Review of manuscript NHESS-2021-14:

“Fatalities associated with the weather in the Czech Republic, 2000–2019”

by Rudolf Brázdil, Kateřina Chromá, et al.

1) General comments

Dear Editor,

dear Authors

This contribution of Brázdil et al. presents an analysis of weather-related fatalities in the Czech Republic during the period of 2000–2019. The study was very meticulously conducted and the manuscript is well organized. The manuscript is moderately well written and largely quite easy to understand. However, and as far as I can judge as a non-native English speaker, the sentence structure and punctuation is sometimes a bit special/awkward. This is a bit confusing here and there. Maybe a final proof-reading by a native English speaker could be helpful. The overall text seems a bit long to me. I make suggestions in various places on how it could be shortened slightly (if this is desired by the editors).

Presumably, data collection was very laborious, which makes this work all the more valuable. The authors have also given a lot of thought to the completeness of their data, which is also important, and discuss this point in great detail in the discussion. Furthermore, the authors show how difficult it is to compare, let alone combine, different data sources (e.g., national statistical offices or police). More attention should be paid to this point in the future. It is difficult enough for a country or region to compile databases on fatalities caused by natural hazards and weather extremes, useful synergies would be a great help.

In Europe, several similar overviews o those of the authors have emerged in recent years. The effort of the authors Brázdil et al. fits in perfectly here. This study is very important, not the least to help Czech authorities to better identify potential improvements in hazard prevention related to severe weather situations and natural hazard processes and to reduce the number of victims in the future.

I have compiled my criticisms and comments in quite a bit of detail below and refer you to the second part of this review. Among other things, the title could be worded a bit more "crisply". Here I just want to briefly mention my clear main point of criticism, which is explained more in detail in the comments to the Methods and Discussion sections. For me, the division of the various fatalities considered here into nine classes/types is problematic. Meteorological causes and hydrological (as well as geomorphological and avalanche specific)

consequences are mixed. In my opinion, this needs to be reconsidered or at least better and more extensively argued in the text.

Moreover, the importance of traffic accidents in this compilation is immense. Because (at least it seems so to the reader) as soon as the weather conditions were not optimal during an accident on the road, such a fatal accident was recorded. Here, in my opinion, the authors need to better explain how they proceeded and why.

In summary, this manuscript will definitely be of interest for the research community and therefore should in my opinion be published in NHESS. I am looking forward to it. Given the considerable number of minor comments, and the general criticism with a “major” character, I suggest that the paper be accepted pending moderate revisions.

I provide below a list of comments and suggestions specific to the different sections of the article. I ask the authors to consider these.

2) Specific comments regarding the different sections

Title

The title is a bit general and unspecific (weak). I suggest something slightly more specific, such as "Fatalities associated with severe weather in the Czech Republic, 2000–2019" or "Fatalities associated with severe weather situations in the Czech Republic, 2000–2019". In the second suggestion, “situations” could also be replaced by “events”.

Introduction

The introduction of the article has an adequate length and it draws the reader's attention to the interesting and important topic of this article. In some places, the wording could be a little more precise, and one aspect that is important for the article has not yet been taken into account enough (see comments below).

Also, , the authors do not "sell" their manuscript very well in the last paragraph of the introduction. Instead of describing the structure of the text with its different sections (which is fine but not absolutely necessary), they should try to better explain the goals of this research. Moreover, it is also important for the readers to know what is new in this paper, respectively what progress the study represents for disaster risk reduction in the Czech Republic specifically and in Europe in general.

Further comments:

L33: The authors mention world-wide or continental scales; but there are also many studies and articles that examine fatalities due to weather events or natural hazards at the national level. Is there a reason why these are not mentioned here?

L34: Consider changing to “presented a broad world-wide” (instead of “broader”)

L40-41: This is a little confusing. The authors write that “particular attention has been paid to deaths associated with heat-waves and floods”. Where? In this article specifically or is this meant in general?
The focus within this introduction on heat waves and floods should be better described and justified. After all, almost half of the fatalities described in this study are due to traffic accidents in problematic weather situations (ice and snow covered roads, fog and rain). Why is this not addressed in the Introduction? Are there no compilations and studies on this kind of incidents in research?

