A non-comprehensive literature review comparing regional, continental and global trends in Human influence of flood risk

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Introduction / Motivation

Flooding is a critical global challenge, with potentially catastrophic implications for human populations and infrastructure. As the frequency of flooding events is predicted to rise due to a multitude of factors (climate change – although the evidence being non conclusive – being suggested by multiple references as one major driver, understanding the complex interplay between human behaviour trends and flood risk becomes of increasing interest (Mazzoleni et al., 2021; Miller and Hutchins, 2017; Paprotny et al., 2018).

In Mazzoleni et al. (2021) the following 3 are listed as the main flood risk mitigation strategies:

1. Lowering risk by "reducing human presence in flood-prone areas"
2. Structural flood management measures (e.g. levees, dykes etc.)
3. Non-structural measures (e.g. early warning systems)

While I would categorize the first one as a way of reducing the flood exposure, the other two are ways of reducing vulnerability for a given level of exposure. In this context flood risk is understood as defined by UKs local Government Association("Flood risk and flood risk management," 2024):

"Flood risk is a combination of the probability (likelihood or chance) of an event happening and the consequences (impact) if it occurred."

To increase the efficiency, with which the aforementioned flood protection measures are implemented, it is of benefit to understand better the underline relationship between humans and floods (Mazzoleni et al., 2021).

This non-comprehensive literature review examines three papers that provide insights into the trends in flood risk across different scales—global, continental, and regional.

Specifically, the review focuses on the interplay of human behaviour trends and flood risk trends and comparing the results of analysis on a regional, continental and global scale.

Flood risk is influenced by a myriad of factors, including climatic conditions, socio-economic development, and urbanization.

Considering this, three papers with similar frameworks were chosen reducing the risk of deviating biases thereby making the findings of these papers easier to compare. They were published within a span of three years (2017-2020) by European institutions, covering overlapping timeframes, allowing for a coherent analysis of flood risk over similar periods. While Mazzoleni et al. (2021) analyses global trends in human settlement and infrastructure development in floodplains, examining how these factors interact with flood risks and economic losses, Paprotny et al. (2018) is a historical analysis examines the evolution of flood losses in Europe, documenting changes in economic losses and affected populations. Representing analysis on a regional level Miller and Hutchins (2017) investigates the combined effects of urbanization and climate change on urban flooding and water quality in the UK.

Research trends

Miller and Hutchins (2017) concluded, that while simulating precipitation changing a resolution difference from less than 11 km can result in a difference of up to 5 mm/h hourly rainfall predicted for future scenarios. While (Paprotny et al., 2018) does not analyse datasets of multiple resolutions, it clearly states multiple times that the impact of the resolution needs to be considered (Mazzoleni et al., 2021; Miller and Hutchins, 2017; Paprotny et al., 2018). While assuming to render the effects insignificant by normalizing the results, also Mazzoleni et al. (2021) states that the resolution can have a significant effect on the results.

This shows, that when conducting future research, it is crucial to consider the potential impact of data and model resolution on the findings.

Also, societies rising interest in the effects of climate change shows itself with the analysed papers having examined the potential impact it has on flood risk. Although evidence is said to be insufficient for a conclusive link between climate change and changes in UK precipitation history, assessed on a national level, climate change is mentioned to be “by far the biggest driver” for increasing severity of pluvial floodings and overall is suggested to have a significant influence (Miller and Hutchins, 2017). Assessing on a continental and global scale while also attesting that climate change has had a negative impact on flood severity, the correlation is clear and definitive (Mazzoleni et al., 2021; Paprotny et al., 2018).

Whether targeted or not, the 3 papers all examine trends in exposure and vulnerability. The stated population rise by 100% between the years of 1901 and 2014 combined with the trends of urbanization in flood prone areas lead to deducting increasing exposure of population. Paprotny et al. 2018 uses estimations of assets (GDP, wealth and

population) in a flood prone area to assess the overall exposure. Mazzoleni et al. (2021) uses a combination of change in built-up area and human presence change in flood prone areas to estimate exposure trends. All three using the areas affected by the 1 in 100-year-flood of the respective scopes as a reference, making the result comparable.

Analysis

The three of these papers each use a different way of describing the severity of floods.

While the studies mainly use the impact a flood had on society as a proxy for measuring flood severity, Miller and Hutchins (2017) also used flow data studies for drawing conclusions of the magnitude and frequency of flooding events. It clearly states that in the case of pluvial floods in the UK, a trend of increasing frequency and magnitude examined on a sub-catchment scale can be attributed to Urbanisation. Furthermore, the paper gives the example of flooding events from 2007 where an estimated two thirds were attributed to insufficient surface water drainage systems again depicting a certain influence of urbanisation on flood risk, therefor linking it to human behaviour. In combination with the in Miller and Hutchins (2017) numerously predicted uptake in possibly affected population and assets (therefor exposure) it leads to the conclusion that a certain interplay between Human behaviour and flood risk can be witnessed while examining on a regional level.

