 1994). These elaborations have not occurred through the ICPDR, but rather in the form of bilateral agreements regarding transboundary flood measures among Danube countries; however virtually no bilateral agreements exist regarding response to man-made disasters in the basin (Table 52).

Countries	Transboundary Watercourses	Disasters / Emergencies
Austria – Czech Republic	1967**	1994 (Floods Only)
Austria – Germany	1987	1991 (Floods Only)
Austria – Hungary	1956	1959 (Floods Only)
Austria – Slovakia	1967**	1994 (Floods Only)
Austria – Slovenia	1956***	1956* (Floods Only)
Bosnia and Herzegovina – Croatia	1996	1996 (Natural/Manmade Disasters)
Bosnia and Herzegovina – Serbia and Montenegro**	-	2011 (Flood EWS)
Bulgaria – Romania	2004	2004 (Floods Only)
Bulgaria – Serbia	Draft	Draft (Floods Only)
Croatia – Hungary	1994	1994 (Floods Only)
Croatia – Serbia	-	-
Croatia – Slovenia	No Date	1977*** (Coastal Pollution)
Czech Republic – Slovakia	1999	-
Hungary – Romania	1986	2003 (Floods Only)

Table 54. Bilateral agreements on transboundary watercourses and disasters among Danube countries (Adapted from ICPDR, 2009a; ICPDR, 2015a; UNEP, 2002).

Hungary – Slovakia	1956**	2014 (Floods Only)
Hungary – Slovenia	1994	1994 (Floods Only)
Hungary – Ukraine	1997	1998 (Floods Only)
Moldova – Romania	2010	2010 (Floods Only)
Moldova – Ukraine	1994	-
Serbia and Montenegro – Hungary	1955**	1955*
Serbia and Montenegro – Romania	1955**	Under Discussion
Ukraine – Romania	1997	1952*** (Floods Only)
Ukraine – Slovakia	1995	2000 (Floods Only)

* Agreement formed with Czechoslovak Socialist Republic
** Agreement formed with Yugoslavia
***Agreement formed with Union of Soviet Socialist Republics
- No Information Available

To bridge the gap regarding man-made accidents, some Danube basin countries have engaged in such agreements. Bulgaria, Moldova, Romania, Serbia, and Ukraine are pParties to the DRPC, but have separately engaged in the BSEC Agreement on Response to Natural and Man-made disasters (Bruch et al., 2016). Furthermore, the Danube Delta countries (Moldova, Romania, and Ukraine) are working together with the UNECE Industrial Accidents Convention due to the large concentration of oil-related industries in the area in order to improve hazard management, increase transboundary cooperation, and strengthen operational response [1].

At the Danube basin level, the countries have engaged in a series of non-binding Memoranda of Understanding (MOU) referred to as the Danube Declarations, first in 2004, revised in 2010, and updated in 2016. The Declarations reinforce the language of the 1996 Danube River Protection Convention to sustainably manage the waters of the Danube, and reinforce the countries' commitment to continue the work of the WFD and Floods Directive. The 2016 Declaration recognizes the need for increased investment and improved warning systems for flood protection and contamination, as well as improving the exchange of information throughout the Danube (ICPDR, 2016). The Danube River basin countries engage currently in two separate systems for flood monitoring and monitoring pollution from man-made accidents – the Emergency Flood Alert System and the Principal International Alert Centres (PIACs) of the Danube Accident Emergency Warning System (Danube AEWS), respectively. The Emergency Flood Alert System has been functioning since 2003 at the Joint Research Centre, a Directorate General of the European Commission, and works in collaboration with the national authorities of the member states and with a variety of meteorological services. The Emergency Flood Alert System provides two medium-range flood forecasts each day, with 3-10 day advance warning for flooding in the main stem of the Danube. An MOU has been signed with several, but not all of the Danube countries (Austria, Bulgaria, Czech Republic, Germany, Hungary, Moldova, Serbia, Slovakia, Slovenia, and Romania, and negotiations are underway with Bosnia and Herzegovina and Croatia), and information is available 24 hours a day through an online service managed by the Joint Research Centre (ICPDR, 2010). The Emergency Flood Alert System gives national authorities the ability to prepare response measures, including opening temporary flood retention areas, building temporary flood protection structures such as sandbag walls, and adopting civil protection measures such as closing down water supply systems (ICPDR, 2009b). These responses reduce further threat of flooding downstream, and prevent loss of lives and infrastructure. The MOU does not include tributaries draining areas less than 4,000 km^2, therefore the Emergency Flood Alert System does not address flood risks in the Tisza, nor in certain basin countries where significant flood concerns arise, such as Ukraine [1].

Transboundary floods typically affect larger areas, can be more severe, result in a higher number of deaths, and cause increased economic loss than non-transboundary rivers (Baaker, 2009). Therefore, the repeated occurrence of such large, costly flood events (Table 453) highlights the ongoing need for improved strategies for flood preparedness and response, particularly in the absence of coordinated, multi-hazard bilateral and multilateral agreements among basin countries.

The Princip~~l~~ale International Alert Centres (PIACs) of the Danube Accident Emergency Warning System monitor accidental water pollution incidents in the Danube River basin. Unlike the Emergency Flood Alert System, which is linked to monitoring conducted by the European Commission and is transmitted to national authorities (without involving the ICPDR in the monitoring process); the Danube AEWS system is managed by the ICPDR, but does not involve the European Commission. While all contracting parties of the DRPC cooperate with the Danube AEWS, they also are expected to have national policies regarding response to accidental pollution in the Danube that connects to the Principal~~le~~ International Alert Centres. The PIACs are expected to operate on a 24-hour basis within each country, and are in charge of all international communications. When a message regarding potentially serious accidental pollution occurs, the PIAC is responsible for communicating the accident to the ICPDR, and decides whether it is necessary to notify downstream countries, engages experts to assess the impacts of the pollution, and decides what response activities need to be taken at the national level (ICPDR, 2014). Challenges to the Danube AEWS monitoring include territorial gaps (several areas along the Danube and Tisza are not monitored) [3, 4, 5], a limited number of bilateral agreements for response in case the accident exceeds national capacity (Table ~~5~~2~~4~~), and even though a variety of natural and man-made accidents occur (Table ~~2~~4), not all types of man-made accidents are monitored. Increasing pressures are felt by downstream countries from the failure to monitor pollution events in a consistent and effective manner [4]. Furthermore, in order to keep the AEWS operational, there is increasing reliance on citizen reporting of pollution events in some countries [4, 5]. This is particularly problematic in the Tisza countries where the lack of monitoring of both flood and accidental pollution events, combined with limited bilateral agreements raise concern among several countries [4, 5].

In the most recent Tisza River sub-basin MOU (from 2011), the Tisza countries agreed, among other things, to “take coordinated steps to prevent accidental risks, and develop harmonized mitigation and response measures, with the aim to present an updated Inventory of Potential Accidental Risk Spots by the end of 2012” (ICPDR, 2011). This complements the 2009 request in the Danube basin (but as reflected above, has yet to be updated) (ICPDR, 2015b). To date, this has not occurred for the Tisza~~ sub-basin~~, but the language in the MOU does reflect an interest at the sub-basin level to prioritize not only the mapping and development of an Inventory of Potential Accidental Risk Spots, but also the development of harmonized response measures among floods and man-made hazards.

5 Questioning the distinction

While “natural” disasters may be a commonly used term, no disaster can be regarded as entirely natural if people have the capacity to avoid, mitigate, or reduce the risk from it ~~an entirely natural hazard ~~(Picard, 2016). ~~However~~Generally, the vulnerability to lives and livelihoods can be ~~avoided ~~reduced with ~~proper ~~disaster preparedness and response, such as the proper placement, function, and use of early warning systems, ~~flood maintenance, ~~and mitigation works such as levees and controlled flood outlets and properly timed dam releases.

There is an additional shift in what is considered truly a natural disaster as well – not only from the perspective of mitigation or vulnerability, but in acknowledgement of the anthropogenic influences on natural disasters. Climate change is one aspect, but there are also induced earthquakes occurring as a result of slipping faults from fluid injection in hydraulic fracturing (Legere, 2016)~~ and from the weight of shifting water impoundments from Three Gorges (Stone,~~

~~2008)~~, landslides from subsidence and increased land use activities including urbanization (Smith, 2013), and pandemics from deforestation and habitat conversion (Greger, 2007), to name a few. ~~Holistic frameworks that include multiple types of disasters are needed in order to respond effectively.~~

~~Human intervention in the physical environment exposes populations to natural hazards from the built environment, such as housing and associated infrastructure, including industrial facilities, drainage works, and planning—especially when the built environment is not appropriately designed or built to account for the risks~~hazards~~.~~ Human, economic, and environmental losses can be worse in highly populated, urbanized areas; with increased urbanization and climate change, they are placed at increased risk to natural and man-made hazards (Bruch and Goldman, 2012; Huppert and Sparks, 2006). For this reason, natech accidents and other cascading disasters are particularly problematic types of disasters. Simultaneous response efforts are required to attend to both the industrial, chemical, or technological accident as well as the triggering natural disaster. Therefore, expanded definitions of that reflect multiple types of disaster, as well as ~~broad~~ improved frameworks for response to multiple types of disaster, are needed in order to recognize that many disasters can arise from multiple, potentially co-located hazards—and to take the necessary measures to reduce the risks of those hazards.

~~While distinctions among disasters are still claimed for liability in some cases (including in determining deliberate conduct or negligence), the distinction between natural and man-made disasters is largely irrelevant from the perspective of humanitarian response and the humanitarian consequence of multi-hazard events and those that are caused by natural or technological hazards. Furthermore, in the event that disasters are slow-onset, or when the ability to mitigate or~~

~~respond to risk is not timely or effective, the long-term effects of the disaster can be magnified and lead to further vulnerability, such as famine, malnutrition, or mortality (IFRC, 2006).~~

The 2011 Fukushima nuclear disaster in Japan, triggered by the Great East Japan Earthquake and resultant tsunami, illustrated the complex relationship of natural hazards and the built environment and human factors, resulting in natech vulnerabilities. In part as a response to the earthquake, tsunami, and nuclear accident at Fukushima and as a more general approach to providing a comprehensive, multidimensional and multi-sectoral approach to reducing disaster risk, the United Nations member states adopted the Sendai Framework for Disaster Risk Reduction in 2015. To some experts, the preceding 2005 Hyogo Framework for Action focused too much on disaster risk reduction from natural disasters, and ignored industrial accidents and complex accidents like natech accidents [6]. In fact, in a 2011 study by the European Commission, out of 14 EU countries that experienced natech accidents, more than half of the accidents resulted in the release of toxic substances, fires, or explosions (Krausmann and Baranzini, 2012).

