



HAL
open science

Swimming alone? Why linking flood risk perception and behavior requires more than “it’s the individual, stupid”

Samuel Rufat, Alexander Fekete, Iuliana Armaş, Thomas Hartmann,
Christian Kuhlicke, Tim Prior, Thomas Thaler, Ben Wisner

► To cite this version:

Samuel Rufat, Alexander Fekete, Iuliana Armaş, Thomas Hartmann, Christian Kuhlicke, et al.. Swimming alone? Why linking flood risk perception and behavior requires more than “it’s the individual, stupid”. Wiley Interdisciplinary Reviews: Water, 2020, 7 (5), 10.1002/wat2.1462 . hal-02946062

HAL Id: hal-02946062

<https://hal.science/hal-02946062>

Submitted on 28 Apr 2021

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L’archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d’enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Swimming alone?

Why linking flood risk perception and behaviour requires more

Wiley Interdisciplinary Reviews: Water, 7(5), e1462, 2020, doi: [10.1002/wat2.1462](https://doi.org/10.1002/wat2.1462)

Samuel Rufat, Institut Universitaire de France, CY Cergy Paris University, France, samuel.rufat@u-cergy.fr

Alexander Fekete, Institute of Rescue Engineering and Civil Protection, University of Applied Sciences Cologne, Germany, alexander.fekete@th-koeln.de

Iuliana Armaş, University of Bucharest, Romania, iulia_armas@geo.unibuc.ro

Thomas Hartmann, Wageningen University & Research, The Netherlands, thomas.hartmann@wur.nl

Christian Kuhlicke, Helmholtz-Centre for Environmental Research–UFZ, Germany, christian.kuhlicke@ufz.de

Tim Prior, Center for Security Studies, ETH Zürich, Switzerland, tim.prior@sipo.gess.ethz.ch

Thomas Thaler, Institute of Mountain Risk Engineering, University of Natural Resources and Life Sciences (BOKU), Austria, thomas.thaler@boku.ac.at

Ben Wisner, Institute for Risk and Disaster Reduction, University College London, United Kingdom, bwisner@igc.org

Abstract

A common assertion in discussions of flooding is that risk perception is critical and is linked to risk mitigating behaviour. Furthermore, many assert that the adverse effects of floods could be reduced by changes in risk communication, thereby influencing risk perception to foster mitigating behaviour. We argue that these assertions are based on quite questionable underlying assumptions: that stakeholders are generally aware of flood risk, that they have the capacity to engage in disaster risk reduction, and that their actions can be effective. The belief in and policies influenced by these three questionable assertions support, in turn, policies that shift responsibility for flood risk reduction onto individuals and homeowners, without regard for social and spatial justice issues. By contrast, we argue that context matters to understanding the complexity of the relation between flood risk perception and behaviour, local power relations, and other constraints and opportunities that affect stakeholders. Whilst the academic community has long played a pivotal role in supporting practical flood risk management, future research should take a more critical perspective on the underlying assumptions and focus on improving coordination across theories, methods and variables, fostering comparative studies across disciplines, contexts and scales.

Keywords

Behaviour, disaster risk reduction, climate change adaptation, flood risk management, risk perception.

1. INTRODUCTION

Do only stupid people drown and only compulsive gamblers suffer flood losses? This is put in crude terms, but conventional wisdom concerning flood risk management is based on three fundamental assumptions that invite such a cartoon summary. It is assumed that (1) stakeholders are generally aware of flood risk; (2) stakeholders know what to do in order to avoid loss and harm and also have the capacity to engage in Disaster Risk Reduction (DRR) actions; (3) stakeholders are motivated to take these actions and their engagement is effective, one leading to the other. It is often derived from all these assumptions that if people intentionally disregard risks and experience losses, risk communication is decisive in making good these individual errors of judgment and motivation.