L53: Please reconsider the formulation “although other countries have their shares”

L54: The article by Hilker et al. (2009) seems to primarily focus on financial damage caused by floods, landslides and other processes. I guess it is by all means citable here but for Switzerland, Badoux et al. (2016) would probably fit a bit better because it focusses on natural hazard fatalities.

Line 54&57: The article by Petrucci et al. you cite first in the course of the text should be labelled 2019a (and not 2019b)

L62-63: The Salvador et al. (2020) study should rather be mentioned in the second paragraph of the Introduction where studies on heat waves and droughts are addressed. It there a special reason it is placed here?

L74-75: When the authors mention “The general increase in climatic and weather hazards…” do they mean an increase in the number of events? Please include a literature citation that supports this statement.

L78: “The work is based on its own mortality database…” is a bit an awkward formulation. Consider making the text clearer, for example like this: “The work is based on the mortality database compiled by the authors from newspaper data and other official/administrative sources of information”

L89-81: Consider changing to “The results in Section 4 describe weather-related fatalities for various weather phenomena and for all phenomena combined”. Moreover, the second part of the sentence on line 80 does not match the first grammatically.

Data

The three examples of fatality records (L99-116) could be moved to the appendix to shorten the text.

Further comments:

L99: Change to “One of the fatalities of the disastrous August 2002 flood was…”

L133: What are “normal weather conditions”? This should be explained. I guess the authors mean dry weather with good visibility etc. I am not sure if "normal" is the good term, because would mean "rain" is generally an abnormal phenomenon (which is not true).

Methods

The typification of weather events to distinguish weather-related fatalities is not consistent. This is actually my most important criticism of this otherwise very carefully and precisely edited project/article. In my opinion, there is a big confusion between (1) weather phenomena, (2) resulting hydrological and geomorphological processes, (3) resulting traffic accidents, and (4) resulting other accidents.

If floods are considered, why, for example, are mass movements such as landslides, rockfall, and debris flows not considered (at least not mentioned)? These can also be triggered by precipitation. The inconsistency of the present approach is also shown by the fact that avalanches (a mass movement) are taken into account within the weather type “snow”, but the above-mentioned processes (various landslide types) do not seem to have been considered anywhere.

Furthermore, considering road accidents in ice, snow, rain and fog is problematic in my opinion. I am familiar with e.g. the studies by Diakakis & Deligiannakis (2013, Vehicle-related flood fatalities in Greece) or by Coates (1999, Flood Fatalities in Australia, 1788-1996). Both publications show that people often die by drowning when they act carelessly in cars during floods and, for example, enter flood areas / plains or try to cross a watercourse during floods, be it over a bridge or by using a ford. These are flood victims in my opinion. You can also call them traffic victims, but they died mainly because of a natural hazard. But if a driver does not adapt his driving style to the external circumstances (on a wet road, snow-covered road, icy road or in poor visibility) and is involved in a crash, that is for me first and foremost a traffic accident. Of course, the "bad" weather plays a role and the victim can be classified as a weather-related fatality, but a clear distinction must be made from, for example, lightning fatalities, flood fatalities, etc., and the topic should be discussed in detail.

Further comments:

L147: Regarding the “locality”: I suppose this is the locality of the accident or event and not the actual place of death (which can also be in the hospital, for example). Perhaps this could be added.

L155-158: Why do the authors not use one of the three examples described in section 2.1 (L99-116); that would make sense in my opinion.

L160: Maybe indicate that (in contrast to flash flood) these are triggered by long-lasting rainfall; thus consider “single-day or multi-day persistent rainfall” or something similar

L161: I would use the term “snow-melt flood” instead of “snow flood”

L162: Change to “in the rivers”

L162-163: Here is a typical case where it is difficult to distinguish the categories (see general comment on methodology): How are fatalities from the category "floods / flash floods" and "convective storm" distinguished? Both are triggered by very intense, short-term precipitation events. The former category is the consequence, the latter category is the cause. This does not work for me.