The Sendai Framework places unprecedented emphasis on the interaction between hazards (natural and man-made), exposure levels, and pre-existing vulnerability (Aitsi-Selmi and Murray, 2016). It calls to action for improving decision making through a stronger science-policy-practice interface, with four priority areas for action –including strengthening disaster governance with regard to shared resources and at the basin level (UNISDR, 2015).

The Organization for Economic Cooperation and Development (OECD) also provides guidance for the planning and operation of facilities where hazardous substances are located through the use of their 2003 Guiding Principles for Chemical Accident Prevention, Preparedness, and Response. Recognizing the gaps in natech risk management and methodologies, the OECD developed an addendum in 2015 to the Guiding Principles that include 1) an investigation of the prevention of chemical accidents, as well as preparedness for and response to chemical accidents resulting from natural hazards that are not a part of national chemical accident programs; and 2) recommendations for best practices with respect to prevention of, preparedness for, and response to natech accidents (OECD, 2015).

Regional frameworks for response to natural and man-made disasters have been developed by member states of the Black Sea Economic Cooperation (BSEC) and the Association of South East Asian Nations (ASEAN). These regional agreements have also progressed to include national efforts, such as the coordination of technical assistance and resource mobilization during response to natural and man-made disasters (ASEAN, 2010; BSEC, 1998).

6 Building holistic approaches for integrating multilevel disaster response

The transition toward a multi-hazard approach for response to natural and man-made disasters, and the acknowledgement of the risks of natech accidents is occurring at many levels. It is present in the work of the United Nations and the multilevel response frameworks of the EU Civil Protection Mechanism; some regional agencies are also adopting similar agreements (i.e., ASEAN, BSEC). However, there remains a disparity in managing natural and man-made disasters in a holistic manner at the national level, as well as in the monitoring of these types of events at the Danube basin and Tisza sub-basin levels. The challenges are not insurmountable; this section proposes two sets of options for reducing and eventually eliminating the historic dichotomy among approaches to disaster response and monitoring.

6.1 Multi-hazard approaches

The process of building holistic approaches to planning, preparedness, and response can strengthen systems for responding to natural and man-made disasters in a more integrated manner (i.e., adopting a multi-hazard approach). ~~Building holistic disaster risk processes~~These processes may be done at the global (e.g., Sendai), regional (e.g., BSEC), bilateral, and national levels. By adopting a multi-hazard framework for disaster response, the expertise and practices of responders can be enhanced to include improved modeling and assessment approaches, response methodologies and tools, and heightened measures to prevent or mitigate the consequences from natech accidents (Krausmann, Cruz, and Salzano, 2017).

The review of legal and policy frameworks and interviews reflected that while some planning and preparedness activities take place regarding flood hazard, this generally is not the case for accidental pollution (at least in the Danube and Tisza context), and natech accidents are largely removed or ignored [2, 3, 4, 5, 6] (European Commission, 2010; ICPDR, 2015a). Gaps in monitoring were cited along the length of both the Danube and the Tisza in regard to both flooding and accidental pollution, which should also be improved in future planning efforts. The Tisza sub-basin and smaller water bodies are beyond the scope of the WFD, consequently, no holistic monitoring or response measures are in place; regional agreements at the basin or sub-basin level could aid in developing improved response frameworks [2, 3] (McClain et al., 2016).

Improving the mapping of hazards to reflect not only flood hazard, but also risks from man-made disasters and natech events – and integrating these risks into a holistic map of vulnerability to disaster – would provide a foundation for more holistic policies and programming to manage disaster risks. It would also aid in improving measures for preparedness at the national and local levels. Multi-hazard response frameworks provide the opportunity to intervene and mitigate the size of future disasters. Interviews indicate that harmonized approaches to natural and man-made disasters offer additional opportunities to strengthen capacity among transboundary actors [1, 4].

6.2 Multi-hazard response modalities

In order to avoid fragmentation among response to natural and man-made disasters, and empower, guide, and facilitate the institutional arrangements and mandates necessary to improve ~~response to natural and man-made disasters~~these activities, the legal and policy frameworks need to provide the necessary mandates and procedures – this is accomplished by incorporating an integrated, multi-hazard approach to disaster response. In regard to the Danube basin, this could be done in a variety of ways. The Danube River Protection Convention has not been updated or amended since it was originally drafted in 1994, but it unites all countries of the Danube basin and its tributaries under a formal, legal agreement. Cooperation among Danube countries was generally reported as good [3]; therefore, continuing the use of the ICPDR and its expert groups as a mechanism to gain cooperation among the countries on a regional framework for improving monitoring and response could be considered [3, 4, 5]. Another possibility would be to expand the numerous bilateral agreements among the Danube and Tisza countries regarding flooding to also include man-made disasters and natech events. Working on agreements at a regional level improves communication, breaks down barriers (particularly in transboundary situations), and aids in the development of a common legal language among participating parties [1, 2].

Updating conventions and other hard law can be difficult; countries often find soft law to be more flexible, they are sometimes unwilling to adopt binding obligations, particularly in the face of uncertainty (e.g., climate change), or when they feel there might be a need to act quickly to changing circumstances. In this regard, updating the Danube Declaration and the corresponding Tisza MOUs can provide particularly viable options. Through the Declarations and MOUs, the Danube or Tisza countries could decide whether to engage in a particular action through a separate strategy, or pilot project, or whether to incorporate the issue into the broader basin or sub-basin management plan (e.g., improvement of accidental pollution and flood monitoring, integrated accidental pollution and flood maps). Improved vertical and horizontal cooperation was a request of several interviewees, particularly in regard to the risks posed from man-made accidents and how to respond to these accidents [4, 5].

7 Conclusions

The historic distinction between natural and man-made disasters is outdated, counterproductive, and ultimately flawed. Natural disasters have the potential to trigger simultaneous technological or chemical accidents from one or multiple sources. With anthropogenic climate change influencing the frequency and intensity of disasters, the distinctions in ~~preventing,~~ monitoring~~,~~ and responding to disasters from either natural or man-made sources are further called into question. Moreover, increased urbanization and shifting populations are placing more people at greater risk in times of disaster (whether natural or man-made). As a result, it is increasingly clear that there are no purely natural disasters.

Recognizing that the historic distinctions between natural and man-made disasters are no longer relevant, there is increasing recognition of the need to address disasters holistically, regardless of the contributing causes and aggravating factors. This trend is noted in the Sendai Framework, which adopts a multi-hazard risk approach and provides tools for ~~managing~~ responding to disasters that are both natural and man-made (UNISDR, 2015). While the current policy frameworks in the Danube basin and Tisza sub-basin do not address ~~preparedness~~ monitoring and response holistically across types of disasters, the basin countries have several options for more integrated response. A key opportunity is the development or amendment of agreements governing response to natural and man-made disasters. This could be negotiated through updates to the Danube Convention or through bilateral treaties between the basin countries. Improving planning and preparedness through more integrated monitoring and mapping of natural and man-made disasters, such as combining the flood risk areas with the Inventory of Potential Accidental Risk Spots, could be elaborated upon in Declarations and MOUs at the basin and sub-basin levels.

A coordinated approach to natural and man-made disasters, including natech accidents, is currently taken through the European Union Civil Protection Mechanism and BSEC. This is not unique to Europe alone, and other similar regional approaches exist from which to draw lessons (including the ASEAN agreement). The Danube and Tisza countries are well versed in the transboundary impacts from natural and man-made disasters, and natech accidents; climate change is likely to increase the frequency and severity of these events in the foreseeable future. Nevertheless, while approaches for integrating holistic frameworks for disaster response are recognized at multiple levels, implementation within the Danube basin and Tisza sub-basin remains distinct and fragmented.

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What Does Nature Have to Do with It?
Reconsidering Distinctions in International Disaster Response Frameworks in the Danube Basin

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Abstract

This article examines the policy and institutional frameworks for response to natural and man-made disasters occurring in the Danube basin and the Tisza sub-basin. Response to these types of incidents has historically been managed separately, as has the monitoring of these types of incidents. ~~Given policy distinctions in response to natural and man-made disasters,~~W~~ w~~e discuss whether the policy distinctions in response to natural and man-made disasters remain functional given recent international trends toward holistic response to both ~~natural and man-made~~kinds of disasters. We suggest that these distinctions are counterproductive, outdated, and ultimately flawed, a conclude by reflecting on the lessons learned and ~~conclude~~ by proposing an integrated framework for disaster response in the Danube basin and Tisza sub-basin~~and conclude with a reflection of the lessons learned, and propose an integrated framework in the Danube basin and Tisza sub-basin~~.

Keywords: International Disaster Response Frameworks; Natural Disasters; Man-made Accidents; Industrial Accidents; Natech Accidents; Danube River basin; Tisza River Sub-basin

1 Introduction

What are the benefits of maintaining the distinction between natural and man-made disasters? What are the consequences of eliminating this distinction? When a disaster occurs, local and national capacities for disaster response can be overwhelmed, often triggering a request for external, international assistance. The actors engaged in disaster response[1] have historically been determined by the nature of the disaster (i.e., natural disaster, industrial accidents, nuclear accidents, marine oil spills) and legal frameworks typically divide response between natural ~~disasters~~ and ~~response to~~ man-made disasters. However, there is ~~; but with~~ growing recognition that anthropogenic climate change and other human activities such as land use change are ~~is~~ driving more ~~extreme,~~extreme and sometimes cascading events. Cascading events ~~(e.g.,~~refer to ~~the phenomen~~cases ~~on associated with events~~ in which a primary threat is followed by a sequence of secondary or additional hazards~~,~~ ~~Pescaroli and Alexander, 2015).where the effects of disasters are multiplied, or where they are composite, or concurrent)~~ that require complex and often overlapping types of response (Pescaroli and Alexander, 2015). Thus,~~,~~ the question of eliminating ~~this~~ the natural/man-made dichotomy is brought to the forefront. ~~The complexity of disaster events increases with cascading events, both temporally and spatially, due to the interaction of multiple hazards, threats, and vulnerabilities – thus, creating challenges in response~~

[1] While disaster response is considered part of the disaster management cycle, disaster management includes the application of policies and actions regarding disaster risk (i.e., prevention, preparedness and mitigation, response, and recovery). Each have their own set of policy frameworks, actors and mechanisms for implementation. This paper focuses on the disaster response phase specifically, and on the policy frameworks and actors related to requesting and receiving assistance immediately following a disaster, and the legal mechanisms by which responders are deployed.