On a continental and global level, Mazzoleni et al. (2021) and Paprotny et al. (2018) also clearly show a trend in increasing flood severity and frequency.

Mazzoleni et al. (2021) states the influence flood protection measurements can have on the severity of a flood. Furthermore, trends in in urbanization and repopulation of flood prone areas can be witnessed leading to an overall increasing trend in (Mazzoleni et al., 2021; Paprotny et al., 2018). Mazzoleni et al. (2021) is depicting a trend of increasing built-up area and population growth in flood prone areas for most of the analysed states.

Looking at Paprotny et al., 2018 findings there is no convincing evidence that the trend of significant increase in exposure results in a trend of increasing flood losses. After gap-filling missing data and normalising the results in Paprotny et al. (2018) rather show a decreasing trend of flood losses (measuring by means of fatalities, affected people, and economic losses). Here, number of affected people showing the only increasing trend, further showing the non-proportional relationship between exposure and vulnerability.

On a global scale these trends will not be reproduced. Mazzoleni et al. (2021) showing a trend of increasing trend of economic losses for most of the analysed countries when looking annual averaged flood losses.

As societies have developed, advancements in technology, engineering, and governance have enabled the construction of increasingly effective flood protection measures. Innovations have significantly enhanced the ability to mitigate the immediate impacts of floods. This can have multiple consequences one of which being the enabling of urbanization of flood prone areas, therefor again increasing exposure also known as the “safe development paradox”. Aswell some loss mitigation measures are known to have a negative effect on flood severity and frequence(Mazzoleni et al., 2021; Miller and Hutchins, 2017; Paprotny et al., 2018).

Discussion and conclusions

When saying no increase in damages / flood impact the money spent on flood loss mitigation measures is not included in the calculations.

Also Paprotny et al. (2018) bases some of the conclusions drawn on data from 1945-1950 which leaves considerable doubt on how representative some of the conclusions made in the research paper since then where not properly put into the historical context. Europe was in an state of emergency which could have had an influence on the used flood loss data (Caspari, 2022).

Apart from Miller and Hutchins (2017) the analysed papers did not mention climate change scenarios while predicting trends. Since research seems to agree – some like with more confidence than others – that there is evidence linking climate change to the severity of flood events, it could be of some importance to consider the impacts different climate change scenarios would have on the prediction of future flood risk trends.

All three seem to confirm an increasing trend in exposure while still investing a lot into decreasing vulnerability. This raises the question of why this trend can be observed and what is driving humans for these kind of behaviour patterns.

While conclusions like the certain impact of urbanisation on flood severity this can be drawn when looking at data on a sub-regional level, the complex interplay of a multitude of potential factors makes clear separation of causes very difficult when looking at large scale date of continental or even global trends. Furthermore it is stated that human decision patters have the tendency to seem more risk averse when looked at with high-resolution leading me to question how the results would change when using a different resolution (Miller and Hutchins, 2017; Paprotny et al., 2018).

There is little confidence that the contras between the flood loss trends on regional, continental and global level can be attributed to the different scales on which the data was analysed. Rather the difference in results shows the impact the technique used for normalizing had on the results. Also, Mazzoleni et al. (2021) very briefly mentions that trends similar to the ones found on a continental level could be reproduced globally when using a different method for normalizing the results.

References

Caspari, V., 2022. Entwicklungen nach dem Zweiten Weltkrieg, in: Ökonomik und Wirtschaft. Springer Berlin Heidelberg, Berlin, Heidelberg, pp. 195–258. https://doi.org/10.1007/978-3-662-65497-2_13

Flood risk and flood risk management, URL https://www.local.gov.uk/topics/severe-weather/flooding/flood-and-coastal-erosion-risk-management/flood-risk-and-flood-risk (accessed: 01.08.2024, 22:23h)

Mazzoleni, M., Mård, J., Rusca, M., Odongo, V., Lindersson, S., Di Baldassarre, G., 2021. Floodplains in the Anthropocene: A Global Analysis of the Interplay Between Human Population, Built Environment, and Flood Severity. Water Resour. Res. 57, e2020WR027744. https://doi.org/10.1029/2020WR027744

Miller, J.D., Hutchins, M., 2017. The impacts of urbanisation and climate change on urban flooding and urban water quality: A review of the evidence concerning the United Kingdom. J. Hydrol. Reg. Stud. 12, 345–362. https://doi.org/10.1016/j.ejrh.2017.06.006

Paprotny, D., Sebastian, A., Morales-Nápoles, O., Jonkman, S.N., 2018. Trends in flood losses in Europe over the past 150 years. Nat. Commun. 9, 1985. https://doi.org/10.1038/s41467-018-04253-1