L164: To distinguish this category (ii) from the next (iii), I propose to call them "Non-convective windstorms" or "(Non-convective) windstorms". Maybe even: “Non-convective, non-tornadic windstorms”

L167: Downpour (short and very intense rainfall) and hail are phenomena that potentially trigger overland flow and subsequent inundations as well as floods in water courses, overflow and subsequent inundations (in mountainous regions intense rainfall can also trigger e.g. channelized debris-flows); as I understand it, these process chains are covered in (i). What I don't understand exactly is whether there were people in the Czech Republic who were killed directly by heavy precipitation (very unlikely) or hail (possible but unlikely).

L168: Similar to the wind, I would call this category (if it remains so) "Non-convective rain".

L168: Same here (as comment on line 167): were fatalities in this category or event/phenomena type killed by rain? I already mentioned it above in my general comments on the Methods (and will address it again below regarding lines 552-567): I am not sure whether a traffic accident that occurs during rainfall should (always or per definition) be included in the analysis of weather-related climate fatalities. If a person drowns in their car during a flood, it's a clear-cut case. But if a person does not maneuver properly in wet road conditions, it is not a clear case to me. After all, driving on wet roads is a very common thing. The actual cause of an accident can then also be a completely different one.

Results

Section 4 (Results) is extremely detailed and thorough with its nine subsections presenting the various hazardous weather phenomena. The question arises whether all figures 1 to 9 belong in the actual article. Alternatively, Figure 10 (which covers all weather phenomena) could be printed on a full page. The points on the map could be colored according to their type (or different symbols could be used). For the interested reader, Figures 1 through 9 would then be placed in a supplementary material appendix. They contain a great deal of important information, but lengthen the text massively. However, this is the decision of the associated editor or the editor-in-chief. Both options are actually OK for me

Further comments:

L191: I'm not sure if "events" is quite correct in this subtitle; perhaps "categories" or "types" would be more appropriate

L195: Change to “heavy flood in August”
Maybe the authors can make a reference to an article or report which describes the event?

L197: Change to “In terms of monthly distribution,”

L210: Instead of “type of death” I would rather write “type of fatality” here in the caption, exactly the same as on line 153. Please check the entire document and use consistent term.

L210: Instead of “Symbols”, consider using “Abbreviations”

L237: As already mentioned at line 167, I do not doubt that hail can kill people, but this number (8) seems to be quite high.
In the meantime, however, I think I have understood: these are probably road accidents, right? If so, that would have to be indicated here absolutely, otherwise this leads to misunderstandings).

L238: I suggest changing to something like “were simply indicated as having occurred “during a thunderstorm”

L249-250: Change to “4 – rain or hail”, same as on line 237-238 (please be consistent); also, “3 – thunderstorm” is confusing, change to something like “3 – unclear, occurred during thunderstorm”

L253: As mentioned above (Methods) I would use “4.1.4 Non-convective rain” as a subtitle

L256: Change to “In terms of monthly distribution,”

L259: It is not clear to me what the authors mean by “smaller regions” of the Czech Republic. Try to describe more clearly here.

L260-261: “All these fatalities were classified as indirect consequences of vehicle accidents.” I do not understand this statement. To me, these fatalities appear to be a direct consequence of a vehicle accident and an indirect consequence of a non-convective rain event.

L275: With “smaller areas”, do the authors mean “clusters”?

L294: Change to “and 9 % occurred on”

Figure 10: Using a color code in the bar charts is actually a good idea, but some of the colored sections are just too small or narrow to be recognized. Maybe an alternative way of displaying the proportions of the different weather types could be found (and placed e.g. in the appendix).

L381: I would delete "(56.1 % altogether)", it is not really necessary

L382: "Nearly a third of them (30.3 %) fell victim to"; this is confusing. Do the authors mean nearly a third of the 66 or of the 13?

L387-388: The end of this list is a bit confusing.

L393-394: I do not understand this sentence:
"Using the vehicle accident casualties classified within "indirect deaths" and "hazardous behaviour" (96.8 %), 94 % of them died on roads and the remaining 6 % in built-up areas and the countryside." Please try to clarify this.