~~fragmented response frameworks since the main impact from a disaster event can be from its subsidiary events and not necessarily from the triggering event (Pescaroli and Alexander, 2015).~~

In Europe, natural and man-made disasters combined caused total losses of US$ 13 billion in 2015 of which only US$ 6 billion were insured; the predominant losses came from flood events (Swiss Re, 2016). Flooding and pollution are considered to be the primary transboundary pressures of the Danube River basin; however, a number of other man-made accidents occurred in the region (ICPDR, 2015a).

Specifically, i~~I~~n 2000, the Baia Mare and Baia Borsa mine-tailing pond failures mobilized approximately 100,000 m^3 of metal-contaminated water into the Tisza River, eventually polluting the Danube River and Black Sea. Since the industrial accidents occurred originally as a result of significant rainfall and flooding, these events are an example of what are commonly referred to as natech accidents, technological accidents triggered by natural disasters. In 2010, an industrial accident occurred in the Hungarian portion of the Danube River when a dam containing alkaline red sludge collapsed, releasing 1.5 million m^3 of sludge into the surrounding land (approximately 4000 hectares) and waterways (including Kolontár, Torna Creek, and the Danube River), killing 10 people and injuring several hundred more (ICPDR, 2010). In 2014, following Cyclone Tamara, over 1,000 landslide events occurred in Serbia as well as significant flooding, resulting in damage to properties and infrastructure and the inundation of agricultural land. Due to concern over possible breaches in infrastructure to mine tailing dams in the surrounding area, and the harmful effects to human health, technical experts investigated mining sites and provided recommendations for local evacuations (NERC, 2014). In all three disasters, the need for disaster response exceeded the capacity of national actors;

therefore, international response involved the United Nations, the European Commission, and various other international organizations.

While international humanitarian law is generally well defined, the law of international disaster response is still incomplete (Fisher, 2008). Historically, a distinction has been drawn between the scope of response to natural disasters and man-made disasters; however, this distinction is absent from the 2015 Sendai Framework for Disaster Risk Reduction, which adopts a multi-hazard risk approach providing management tools for disasters that are both natural and man-made (UNISDR, 2015). The European Union's disaster response framework is also holistic and includes natural and man-made disasters, and some multilateral sub-regional agreements are also taking similar approaches, such as those adopted by the Association of South East Asian Nations (ASEAN) and the Baltic Sea Economic Cooperation (BSEC). Adopting a multi-hazard, or all-hazards, approach to disaster response allows for recognition of all conditions, natural or man-made, that have the potential to cause injury, illness or death; damage to or loss of infrastructure and property; or social, economic and environmental functional degradation (Kappes, Keiler, von Elverfeldt and Glade, 2012).

With international policies starting to shift toward more holistic frameworks of response that incorporate both natural and man-made disasters, this article explores what this trend will mean for regional institutions in the Danube basin and Tisza sub-basin, whose policy frameworks for monitoring and response continue to distinguish between types of disasters, and resultantly have separate policy response options depending on the type of disaster.

This article begins with an overview of the study area and a description of the methodology. Next is a discussion of the distinctions between natural disasters and industrial accidents – how and why they have been treated differently and how recent developments in international law and practice are raising questions about the merits of these distinctions. It is followed by an examination of the international frameworks governing disaster response in the Danube basin and Tisza sub-basin. Subsequently, the differences in how natural disasters and industrial accidents are monitored, and how they are responded to, are explored. The article discusses the transition of international policies toward more holistic frameworks for response, and concludes with a reflection of how this might affect the Danube basin and Tisza sub-basin.

2 Overview of study area and methodology

The Danube River basin covers more than 800,000 km² – over 10 percent of continental Europe – and flows through the territories of 19 countries with nearly 80 million people residing within the basin. Today, 14 of the 19 countries, plus the EU, have committed to transboundary cooperation in protecting the Danube via the Danube River Protection Convention (DRPC), and work jointly toward the sustainable management of the Danube basin and the implementation of both the European Union's Water Framework Directive (WFD) and Floods Directive (EU FD) (ICPDR 2015a).

Among the tributaries of the Danube River, the Tisza sub-basin has the largest catchment area, and covers approximately 160,000 km² (20 percent of the Danube basin's area), with approximately 14 million people (Fig. 1). There exists a distinct socio-economic contrast in the basin between western and former socialist countries, and since the end of communism in the late 1980s, the central and lower Danube has experienced a rapid shift to free market democracy within the context of increased globalization, privatization, and deregulation. This has led to rural decline as well as increased poverty, unemployment, and depopulation (WWF, 2003). ~~Additionally, as a result of the continuing conflict in Syria and neighboring states, countries in the Danube and throughout Europe are experiencing a significant increase in population from~~

~~refugees, displaced persons, and other migrants who are escaping persecution, conflict, and poverty, and are settling in empty buildings, hotels, or refugee camps that have become ad hoc shelters (UNHCR, 2016)~~

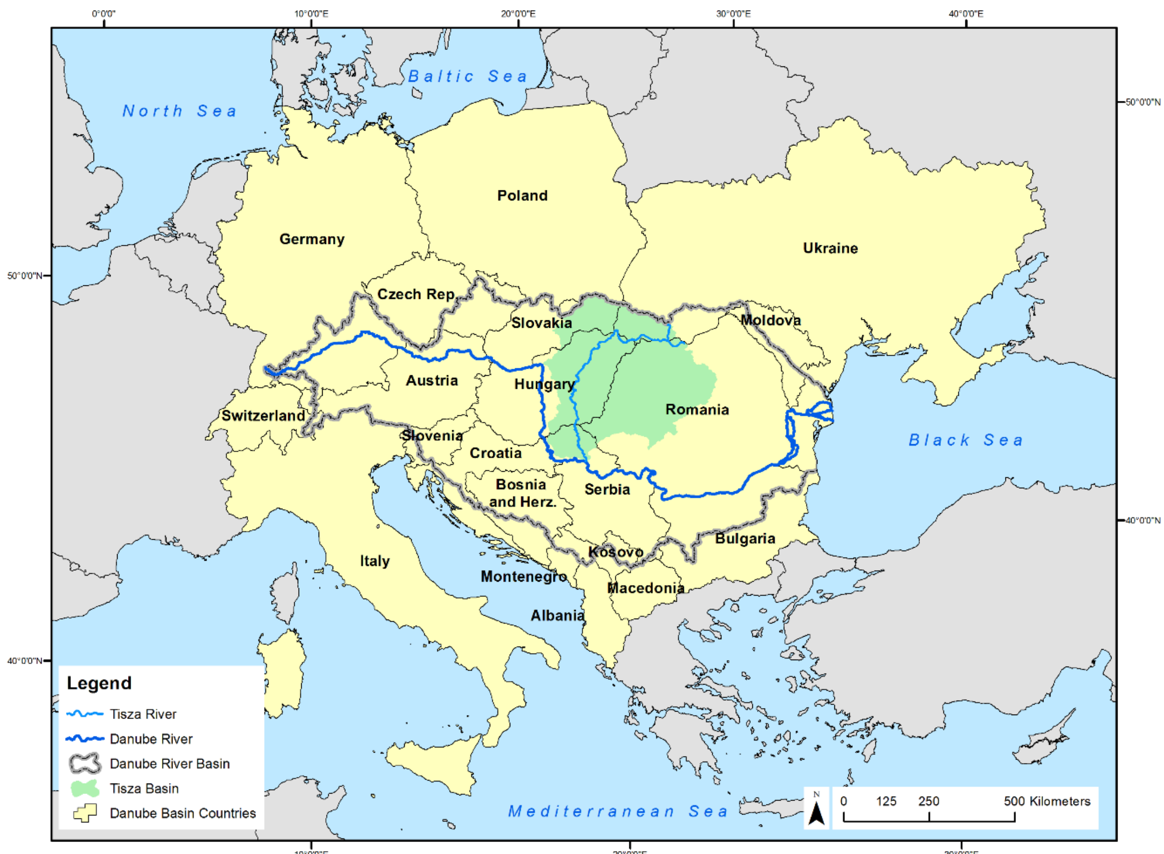

Fig. 1 Map of Danube River basin and Tisza River sub-basin.

~~The headwaters of the Danube are located in the Black Forest of Germany. After leaving the Black Forest the Danube flows generally south-east through Central and Eastern Europe to the Black Sea in eastern Romania (Fig. 1; ICPDR, 2009a).~~ International measures regulating the Danube were first undertaken in 1882 for flood protection and navigation. Dams were constructed within the upper ~~Danube~~ basin for flood mitigation, hydroelectric power generation, and regulation of river levels for navigation. The operation of these dams ~~for these services~~ has been attributed with altering the flow regime of this segment of river and consequently varying the ecological disturbance regime within the river and on the floodplain resulting is substantial changes in the riverine ecosystem (ICPDR. 2009a). The flow regulation provided by the dams and the construction of levees has allowed for the conversion of floodplains and riverine wetlands into area suitable for agricultural and urban development. Today only 12 small reaches (<1 km in length) of the Upper Danube ~~relatively~~ remain relatively untransformed (Schneider, 2010). In the Middle and Lower Danube, the river bed has been dredged repeatedly to maintain a navigable river channel. Along these segments of the Danube River, levees and dams mitigate or prevent inundation of over 72 percent of the floodplain. The substantial reduction in~~s~~ Danube's connection with its floodplain combined with wastewater discharge from agricultural and industrial sources, and increasing levels of pollutants along these river segments have substantially altered or damaged riverine ecosystem and reduced resiliency of urban and rural communities to large floods which exceed the protection level of their flood mitigation measures (Schneider, 2010; UNECE, 2011). The degree of industrial development and amount of pollution created by the industrial sector varies among Danube countries. In general, pulp and paper industries represent the largest contributors of pollution, followed by chemical, textile, and food industries (ICPDR 2009a).

The Tisza headwaters are located in the Carpathian Mountains in Ukraine. From these headwaters the Tisza River flows southwest across central portions of the great Hungarian Plain into the Danube River in Serbia (Fig. 1; ICPDR, 2008a). ~~Precipitation within the Tisza basin is generally concentrated in the Carpathian mountains within the upper portion of the watershed.~~ I~~The i~~ntense, concentrated ~~ity of the~~ rainfall and the steep terrain coupled with deforestation and channelization of many streams ~~within this portion of the Tisza watershed,~~ result~~s~~ in some of the most sudden and high-energy flooding in Europe~~. Flood levels along the upper reaches of the Tisza can range up to 12 m deep within as little as 24-36 hours~~ (Nagy et al., 2010). The sudden water level rises coupled with the high energy of the flows often threaten human lives and result in substantial damage to infrastructure and croplands (ICPDR, 2008a).

While industrial production has dropped drastically in the Tisza since the 1990s, there remain a variety of industries that contribute to the economy of the region, and the legacy of heavily concentrated industrial activities continues to threaten the surrounding ecosystems. The main industrial regions of the Tisza are located in Romania and Hungary, where the potential for ~~greatest~~ flood damage and losses is also greatest. Chemical and petrochemical industries (including oil refinery, storage and transport) are important for both Hungary and Ukraine, and the cellulose and paper, textile, and furniture industries are also present predominantly in the upper portion of the Tisza in Slovakia, Romania, and Ukraine (ICPDR, 2011). ~~Beyond the threat of mobilizing hazardous materials from industrial activities directly into the Danube or Tisza Rivers, the risks posed from industrial accidents to the surrounding communities, particularly with increasing urbanization, is of growing concern.~~

Mining activities, and the accidental spills of chemical substances, have affected the aquatic environment and water quality within the Tisza sub-basin since the 2000 Baia Mare and Baia Borsa natech accidents (JEU, 2000). Natech accidents present significant challenges, as natural events can trigger multiple and simultaneous accidents in one installation, or depending on the impact of the natural hazard, in several hazardous facilities at the same time (Krausmann and Baranzini, 2012). Furthermore, natechs present additional difficulties ~~to already fragmented disaster response activities,~~ as they remain absent from disaster response frameworks (Krausmann, Cruz, and Salzano, 2017). A 2009 assessment identified more than 92 potential sources for industrial and waste deposits; however, the list does not include abandoned mine sites and their mine tailing dams – only those from currently operational mines (ICPDR, 2015a). Therefore, the potential risk of accidental pollution could be substantially higher (ICPDR, 2015a).

~~2.1~~ Methodology

The ~~analysis~~ examination of policy and institutional frameworks for monitoring and responding to natural disasters and man-made accidents in the Danube ~~River basin~~ and Tisza ~~River sub-basin~~ ~~was conducted~~occurred through a combination of primary and secondary data collection and analysis. The primary data ~~collection and analysis~~ consisted of semi-structured interviews, while the secondary data ~~analysis~~ included analysis of the legally binding mechanisms in the region, including conventions and directives (Table 1), of bilateral agreements (Table 2), and a literature review of peer-reviewed publications and white papers, providing for ~~and~~ an analysis of international laws, policies, and institutions within the Danube basin and Tisza sub-basin regarding the provision of disaster response. Semi-structured interviews were conducted over an eight-month period from January to August 2013. This format of interviews was chosen so that the pre-determined set of interview questions could be expanded through the natural course of conversation and allow for a more thorough understanding of what was initially queried – in particular, each expert interviewed was provided with the freedom to express their personal views in their own terms.

Table 1. List of legally binding mechanisms for Danube basin and Tisza sub-basin.

Governing Body	**Convention**	**Type of Instrument**	**Description of Instrument**
UN Economic Commission for Europe	Industrial Accidents Convention	Legally binding for parties to	Determines actions of request

		convention.	for assistance and response for industrial accidents specifically.
European Commission	Water Framework Directive	Legally binding for EU member states, and though Danube Convention.	Sets basin-level management of water quality and quantity.
European Commission	Floods Directive	Legally binding for EU member states, and though Danube Convention.	Requires action regarding flood mapping at the basin level.
European Commission	Seveso Directives	Legally binding for EU member states.	Requires corporations to list possible risk of industrial accident, and develop preparedness plans.
European Commission	Civil Protection Mechanism Directive	Legally binding for EU member states,	First EU-wide law to include multiple-hazards in disaster risk strategies.
International Commission for the Protection of the Danube River (ICPDR)	Danube River Protection Convention	Legally binding for Danube member states.	Provides integrated framework for all Danube countries to participate in basin-level management, regardless of EU affiliation.

Table 2. List of bilateral agreements within countries in the Danube basin and Tisza sub-basin.

Countries	**Transboundary Watercourses**	**Disasters / Emergencies**
Austria – Czech Republic	1967*	1994 (Floods Only)
Austria – Germany	1987	1991 (Floods Only)
Austria – Hungary	1956	1959 (Floods Only)

Austria – Slovakia	1967*	1994 (Floods Only)
Austria – Slovenia	1956***	1956* (Floods Only)
Bosnia and Herzegovina – Croatia	1996	1996 (Natural/Manmade Disasters)
Bosnia and Herzegovina – Serbia and Montenegro**	-	2011 (Flood EWS)
Bulgaria – Romania	2004	2004 (Floods Only)
Bulgaria – Serbia	Draft	Draft (Floods Only)
Croatia – Hungary	1994	1994 (Floods Only)
Croatia – Serbia	-	-
Croatia – Slovenia	No Date	1977*** (Coastal Pollution)
Czech Republic – Slovakia	1999	-
Hungary – Romania	1986	2003 (Floods Only)
Hungary – Slovakia	1956*	2014 (Floods Only)
Hungary – Slovenia	1994	1994 (Floods Only)
Hungary – Ukraine	1997	1998 (Floods Only)
Moldova – Romania	2010	2010 (Floods Only)
Moldova – Ukraine	1994	-
Serbia and Montenegro – Hungary	1955**	1955*
Serbia and Montenegro – Romania	1955**	Under Discussion
Ukraine – Romania	1997	1952*** (Floods Only)
Ukraine – Slovakia	1995	2000 (Floods Only)

* Agreement formed with Czechoslovak Socialist Republic
** Agreement formed with Yugoslavia
***Agreement formed with Union of Soviet Socialist Republics
- No Information Available

Seventy-one interviews were conducted in various locations throughout Europe. The interviews took place with experts ~~working within~~in the International Commission for the Protection of the Danube River, ~~within~~ the expert groups of the International Commission for the Protection of the Danube River (i.e., Tisza group, river basin management, flood protection, and accident prevention and control), with respondents working at the national ministries, water management directorates, and non-governmental organizations in the Tisza and Danube countries, as well as with experts ~~working within~~ in the European Commission~~,~~ and the United Nations~~ involved in the Danube basin and Tisza sub-basin~~. Those interviewed were chosen based on their knowledge of and work within the Danube River basin and Tisza sub-basin. Given public roles, the interviews are intentionally left anonymous to ensure candidness in the responses~~ (Table 1)~~. Thus, only the kind of organization the experts work for is identified - the numbers appearing in brackets in the table below refer to the interview citations in text; ~~reflect~~ multiple interviews were conducted within~~at~~ each level of governance indicated (Table ~~1~~3). The questions focused on how Danube basin and Tisza sub-basin policies and laws were implemented in practice, as well as the perceptions of the experts regarding the frameworks and implementation of disaster monitoring and response throughout the Danube basin and Tisza sub-basin.[2]

Table ~~1~~3. Organizations from which experts were drawn for interviews.

International	United Nations, United Nations Economic Commission for Europe, and United Nations Environment Programme (UNEP)/UN Office for the Coordination of Humanitarian Affairs (OCHA) Joint Environment Unit [1]
Regional	European Commission [2]
	International Commission for the Protection of the Danube River (ICPDR) and Expert Groups (Tisza Group, River Basin Management, Flood Protection, and Accident Prevention and Control) [3]
National	National Ministries of Environment, Rural Development, Interior, Environment Agency [4]
	Water Directorates [5]
Non-State Actors	NGOs [6]

***** Numbers in brackets refer to interview citations in text.

3 Distinctions between natural disasters and man-made accidents in policy frameworks

[2] Questions relevant to international frameworks for disaster response included: (1) What are the respective roles in multilevel governance in regard to response for natural and man-made disasters? (2) To what extent are natural and man-made disasters included in policy frameworks for response; in what context and at what level, and what is the language being used? (3) What gaps exist between policies and practice in regard to response for natural and man-made disasters? (4) What constraints or opportunities exist in including policies for response to natural and man-made disasters; which type would be most effective and at what level?

~~Traditionally~~ ~~T~~The approaches used for describing, limiting, and categorizing disasters fundamentally shape~~s~~ the methods for monitoring and responding to disasters. They determine the solutions utilized, the resources allocated, and the governance frameworks selected by categorizing the types of disaster into that which is natural or man-made. It is therefore important to ~~understand~~recognize the etiology of disaster in order to understand why the distinctions among the various types of disasters still remain. These are discussed below.

3.1 Rationale for different treatment between natural and man-made disasters

~~The manner in which disasters are framed by society has evolved over time, still the role of human responsibility features prominently in disaster narratives.~~ Natural ~~disasters~~ hazards are naturally occurring physical phenomena, which can include earthquakes, landslides, tsunamis, volcanoes, and floods. Disasters disrupt individuals and communities at various scales due to hazardous events interacting with conditions of exposure, vulnerability, and risk – leading to human, material, economic and environmental losses and impacts.[3] Natural disasters have historically been characterized either (1) as a direct form of punishment from God for the sins of humanity, or (2) in more recent history~~more recently~~ as an "act of God" that removed humans from culpability (Rozario, 2007). ~~The framing of natural disasters continues to shift, and some natural events – earthquakes, hurricanes, tsunamis – only become disasters as they impact and interact with individuals and communities.~~ The consequences of natural disasters become a function of where people reside~~ – along coastlines, in floodplains, in vicinity of fault lines, and within mountainous regions –~~ and their overall vulnerability, including aging infrastructure and a

[3] Exposure is understood as people, infrastructure and housing, production capacities and other human assets located in hazard-prone areas. Vulnerability is defined as a set of physical, social, economic and environmental factors or processes that increase the susceptibility of an individual, a community, assets or systems to the impacts of hazards. Disaster risk is the potential loss of life, injury, or damaged assets occurring to an individual or community as a function of hazard, exposure and vulnerability (UNISDR, 2015).

function of their ability to monitor and prepare for these events (Peel and Fisher, 2016). Vulnerability within and between populations can vary, and occurs for multiple reasons – social inequalities, community demographics (e.g., age and poverty), lack of access to health care, and limited access to jobs or to lifelines (e.g., emergency response, goods, services) (Cutter and Emrich, 2006). While building in disaster-prone areas is not the sole responsibility of individuals, they do share responsibility for investing in the risk involved. The existence of moral hazard[4] can increase the amount of damage from disaster and reduce the capacity of insurance to cover disaster loss; this occurs due to individuals acting irresponsibly and because of those who erroneously believe there is coverage for any loss incurred (Smith, 2013). For example, offering insurance encourages people to build and live in flood-prone areas, in spite of the known risks – if insurance were not available, the household would absorb the entirety of the risk and prospective buyers would most likely choose to reside elsewhere. Additionally, as seen with some large disasters such as Hurricane Katrina, losses suffered by policyholders can be several times larger than collected premiums, consuming insurers' capital and, if the losses are severe enough, not only jeopardize claim payments, but also cause insurance companies to declare bankruptcy before covering any – or only some – insured losses (Nekoui and Drexler, 2016). For example, while the total economic loss incurred during Hurricane Katrina is assessed at approximately US$ 125 billion, insured losses covered an estimated US$ 45 billion, however, only an estimated US$ 2 million in insurance claims were paid (Munich Re, 2005). Moral hazard can also exist in disaster preparedness and response activities when actors believe they

[4] For purposes of this paper and described by Munich Re (2007), moral hazard is a lack of incentive by an individual to guard or protect against risk (or to enter into a situation of risk), knowing that they are protected from risk through insurance, which results in higher insurance loss claims. Examples provided are assured compensation for flood damage, leading to increased building in flood-prone areas and assured compensation for crop losses in drought-prone areas that encourage farmers to grow more compensated crops instead of planting alternative crops or adopting alternative land uses.