L405: Consider changing subtitle to: "4.3.1 Official demographic databases (CSO)"

L444: Consider changing subtitle to: "4.3.2 Police database of vehicle accidents"

L448: For clarity, consider extending to: "A mean of 879.4 total fatalities per year was recorded for 2000–2019 due to traffic accidents, of which"

L450: Is "deteriorating" really the right term here? In the caption of Fig. 13 you use "inclement". Consistency is important

L459-462: Please state clearly in the caption which data is shown here (own database or Czech police database). This is especially important for those readers who first look at all the figures before (perhaps) reading text.
Also, what is "normal" (weather); where is the threshold between normal and not normal (inclement); this needs to be addressed. I also mention this point in my comment to the discussion.

Figure 13: Which color shows "normal" weather in Figure 13? Have you declared that?

Discussion

The **first subsection** of the discussion (5.1 Data uncertainty) is well structured and very detailed (perhaps almost a bit too long/detailed). It covers the important points that control data uncertainty. The part between lines 473 and 481 could possibly be streamlined a bit.

The reviewer would be very interested in one additional point. The study was made (mainly) by means of information from the print edition of one daily newspaper (Právo) and its

Internet counterpart (Novinky.cz). The use of different editions devoting space to individual regions of the Czech Republic ensured that decentralized events could also be identified. But to what extent? I would like the authors' assessment of whether the study would have benefited from (i) examining several daily newspapers and/or (ii) including regional and local newspapers. It is clear to me that this endeavor would probably have been far too burdensome, but I think this question should be briefly discussed in this section of the manuscript.

In the **second subsection** of the discussion (5.2 Weather-related fatalities in diff. databases) the authors mention the most important point at the beginning on line 505: the different data sources "are not (fully) comparable". The reviewer would even say they are not (really) comparable. (In all honesty,) This somewhat reduces my interest in this part of the study (or discussion). Nevertheless, it is of course important that the authors point out the problems with the comparative use of data from different sources. And they do it extensively and completely. If the editor concludes that the paper needs to be shortened somewhat, it could be amended here. Figure 14 and its description in the text, while interesting, takes up quite a bit of space. A more concise approach could certainly be taken here.

The **third subchapter** of the discussion (5.3 The broader context) is, in my opinion, a bit long and, above all, not very well organized (with the exception of the very well worded and meaningful last paragraph, L 638-648). I do not find a common thread in it. I feel that the authors list a bit too many comparisons with various other studies (Czech an and international) in this subsection. The order in which they are mentioned does not always seem clear and partly I am not sure that all comparisons are very helpful in assessing the facts and figures in this article.

Further comments:

L465: Avoid using "created" twice in the same sentence. Maybe change to: "The new database of weather-related fatalities developed for the purposes of this study…"

L471-472: Consider changing to "over a 20-year period may". For, yes, societal changes took place during these 20 years, but this time period does not represent a very long time period compared to study periods in other similar investigations such as 200 plus years in Coates (1999) or 50 years in Atkins and Williams (2000).

L506: The reference should be made to (Fig. 12, X31) and not to Fig. 11

L510: In "These series included mean DJF temperature, mean minimum temperature Tmin,…" are mean *daily* temperatures and mean *daily* minimum temperatures meant?

L531: consider extending to "23 casualties against 15 in our data collection."

L533-534: I do not know the spatial distribution and density of meteorological stations in the Czech Republic (the values are probably comparable with the values in other European countries), but since convective thunderstorms can occur on a very small scale, this argument is not necessarily a strong one.

L534-535: I do not understand “From the other point of view”. Why “other”, I am a bit confused. The 26.02.2003 and 14.10.2017 incidents come from the CSO database, right?

L539: This is the first time in the text that landslides are mentioned. Up to this point, it is not clear to the reader that landslides are considered in this compilation. This would have to be adjusted in chapter 3.