~~are sufficiently prepared to respond to any event or crises. During Hurricane Katrina, despite emergency preparations, preexisting social vulnerabilities and the collective failure to adequately respond to the emergency made response inadequate for the type of complex emergency relief needed (Cutter and Emrich, 2006).~~

Industrial accidents and other man-made accidents are traditionally ~~considered~~ governed and responded to separately from natural disasters. The role of human agency features even more prominently in these events, due to potential moral or legal obligations to mitigate risk (e.g., preparedness, insurance, disaster aid). Man-made disasters suggest potential moral and legal obligations to both aid the victims of the disaster in a response capacity in the period immediately following the disaster, as well as to compensate those who are harmed during their long-term recovery (Verchick, 2012). The liability is only effective if a polluter can be identified or liability can be assigned. As disasters continue to multiply, cascade ~~become more complex~~, and their costs mount, responsibility for the disaster also becomes more complex. For example, in assigning liability to the 2010 red sludge spill in Hungary, early reports from the Hungarian Prime Minister Victor Orbán indicated that the breach was likely due to human error, and that “there was no sign the disaster was caused by natural causes, therefore it must be caused by people” (Dunai, 2010). In ongoing efforts to determine human negligence, it was determined that flooding and subsidence led to structural breaches in the reservoir containing the alumina, yet it remained difficult to prove whether officials at the MAL alumina facility knew of the weakened infrastructure (NDGDM, 2010).

The degree of uncertainty related to the amount of damage and probability of occurrence is very high with disasters, particularly those influenced by climate change (Greiving et al., 2012; Munich Re, 2016). Liability can be more difficult to calculate and assign in these cases, in part because disaster loss agencies (i.e., Munich Re, Swiss Re), are often accounting for specific losses from flooding and sudden-onset disasters that are more easily quantified, whereas the impact of slow-onset, or "silent", disasters ~~related to climate change~~ can be more difficult to quantify ~~since they occur slowly over time~~ (IFRC, 2013). Therefore, due to numerous anthropogenic influences on these events ~~(including anthropogenic effects of climate change/slow-onset events)~~, it is misleading to continue the differentiation in terminology between "natural" versus "man-made" disasters, and the frameworks that govern mechanisms for disaster response.

3.2 Dimensions for different treatment

Increased frequency of major disasters, legal barriers to disaster response, and the absence of unified response ~~to both natural disasters and man-made accidents~~ have led to increased attention at a variety of levels for more integrated international frameworks ~~for disaster response~~ (IFRC, 2007). The fragmented nature of disaster response has emerged from the need to address specific types of disasters, in specific regions, or response modalities. Furthermore, while natural disasters and industrial and nuclear accidents have established frameworks for response, natech accidents are often missing from chemical accident response programs (OECD, 2015). Natech accidents can lead to the release of toxic substances, fires, or explosions and result in injuries and fatalities; therefore, the lack of consideration for natech response mechanisms, planning tools or response programs can be an external risk source for chemical and nuclear facilities (Krausmann and Baranzini, 2012). Some international instruments, such as the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency and the Convention on Early Notification of a Nuclear Accident apply only to specific types of disaster. While the Nuclear Accidents Conventions were adopted almost immediately following the

Chernobyl nuclear accident, there still remains no similar overarching global framework for notification or assistance in response to industrial accidents, or for environmental emergencies more broadly (Bruch et al., 2016). Other disaster frameworks, like the Tampere Convention, apply only to a single sector or area of relief ~~(such e.g., as the provision of importing telecommunication resources following disasters caused by nature or human activity, or whether occurring suddenly or as the result of complex, long-term processes)~~. ~~-~~Conversely~~However~~, the ability to provide disaster response for natural disasters is quite broad and is included in a number of international frameworks. A question of applicability of agreements arises, however, when a complex disaster occurs and multiple institutions have a mandate for response, but it is unclear which institution should take the lead in responding or coordinating response efforts (Bruch et al., 2016). ~~During the Lebanon crisis in 2006, international assistance was requested in response to the bombing of fuel storage tanks at a power station, and over 70 countries and organizations responded – it was unclear who should take lead, and the need for coordination was reflected among response efforts (Nijenhuis, 2014).~~

An additional ~~difficulty~~ challenge with fragmented disaster response frameworks lies in the types of international actors engaged in natural disasters and man-made accident response. Generally, there is a failure to include non-state actors, the private sector, or individuals in response efforts to disasters (IFRC, 2007). The Tampere Convention and the sub-regional Black Sea Economic Cooperation (BSEC) and Association of South East Asian Nations (ASEAN) agreements are exceptions. With the Tampere Convention, for example, the decision to offer assistance, the type of assistance provided, and the terms of assistance are up to the discretion of the non-state actors offering assistance (Bruch et al., 2016). Given the increasing role of private funds in disaster response and relief operations, ~~considering the~~ including~~sion of~~ these actors in disaster frameworks can be beneficial. ~~Oftentimes, there is the assumption that assets and personnel are provided as a favor to an affected state government, where when in reality they might are normally be expected to reimburse costs and manage how assistance is carried out (Bruch et al., 2016). However, efforts are increasingly being made to clarify the respective roles of actors and institutions in regard to disaster response, and more recently laws are changing in favor of including broader terminology to comprise both natural and man-made disasters (IFRC, 2007).~~

4 Disaster frameworks in the Danube basin and Tisza sub-basin

Response to natural and man-made disasters, including natech accidents, is governed by a range of global, regional and national laws, policies, and soft-law instruments. In the Danube basin and Tisza sub-basin this includes the Industrial Accidents Convention and the Seveso Directive, the Water Framework Directive and the Floods Directive, as well as treaties and policies developed at the level of the Danube and Tisza. ~~Here~~As such, natural and man-made disasters continue to be treated as distinct and separate issues, where monitoring and response are managed independently.

~~4.1 Introduction to Danube basin and Tisza sub-basin~~

In 1994, the Danube countries developed the Danube River Protection Convention (DRPC), a legally binding instrument that ensures ~~to ensure~~ sustainable management of the Danube River. Through the International Commission for the Protection of the Danube River (ICPDR), the DRPC requested the ICPDR to coordinate the activities of the EU Water Framework Directive (WFD) and EU Floods Directive among the Danube member states. The WFD and Floods Directive are legally binding to members of the European Union, but through the DRPC become legally binding to all Danube member states, regardless of EU member status.

~~among the EU member states~~. The WFD combines the monitoring and assessment of ~~surface and groundwater~~water quality in the basin, and the Floods Directive instructs national authorities to establish flood risk management plans by 2015, linking the objectives of the WFD and the risk to these objectives from flooding or coastal erosion through the Floods Directive, and integrating them into basin level activities via the ICPDR. However, because not all countries of the Danube are EU member states, not all measures and outcomes of the WFD and Floods Directive are implemented equally among the basin countries.

The Danube ~~basin~~ and the Tisza ~~sub-basin~~ have experienced numerous natural and man-made disasters, including natech accidents (e.g., Baia Mare Cyanide Spill, Hungarian Chemical Accident, and recent Serbian landslides) (European Commission, 2016). These are tallied in Table ~~2~~4. However, the frameworks for disaster response at the levels of the United Nations, the European Union, and those utilized by the ICPDR ~~and implemented at the national level by the Danube countries,~~ are restricted to particular types of disaster – monitoring and response to flooding is the most advanced throughout the basin, while pollution is monitored, but does not have the same frameworks for response. Additionally, there remain a variety of natural and man-made disasters that ~~occur throughout the basin~~ that are not integrated into any type of basin monitoring or response framework, including fire, and drought~~, and other types of predictive climate modeling~~.

Table 4. Natural and man-made disasters in the Danube basin, reported by country, 2000-2012

~~**Table 2.** Natural and man-made disasters in the Danube basin, reported by country (2000-2012,). (Adapted from European Commission, 2016.)~~

2000	Mine tailing failure/cyanide and heavy metal pollution (natech)	Romania, Hungary, Bulgaria, Macedonia
	Landslide/avalanche	Austria, Slovenia
	Extreme temp./drought	Bulgaria, Croatia, Slovenia
	Flooding	Croatia, Hungary, Romania, Slovenia

	Severe ice storms	Moldova, Ukraine
	Wildfires	Croatia, Slovakia
	Factory fire	Slovenia
2001	Mining accident (natech)	Slovenia
	Flooding	Croatia, Hungary, Romania, Slovakia, Ukraine
2002	Industrial fire at waste dump	Slovenia
2003	Mining accident (natech)	Slovenia
	Extreme temp./drought	Austria, Croatia, Germany, Slovenia, Bosnia and Herzegovina
	Flash floods/severe storms	Hungary
	Wildfires	Slovenia
2004	Drinking water pollution (natech)	Hungary
	Dam failure	Romania
	Earthquake	Slovenia
	Flooding/severe storms	Hungary, Slovakia
	Drought	Bosnia and Herzegovina
2005	Landslides	Slovenia
	Flooding/Severe Storms	All Danube Countries, except Ukraine
2006	Avian (H5N1) flu pandemic	Hungary, Romania, Slovenia
	Aircraft accident	Hungary
	Earthquake	Hungary
	Extreme Temp.	Bulgaria
	Wildfires	Slovenia
2007	Wildfires/forest fires	Bulgaria, Croatia
	Hurricane	Germany
	Extreme temp./drought	Austria, Bulgaria, Croatia, Hungary, Romania, Slovakia, Bosnia and Herzegovina, Montenegro, Serbia, Moldova
	Flash floods/severe storms	Bulgaria, Germany, Hungary, Romania, Slovenia, Montenegro, Serbia, Ukraine
2008	Transportation accident	Croatia
	Extreme temp.	Bulgaria
	Forest fires	Bulgaria
	Flash floods/severe storms	Hungary
	Flooding	Romania, Slovakia, Slovenia, Serbia, Moldova, Ukraine
2009	Swine (H1N1) flu pandemic	All Danube Countries
	Ice storms/blizzard	Croatia, Romania, Bosnia

		and Herzegovina, Ukraine
2010	Chemical accident (natech)	Hungary
	Earthquake	Serbia
2012	Ice storms/blizzards	Bulgaria, Hungary, Romania, Montenegro, Serbia, Moldova, Ukraine
	Extreme temp./drought	Moldova

-Note that economic losses, deaths and displacements are not reported to either European Commission or ICPDR.
- Where indicated, natech accidents occurred because of initial flood event that led to subsidiary release of chemicals/pollutants.
-Adapted from European Commission, 2016.

4.~~2~~ 1 How disasters are treated differently within response frameworks

~~In the absence of a centralized institution for disaster response, the development of a large and diverse international disaster relief community has occurred. Initially, the large-scale relief work after natural disasters was undertaken by the Red Cross movement at the end of the 19th century, but eventually the disaster relief community expanded capacity and function to include a variety of disaster assistance activities and involve other international initiatives and organizations (IFRC, 2007). The United Nations (UN) began humanitarian work shortly after World War II with agencies such as the United Nations High Commission for Refugees (UNHCR), and predecessor agencies such as the United Nations Office for the Coordination of Humanitarian Affairs (UN OCHA) are now regularly engaged in disaster response and relief (IFRC, 2007).~~

Numerous frameworks for response to natural disasters exist (Table ~~3~~1). Apart from natural disasters, the United Nations Economic Commission for Europe's (UNECE) Industrial Accident Convention applies to land-based, non-military, and non-radiological industrial accidents (UNECE, 2009). Through the convention, response for industrial accidents is provided through bilateral or multilateral arrangements. If no prior agreements exist, an affected country can request assistance from other parties through mutual assistance agreements. However, in these situations, it is the responsibility of the requesting country to cover all costs, unless otherwise agreed upon among the responding countries (UNECE, 2009). One example is the 2002 UN General Assembly Resolution 57/150 on "Strengthening Effectiveness and Coordination of Urban Search and Rescue Assistance" (UN, 2003). While non-binding, the resolution highlights the importance of national responsibility to victims of natural disasters within country borders, but in the event that an incident exceeds country capacity, Urban Search and Rescue (USAR) assistance through the International Search and Rescue Advisory Group (INSARAG) can supplement local rescuers, and the coordination of these resources, particularly following earthquakes or other events leading to structural collapse (INSARAG, 2016).

Table 3. List of legally binding mechanisms for Danube basin and Tisza sub-basin.

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Governing Body	**Convention**	**Type of Instrument**	**Description of Instrument**
UN Economic Commission for Europe	Industrial Accidents Convention	Legally binding for parties to convention.	Determines actions of request for assistance and response for industrial accidents specifically.
European Commission	Water Framework Directive	Legally binding for EU member states, and though Danube Convention.	Sets basin-level management of water quality and quantity.
European Commission	Floods Directive	Legally binding for EU member states, and though Danube Convention.	Requires action regarding flood mapping at the basin level.
European Commission	Seveso Directives	Legally binding for EU member states.	Requires corporations to list possible risk of industrial accident, and develop

			preparedness plans.
European Commission	Civil Protection Mechanism Directive	Legally binding for EU member states,	First EU-wide law to include multiple hazards in disaster risk strategies.
International Commission for the Protection of the Danube River (ICPDR)	Danube River Protection Convention	Legally binding for Danube member states.	Provides integrated framework for all Danube countries to participate in basin-level management, regardless of EU affiliation.

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Table 5. Estimated human and economic loss in Danube per flood event, 2002-2014

Table 43. Estimated human and economic loss in Danube per flood event (2002-2014) (Adapted from ICPDR, 2008b and ICPDR, 2015b).

Flood Year	# Deaths or # Displaced	Economic Losses €
2002	N/A	N/A
2006	N/A	> €6 billion
2010	35 deaths	€2 billion
2013	9 deaths	€2.4 billion
2014	79 deaths; 137,000 displaced	€4 billion

*N/A – Data not available

-Adapted from ICPDR, 2008b and ICPDR, 2015b

The facilitation of international disaster response can be inadequate if mobilization is untimely, or fails to include sufficient financial support. Response frameworks may neglect or place disproportionate attention on certain types of disasters, which could become more problematic with growing concerns over climate change and increased urbanization. ~~For example, there is visible delayed response for sudden-onset disasters such as the 2005 Indian Ocean tsunami and the 2010 Haiti earthquake which received the majority of funding support within one to three months of the initial request, compared to the slow-onset drought events of the 2011 appeals by Kenya and Somalia where funding was not provided until nearly 7-12 months after the initial request (GHA, 2013). In 2005, nearly three quarters of all UN contributions for natural disasters arrived within a month of their appeal; the comparable figure for complex emergencies was only seven percent (IFRC, 2007).~~

~~While differences exist among slow-onset and sudden-onset disasters, they can create cumulative impacts to the community that increase vulnerability and lead to larger disasters in the future – precipitation deficiencies in soil and water lead to drought and when combined with high temperatures and dry conditions, this can lead to wildfires (e.g., extreme fire hazard situations in the eastern US and south-east Australia) (Smith, 2013).~~

~~The growing size and diversity of international responders to disasters can have ramifications for the facilitation, coordination, and quality of response efforts (IFRC, 2007).~~ Diverse systems of response are implemented among the Danube basin countries due to the variety of disasters experienced. Some utilize a single Civil Protection Mechanism, while others rely on multiple parties among Ministries of the Interior, Ministries of Rural Development, Water Directorates, and a variety of additional local protection committees [4, 5]. Interviews indicated that not all responders/parties are sufficiently trained, and many lack managerial or technical capacity to manage specific disasters appropriately [4]. There is also large compartmentalization of tasks at lower levels – both regional and local – where integration among the various types of disaster, as well as increased cooperation is needed [2, 3]. Other than the fact that these diverse actors are providing certain types of disaster assistance, there is nothing uniting them – no international or regional disaster response system. Given the increased frequency of natural and man-made disasters and the growing number of actors involved in disaster response efforts, ensuring effectiveness of aid should not detract from response and assistance (IFRC, 2007).

Besides the diverse ensemble of international organizations with a mandate and capacity for responding to natural disasters and/or specific types of technological or industrial accidents, there are also agencies experienced in particular types of international disasters, but which may not necessarily have the mandate or capacity for response. In 1994, the United Nations Environment Programme (UNEP) and the UN Department of Humanitarian Affairs (DHA, the predecessor of OCHA), developed an administrative arrangement through an exchange of letters (Bruch et al., 2016). The arrangement relies on the environmental mandates of UNEP and the humanitarian mandates of the DHA. Through UNEP's Governing Council Decision UNEP/GC.26/15 on "Strengthening International Cooperation on the Environmental Aspects of Emergency Response and Preparedness", the Joint UNEP/UN OCHA Environment Unit (JEU) plays a leading role in facilitating coordination among international organizations in the event of natural and man-made disasters, including natech accidents, which are more broadly termed environmental emergencies (UNEP, 2011). The JEU has a number of existing agreements and interface procedures in place with these organizations, in order to facilitate response~~, particularly because there is a lack of familiarity among UN member states regarding existing regional and international systems for response to the various types of disasters, as well as the coordination between them~~. For example, the JEU facilitated international agreements and interface procedures to aid with response between UN Disaster Assessment and Coordination (UNDAC) and the EU Civil Protection Mechanism to the 2014 Serbian landslides following Cyclone Tamara (NERC, 2014). During the 2000 Baia Mare natech accident in the Tisza River sub-basin, sixteen experts from seven countries deployed for response to the natech accident, and the JEU assisted to coordinate response efforts among UNDAC, the European Commission, the Military Civil Defence Unit, the World Health Organization, and a variety of other actors (JEU, 2000).

At the regional level, the European Union’s Civil Protection Mechanism (EU CPM) is an instrument for disaster response that protects people, the environment, property, and cultural heritage in the event of natural or man-made disasters, occurring within or outside of the European Community (European Commission, 2016). Disasters are monitored internationally through the Emergency Response Coordination Centre (ERCC) in cooperation with the JEU and with participating states.

The European Union’s Seveso Directives (I enacted in 1982, II enacted in 1996, and III enacted in 2012) are some of the earliest pieces of legislation to address disaster risk (European Community, 1982; European Community, 1996; European Community, 2012). The various iterations of the Directive govern the establishments where dangerous substances are present, and require the establishments to classify and report the amounts, types, and locations of dangerous substances present. The majority of the Directives' focus is on notification requirements and accident prevention~~, including notification to the public due to the increased risk by natural disasters associated with the location of the establishment and associated risks from natech accidents~~ (European Union, 2012). The responsibility for response under the Directives falls on the ~~establishment~~ industries for developing preparedness response measures in advance of an accident, and notifying the competent authority in case of a major accident (European Union, 2012). However, a 2012 study by the European Commission indicated that industry in nearly half of the EU countries is believed to insufficiently consider natech risks in their preparedness response measures (Krausmann and Baranzini, 2012).

The EU Floods Directive provides a framework for addressing risk from natural disasters, specifically floods. While inspired not only by the damaging effects of floods, but also by increasing flood risks as a result of climate change, the main objective of the Directive is to require member states to assess and manage risks of flooding ~~within their territories~~ and to develop flood risk management plans. Though the plans are restricted to areas considered at high risk of floods, these are not integrated into other types of plans and maps available – such as the Inventory of Potential Accidental Risk Spots in the Danube[5] – nor are they used for developing preparedness response measures in advance of an accident or natural disaster, such as in the case of the Seveso Directive. Though the Flood Directive was expected to reduce flood risk, interviewees voiced disappointment regarding the limitations of integrating disaster risk more broadly, particularly in relation to water quality and accidental pollution [3]. These present as

[5] Pursuant to the 2001 Baia Mare natech accident in Romania, the ICPDR conducted a qualitative evaluation of the hazardous locations in the Danube catchment area, with reference to location of possible water pollution. The report of Inventory of Potential Accidental Risk Spots was released in 2001, and has not been updated since (ICPDR, 2001; ICPDR, 2015a).

policy limitations to the Water Framework Directive and Flood Directive, as neither of the two directives require the integration of disaster risk of both floods and accidental pollution.