552-567: The statements made by the authors in this paragraph confirm my concern and reluctance to include (all) traffic accidents in the compilation of an overview of weather-related fatalities. This is because, in a sense, it is a question of "thresholds." Take, for example, the category "Rain" in the present database, or "Rain" and "Onset of rain and light rain" in the police data. With an annual precipitation total of 450 to 550 mm in the Prague region, a light precipitation of 5 mm in say 4 hours cannot be considered as "abnormal" weather (there are probably about 80-100 rainy days in Prague annually). A traffic accident occurring in such conditions cannot, in my opinion, result in a weather-related fatality.

Theoretically, only cases that occur as a result of exceptional weather should be taken into account. Or how do the authors see it? I think this needs to be addressed in this article. Even more so when you consider that 563 of the 1164 deaths (48.4%) in this database are traffic accidents. I dare to say that this percentage is quite extraordinary compared to countries worldwide (I don't think the authors mention this in section 5.3, for example).

L586-589: I do not think these two studies are comparable. The present work lists weather-related fatalities. The Swiss study, on the other hand, describes natural hazard processes and does e.g. not include frost and heat deaths, nor does it include traffic accidents that occur during “non-normal” weather conditions.

L590: Typo, please change to “an average of 42.6 fatalities a year;” (without closing parenthesis)

L597: What does “their” (in “the structure of their total of”) refer to? The entire EUFF or the “remaining regions”? Please try to be accurate here.

L603-608: Since the article is already quite long and this type of accident occurs only slightly in the previous study, I would omit this section. The number 4000 from Sharma et al (2020) is actually worthless if no time period can be associated with it.

L611: Consider clarifying and changing to: “glaze ice, snow and for all weather-related fatalities. Windstorms show a significant decreasing linear trend only according to the

Mann-Kendall test. The remaining types of weather-related fatalities returned statistically insignificant trends."

L619: I don't understand exactly what the authors mean by "total natural deaths." That has nothing to do with weather-related deaths, does it? If so, why is that of interest here? I propose to significantly shorten the text from line 617 to 624.

L629-637: It should be taken into account that, in general, the number of traffic fatalities is decreasing in many European countries, regardless of the weather. This development is very clear, e.g. in Germany and France, where the number of traffic fatalities has decreased 5 to 6 times since the early 1970s. Many of the reasons for this are given by the authors in the text (L 633-635). The citation of the Audrey (2010) study is interesting, but this general trend should definitely be stated in this paragraph, for example at the end of it.

L631-632: I do not understand the use of "Because" at the beginning of the sentence. I suggest rephrasing (maybe making two sentences). The second sentence could start with "However, the influence..."

Conclusions

The conclusions are concise, which I like, and present the key findings of the study. They can be read and understood independently of the overall text, which is becoming increasingly important for the large number of so-called "cross-readers" these days.

I would add in point (iv), (v), or directly below these points that comparing fatality data from different sources within the same country is problematic or difficult (as shown in Sections 5.2 and 5.3) and that comparison with similar studies from other countries is also challenging (as shown in Section 5.3).

Further comments:

L651: Consider changing to "for the Czech Republic in the period 2000–2019,"

L653: Please check "constitutes a unique data source for.. …structures of such casualties". What do the authors mean exactly by structures of such casualties? Clarify.

L655: Change to "In the monthly distribution of fatalities,"

L6655-656: Consider changing to "The decreasing linear trends in fatalities from 2000-2019 were statistically significant only for fatalities caused by all weather factors combined and for fatalities caused by…"

L659: Again, I have a Problem with the term “structure of fatalities”; but maybe the problem is with me. Do the authors mean (?):
“The composition of weather-related fatalities with respect to different distinguishing criteria indicates…”

References

Atkins, D. and Williams, K. (2000): 50 Years of Avalanche Deaths in the United States . In: Proceedings of the 2000 International Snow Science Workshop, October 1-6, Big Sky, Montana, p. 16-20 [https://arc.lib.montana.edu/snow-science/objects/issw-2000-016-020.pdf]

Coates, L. (1999): Flood Fatalities in Australia, 1788–1996, Australian Geographer, 30, 391–408 [doi:10.1080/00049189993657]

Diakakis, M. and Deligiannakis, G. (2013): Vehicle-related flood fatalities in Greece, Environmental Hazards, 12, 278–290 [doi:10.1080/17477891.2013.832651]