The European Union also developed a set of macro-regional strategies for the Adriatic and Ionian, Alpine, Baltic Sea, and Danube regions (European Commission, 2010). While the intent ~~from the EU~~ was to not provide new EU funding, these integrated frameworks are supported by EU Structural and Investment Funds in order to address common challenges faced in each defined area ~~in order to strengthen cooperation and achieve greater economic, social, and territorial cohesion~~. In the Danube Strategy, risks from floods and industrial accidents are reflected as having substantially negative transnational impacts, and are listed as requiring preventive and disaster management measures that are implemented jointly, with the understanding that work undertaken in isolation in one place (e.g., to build levees) displaces the problem and places neighboring regions at greater risk of flooding (European Commission, 2010). Other man-made disasters are integrated in the discussion of risks, as well as the need to account for climate change by taking a regional focus at the basin level (European Commission, 2010, p. 8). In a 2015 European Commission Communication report ~~following implementation of the Danube Strategy~~, several limitations were highlighted, including: the need to improve efforts to reduce the Danube region's risk of exposure to major floods and accidental hazardous material releases; limited political commitment, funding, and capacity among countries and institutions in the Danube; lack of staff, funding, and expertise impeding participation, particularly in lesser-developed areas of Danube – the report also acknowledged that these challenges are more acute in non-EU countries (EPRS, 2015). The limitations in funding, technical expertise, and capacity were confirmed in interviews with experts at various levels, who also noted how this leads to uneven implementation of EU Directives within the basin that can create pockets of vulnerability to both flood risk and risks from industrial accidents [2, 3, 4].

While the Danube Strategy does not provide a framework for response to natural and man-made disasters, it does highlight the EU's continued support for managing multi-hazard response at multiple levels, particularly through Priority Area 5 "To Manage Environmental Risks". Specifically, it requests that the countries "strengthen operational cooperation among emergency response authorities in the Danube countries and improve the interoperability for risks that are common to an important number of countries in the region (i.e., floods and risks of other natural and man-made disasters)", and advises that each country's civil protection mechanism have an ~~updated~~ understanding of neighboring country's systems so that response teams can function smoothly in case of emergencies ~~involving bilateral, European, or international response~~ (EUSDR, 2015). Experts also expressed the need for formal agreements with specific language on integrated mapping of complex disasters, as well as provisions addressing response to both natural and man-made disasters, particularly if additional grants could be given from the EU to support these activities [2, 3, 4, 5]. Some interviewees reflected that the regional Strategy depended on stronger countries helping the weaker ones, but limitations with funding and capacity are difficult to overcome [2]. In the 2015 Annual Report on implementation of the Danube Strategy produced by the Danube countries, all projects focused on implementation of the Floods Directive. The only mention of industrial accidents was to reflect the failure to include an updated Inventory of Potential Accidental Risk Spots along the Danube, which is also discussed in the 2015 Danube River Basin Management Plan (DRBMP) (EUSDR, 2015; ICPDR, 2015b). Given past issues with mine tailing collapses and other pollution disasters associated with flooding, the 2015 DRBMP acknowledged the need to update the Inventory of Potential Accidental Risk Spots promptly (ICPDR, 2015b). Unfortunately, this recommendation from the 2015 DRBMP, and initially expressed in first Danube River Basin Management Plan of 2009, has yet to be realized.

Through the 1994 Danube River Protection Convention, Article 17 provides for mutual assistance "where a critical situation of riverine conditions should arise". While "critical situation" is not defined, Article 17 indicates that the ICPDR will elaborate procedures for mutual assistance including, the facilities and services to be rendered by the contracting party, the facilitation of border-crossing formalities, arrangements for compensation, and methods of reimbursement (ICPDR, 1994). These elaborations have not occurred through the ICPDR, but rather in the form of bilateral agreements regarding transboundary flood measures among Danube countries; however virtually no bilateral agreements exist regarding response to man-made disasters in the basin (Table 52).

Countries	Transboundary Watercourses	Disasters / Emergencies
Austria – Czech Republic	1967**	1994 (Floods Only)
Austria – Germany	1987	1991 (Floods Only)
Austria – Hungary	1956	1959 (Floods Only)
Austria – Slovakia	1967**	1994 (Floods Only)
Austria – Slovenia	1956***	1956* (Floods Only)
Bosnia and Herzegovina – Croatia	1996	1996 (Natural/Manmade Disasters)
Bosnia and Herzegovina – Serbia and Montenegro**	-	2011 (Flood EWS)
Bulgaria – Romania	2004	2004 (Floods Only)
Bulgaria – Serbia	Draft	Draft (Floods Only)
Croatia – Hungary	1994	1994 (Floods Only)
Croatia – Serbia	-	-
Croatia – Slovenia	No Date	1977*** (Coastal Pollution)
Czech Republic – Slovakia	1999	-

Table 54. Bilateral agreements on transboundary watercourses and disasters among Danube countries (Adapted from ICPDR, 2009a; ICPDR, 2015a; UNEP, 2002).

Hungary – Romania	1986	2003 (Floods Only)
Hungary – Slovakia	1956**	2014 (Floods Only)
Hungary – Slovenia	1994	1994 (Floods Only)
Hungary – Ukraine	1997	1998 (Floods Only)
Moldova – Romania	2010	2010 (Floods Only)
Moldova – Ukraine	1994	-
Serbia and Montenegro – Hungary	1955**	1955*
Serbia and Montenegro – Romania	1955**	Under Discussion
Ukraine – Romania	1997	1952*** (Floods Only)
Ukraine – Slovakia	1995	2000 (Floods Only)

* Agreement formed with Czechoslovak Socialist Republic
** Agreement formed with Yugoslavia
***Agreement formed with Union of Soviet Socialist Republics
- No Information Available

To bridge the gap regarding man-made accidents, some Danube basin countries have engaged in such agreements. Bulgaria, Moldova, Romania, Serbia, and Ukraine are pParties to the DRPC, but have separately engaged in the BSEC Agreement on Response to Natural and Man-made disasters (Bruch et al., 2016). Furthermore, the Danube Delta countries (Moldova, Romania, and Ukraine) are working together with the UNECE Industrial Accidents Convention due to the large concentration of oil-related industries in the area in order to improve hazard management, increase transboundary cooperation, and strengthen operational response [1].

At the Danube basin level, the countries have engaged in a series of non-binding Memoranda of Understanding (MOU) referred to as the Danube Declarations, first in 2004, revised in 2010, and updated in 2016. The Declarations reinforce the language of the 1996 Danube River Protection Convention to sustainably manage the waters of the Danube, and reinforce the countries' commitment to continue the work of the WFD and Floods Directive. The 2016 Declaration recognizes the need for increased investment and improved warning systems for flood protection and contamination, as well as improving the exchange of information throughout the Danube (ICPDR, 2016). The Danube River basin countries engage currently in two separate systems for flood monitoring and monitoring pollution from man-made accidents – the Emergency Flood Alert System and the Principal International Alert Centres (PIACs) of the Danube Accident Emergency Warning System (Danube AEWS), respectively. The Emergency Flood Alert System has been functioning since 2003 at the Joint Research Centre, a Directorate General of the European Commission, and works in collaboration with the national authorities of the member states and with a variety of meteorological services. The Emergency Flood Alert System provides two medium-range flood forecasts each day, with 3-10 day advance warning for flooding in the main stem of the Danube. An MOU has been signed with several, but not all of the Danube countries (Austria, Bulgaria, Czech Republic, Germany, Hungary, Moldova, Serbia, Slovakia, Slovenia, and Romania, and negotiations are underway with Bosnia and Herzegovina and Croatia), and information is available 24 hours a day through an online service managed by the Joint Research Centre (ICPDR, 2010). The Emergency Flood Alert System gives national authorities the ability to prepare response measures, including opening temporary flood retention areas, building temporary flood protection structures such as sandbag walls, and adopting civil protection measures such as closing down water supply systems (ICPDR, 2009b). These responses reduce further threat of flooding downstream, and prevent loss of lives and infrastructure. The MOU does not include tributaries draining areas less than 4,000 km^2, therefore the Emergency Flood Alert System does not address flood risks in the Tisza, nor in certain basin countries where significant flood concerns arise, such as Ukraine [1].

Transboundary floods typically affect larger areas, can be more severe, result in a higher number of deaths, and cause increased economic loss than non-transboundary rivers (Baaker, 2009). Therefore, the repeated occurrence of such large, costly flood events (Table 453) highlights the ongoing need for improved strategies for flood preparedness and response, particularly in the absence of coordinated, multi-hazard bilateral and multilateral agreements among basin countries.

The Principlale International Alert Centres (PIACs) of the Danube Accident Emergency Warning System monitor accidental water pollution incidents in the Danube River basin. Unlike the Emergency Flood Alert System, which is linked to monitoring conducted by the European Commission and is transmitted to national authorities (without involving the ICPDR in the monitoring process); the Danube AEWS system is managed by the ICPDR, but does not involve the European Commission. While all contracting parties of the DRPC cooperate with the Danube AEWS, they also are expected to have national policies regarding response to accidental pollution in the Danube that connects to the Principalle International Alert Centres. The PIACs are expected to operate on a 24-hour basis within each country, and are in charge of all international communications. When a message regarding potentially serious accidental pollution occurs, the PIAC is responsible for communicating the accident to the ICPDR, and decides whether it is necessary to notify downstream countries, engages experts to assess the impacts of the pollution, and decides what response activities need to be taken at the national level (ICPDR, 2014). Challenges to the Danube AEWS monitoring include territorial gaps (several areas along the Danube and Tisza are not monitored) [3, 4, 5], a limited number of bilateral agreements for response in case the accident exceeds national capacity (Table 524), and even though a variety of natural and man-made accidents occur (Table 24), not all types of man-made accidents are monitored. Increasing pressures are felt by downstream countries from the failure to monitor pollution events in a consistent and effective manner [4]. Furthermore, in order to keep the AEWS operational, there is increasing reliance on citizen reporting of pollution events in some countries [4, 5]. This is particularly problematic in the Tisza countries where the lack of monitoring of both flood and accidental pollution events, combined with limited bilateral agreements raise concern among several countries [4, 5].

In the most recent Tisza River sub-basin MOU (from 2011), the Tisza countries agreed, among other things, to "take coordinated steps to prevent accidental risks, and develop harmonized mitigation and response measures, with the aim to present an updated Inventory of Potential Accidental Risk Spots by the end of 2012" (ICPDR, 2011). This complements the 2009 request in the Danube basin (but as reflected above, has yet to be updated) (ICPDR, 2015b). To date, this has not occurred for the Tisza ~~sub-basin~~, but the language in the MOU does reflect an interest at the sub-basin level to prioritize not only the mapping and development of an Inventory of Potential Accidental Risk Spots, but also the development of harmonized response measures among floods and man-made hazards.

5 Questioning the distinction

While "natural" disasters may be a commonly used term, no disaster can be regarded as entirely natural if people have the capacity to avoid, mitigate, or reduce the risk from it ~~an entirely natural hazard~~ (Picard, 2016). ~~However~~Generally, the vulnerability to lives and livelihoods can be ~~avoided~~ reduced with ~~proper~~ disaster preparedness and response, such as the proper placement, function, and use of early warning systems, ~~flood maintenance,~~ and mitigation works such as levees and controlled flood outlets and properly timed dam releases.

There is an additional shift in what is considered truly a natural disaster as well – not only from the perspective of mitigation or vulnerability, but in acknowledgement of the anthropogenic influences on natural disasters. Climate change is one aspect, but there are also induced earthquakes occurring as a result of slipping faults from fluid injection in hydraulic fracturing

(Legere, 2016)~~ and from the weight of shifting water impoundments from Three Gorges (Stone, 2008)~~, landslides from subsidence and increased land use activities including urbanization (Smith, 2013), and pandemics from deforestation and habitat conversion (Greger, 2007), to name a few. ~~Holistic frameworks that include multiple types of disasters are needed in order to respond effectively.~~

~~Human intervention in the physical environment exposes populations to natural hazards from the built environment, such as housing and associated infrastructure, including industrial facilities, drainage works, and planning—especially when the built environment is not appropriately designed or built to account for the risks~~hazards~~.~~ Human, economic, and environmental losses can be worse in highly populated, urbanized areas; with increased urbanization and climate change, they are placed at increased risk to natural and man-made hazards (Bruch and Goldman, 2012; Huppert and Sparks, 2006). For this reason, natech accidents and other cascading disasters are particularly problematic types of disasters. Simultaneous response efforts are required to attend to both the industrial, chemical, or technological accident as well as the triggering natural disaster. Therefore, expanded definitions of that reflect multiple types of disaster, as well as ~~broad~~ improved frameworks for response to multiple types of disaster, are needed in order to recognize that many disasters can arise from multiple, potentially co-located hazards—and to take the necessary measures to reduce the risks of those hazards.

~~While distinctions among disasters are still claimed for liability in some cases (including in determining deliberate conduct or negligence), the distinction between natural and man-made disasters is largely irrelevant from the perspective of humanitarian response and the humanitarian consequence of multi-hazard events and those that are caused by natural or technological~~

~~hazards. Furthermore, in the event that disasters are slow-onset, or when the ability to mitigate or respond to risk is not timely or effective, the long-term effects of the disaster can be magnified and lead to further vulnerability, such as famine, malnutrition, or mortality (IFRC, 2006).~~

The 2011 Fukushima nuclear disaster in Japan, triggered by the Great East Japan Earthquake and resultant tsunami, illustrated the complex relationship of natural hazards and the built environment and human factors, resulting in natech vulnerabilities. In part as a response to the earthquake, tsunami, and nuclear accident at Fukushima and as a more general approach to providing a comprehensive, multidimensional and multi-sectoral approach to reducing disaster risk, the United Nations member states adopted the Sendai Framework for Disaster Risk Reduction in 2015. To some experts, the preceding 2005 Hyogo Framework for Action focused too much on disaster risk reduction from natural disasters, and ignored industrial accidents and complex accidents like natech accidents [6]. In fact, in a 2011 study by the European Commission, out of 14 EU countries that experienced natech accidents, more than half of the accidents resulted in the release of toxic substances, fires, or explosions (Krausmann and Baranzini, 2012).

The Sendai Framework places unprecedented emphasis on the interaction between hazards (natural and man-made), exposure levels, and pre-existing vulnerability (Aitsi-Selmi and Murray, 2016). It calls to action for improving decision making through a stronger science-policy-practice interface, with four priority areas for action –including strengthening disaster governance with regard to shared resources and at the basin level (UNISDR, 2015).

The Organization for Economic Cooperation and Development (OECD) also provides guidance for the planning and operation of facilities where hazardous substances are located through the use of their 2003 Guiding Principles for Chemical Accident Prevention, Preparedness, and Response. Recognizing the gaps in natech risk management and methodologies, the OECD developed an addendum in 2015 to the Guiding Principles that include 1) an investigation of the prevention of chemical accidents, as well as preparedness for and response to chemical accidents resulting from natural hazards that are not a part of national chemical accident programs; and 2) recommendations for best practices with respect to prevention of, preparedness for, and response to natech accidents (OECD, 2015).

Regional frameworks for response to natural and man-made disasters have been developed by member states of the Black Sea Economic Cooperation (BSEC) and the Association of South East Asian Nations (ASEAN). These regional agreements have also progressed to include national efforts, such as the coordination of technical assistance and resource mobilization during response to natural and man-made disasters (ASEAN, 2010; BSEC, 1998).

6 Building holistic approaches for integrating multilevel disaster response

The transition toward a multi-hazard approach for response to natural and man-made disasters, and the acknowledgement of the risks of natech accidents is occurring at many levels. It is present in the work of the United Nations and the multilevel response frameworks of the EU Civil Protection Mechanism; some regional agencies are also adopting similar agreements (i.e., ASEAN, BSEC). However, there remains a disparity in managing natural and man-made disasters in a holistic manner at the national level, as well as in the monitoring of these types of events at the Danube basin and Tisza sub-basin levels. The challenges are not insurmountable; this section proposes two sets of options for reducing and eventually eliminating the historic dichotomy among approaches to disaster response and monitoring.

6.1 Multi-hazard approaches

The process of building holistic approaches to planning, preparedness, and response can strengthen systems for responding to natural and man-made disasters in a more integrated manner (i.e., adopting a multi-hazard approach). ~~Building holistic disaster risk processes~~These processes may be done at the global (e.g., Sendai), regional (e.g., BSEC), bilateral, and national levels. By adopting a multi-hazard framework for disaster response, the expertise and practices of responders can be enhanced to include improved modeling and assessment approaches, response methodologies and tools, and heightened measures to prevent or mitigate the consequences from natech accidents (Krausmann, Cruz, and Salzano, 2017).

The review of legal and policy frameworks and interviews reflected that while some planning and preparedness activities take place regarding flood hazard, this generally is not the case for accidental pollution (at least in the Danube and Tisza context), and natech accidents are largely removed or ignored [2, 3, 4, 5, 6] (European Commission, 2010; ICPDR, 2015a). Gaps in monitoring were cited along the length of both the Danube and the Tisza in regard to both flooding and accidental pollution, which should also be improved in future planning efforts. The Tisza sub-basin and smaller water bodies are beyond the scope of the WFD, consequently, no holistic monitoring or response measures are in place; regional agreements at the basin or sub-basin level could aid in developing improved response frameworks [2, 3] (McClain et al., 2016).

Improving the mapping of hazards to reflect not only flood hazard, but also risks from man-made disasters and natech events – and integrating these risks into a holistic map of vulnerability to disaster – would provide a foundation for more holistic policies and programming to manage disaster risks. It would also aid in improving measures for preparedness at the national and local levels. Multi-hazard response frameworks provide the opportunity to intervene and mitigate the size of future disasters. Interviews indicate that harmonized approaches to natural and man-made disasters offer additional opportunities to strengthen capacity among transboundary actors [1, 4].

6.2 Multi-hazard response modalities

In order to avoid fragmentation among response to natural and man-made disasters, and empower, guide, and facilitate the institutional arrangements and mandates necessary to improve ~~response to natural and man-made disasters~~these activities, the legal and policy frameworks need to provide the necessary mandates and procedures – this is accomplished by incorporating an integrated, multi-hazard approach to disaster response. In regard to the Danube basin, this could be done in a variety of ways. The Danube River Protection Convention has not been updated or amended since it was originally drafted in 1994, but it unites all countries of the Danube basin and its tributaries under a formal, legal agreement. Cooperation among Danube countries was generally reported as good [3]; therefore, continuing the use of the ICPDR and its expert groups as a mechanism to gain cooperation among the countries on a regional framework for improving monitoring and response could be considered [3, 4, 5]. Another possibility would be to expand the numerous bilateral agreements among the Danube and Tisza countries regarding flooding to also include man-made disasters and natech events. Working on agreements at a regional level improves communication, breaks down barriers (particularly in transboundary situations), and aids in the development of a common legal language among participating parties [1, 2].

Updating conventions and other hard law can be difficult; countries often find soft law to be more flexible, they are sometimes unwilling to adopt binding obligations, particularly in the face of uncertainty (e.g., climate change), or when they feel there might be a need to act quickly to changing circumstances. In this regard, updating the Danube Declaration and the corresponding Tisza MOUs can provide particularly viable options. Through the Declarations and MOUs, the Danube or Tisza countries could decide whether to engage in a particular action through a separate strategy, or pilot project, or whether to incorporate the issue into the broader basin or sub-basin management plan (e.g., improvement of accidental pollution and flood monitoring, integrated accidental pollution and flood maps). Improved vertical and horizontal cooperation was a request of several interviewees, particularly in regard to the risks posed from man-made accidents and how to respond to these accidents [4, 5].

7 Conclusions

The historic distinction between natural and man-made disasters is outdated, counterproductive, and ultimately flawed. Natural disasters have the potential to trigger simultaneous technological or chemical accidents from one or multiple sources. With anthropogenic climate change influencing the frequency and intensity of disasters, the distinctions in ~~preventing,~~ monitoring~~,~~ and responding to disasters from either natural or man-made sources are further called into question. Moreover, increased urbanization and shifting populations are placing more people at greater risk in times of disaster (whether natural or man-made). As a result, it is increasingly clear that there are no purely natural disasters.

Recognizing that the historic distinctions between natural and man-made disasters are no longer relevant, there is increasing recognition of the need to address disasters holistically, regardless of the contributing causes and aggravating factors. This trend is noted in the Sendai Framework, which adopts a multi-hazard risk approach and provides tools for ~~managing~~ responding to disasters that are both natural and man-made (UNISDR, 2015). While the current policy frameworks in the Danube basin and Tisza sub-basin do not address ~~preparedness~~ monitoring and response holistically across types of disasters, the basin countries have several options for more integrated response. A key opportunity is the development or amendment of agreements governing response to natural and man-made disasters. This could be negotiated through updates to the Danube Convention or through bilateral treaties between the basin countries. Improving planning and preparedness through more integrated monitoring and mapping of natural and man-made disasters, such as combining the flood risk areas with the Inventory of Potential Accidental Risk Spots, could be elaborated upon in Declarations and MOUs at the basin and sub-basin levels.

A coordinated approach to natural and man-made disasters, including natech accidents, is currently taken through the European Union Civil Protection Mechanism and BSEC. This is not unique to Europe alone, and other similar regional approaches exist from which to draw lessons (including the ASEAN agreement). The Danube and Tisza countries are well versed in the transboundary impacts from natural and man-made disasters, and natech accidents; climate change is likely to increase the frequency and severity of these events in the foreseeable future. Nevertheless, while approaches for integrating holistic frameworks for disaster response are recognized at multiple levels, implementation within the Danube basin and Tisza sub-basin remains distinct and fragmented.

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