Such a top-down understanding of individual flood behaviour and risk communication must be challenged from the point of view of the fundamental changes in flood risk management in recent years. Central to this fundamental shift is the idea of flood risk governance (Hartmann et al. 2017), which implies that multiple stakeholders need to act, exchange ideas and collaborate to tackle flood risks at different temporal and spatial scales. People's choices and behaviours before, during, and immediately after a disaster can dramatically affect the impacts, vulnerability, recovery time and resilience of individuals and communities (Slavikova 2018, Jüpner 2018, Reghezza et al. 2015). These changes necessitate a change in the meaning of risk communication (Nobert and Demeritt, 2014). Top-down approaches are sometimes encouraged by uncritical use of indicators and models. We share a certain scepticism towards semi-quantitative indicators (Heesen et al. 2014), and we urge avoiding the development new indicators without a deep understanding of what they represent, just as one should avoid using models before their comprehensive empirical validation (Rufat et al. 2019).

We believe what is required is a shift to collaborative and participatory approaches to flood risk governance. This belief is in line with the evolution of DRR thinking and policy that have begun to foster public engagement, social capacity, community participation as well as individual responsibility. This trend applies to many countries in Europe and also to North America (Suykens et al 2019, Tarlock & Albrecht 2016), as well as to China (Dai et al. 2019). However, in these cases and also in other countries where individual perception and behaviour are invoked (Ferdous et al 2019), the precise role of the individual and limits on individual action remain unclear. Indeed, the concept of DRR by individuals is built on questionable assumptions, as suggested above. Also, our current understanding of risk perception, underlying motivations and capacities is still limited and fragmented (Lechowska 2018, Wachinger et al. 2013). Piecemeal and disconnected research has handicapped the cross-validation of research results, inhibiting the academic community's ability to build on previous knowledge, to move the research field forward, and to best support flood risk reduction activities (Rufat & Fekete 2019).

2. LAST DECADES: INCREASING ENGAGEMENT, FRAGMENTING KNOWLEDGE

During the last two decades, DRR policies have increasingly highlighted the importance of raising individuals' awareness and encouraging them to take actions to reduce hazard impacts (Bubeck et al. 2017), whilst overlooking some early critics of such an approach (Hewitt 1983). Some national flood management policies define the roles and responsibilities of individuals and homeowners implicitly, as is the case in the United Kingdom, the Netherlands and Poland, for example. Elsewhere these responsibilities are more explicitly defined for households, communities, or companies through

specific policies (Thaler et al. 2016). German water law, for example, highlights that everyone who might be affected by flood risk shall take necessary precautions to mitigate their own risk (article 5). Such an approach encourages differing protection levels across society (Hartmann et al. 2015), and thereby result in unequal patterns of exposure and protection (Thaler et al. 2019). Different financial flood recovery schemes deal differently with issues of equity and justice, as recent studies from the USA and Europe illustrate (Emrich et al. 2019, Slavikova et al. 2019). Assuming individuals must take responsibility to protect themselves and increase their own resilience, there are likely to be significant downstream consequences with respect to the privatisation of DRR (Kuhlicke 2019). This shift can be interpreted as mirroring the political agenda of individualising responsibilities, a turn that can also be observed in other domains of public policy, such as health care, or labour market policy (Bogliacino et al. 2016).

Underlying this trend are three fundamental assumptions that are important to challenge: Is it generally true that individual actions have positive disaster mitigating effects? Are most individuals motivated to take protective actions on the basis of a perception of risk? Do most individuals have the financial, organizational, technological and other resources to take such DRR actions?

Considerable progress has been made by researchers exploring such questions, including studies of motivation driving adaptive behaviour (Bamberg et al. 2017, van Valkengoed et al. 2019), the effectiveness of adaptive actions (Kreibich et al. 2015), as well as on the critical role of resources individuals require to prepare for, cope with and recover from the impact of flood events (Sayers et al. 2018). Clearly both exposure and adaptive/coping capacities are unequally distributed among different groups within all societies (Montgomery et al. 2015). Disadvantage and vulnerability to flooding also exists in materially advantaged societies (Roth et al. 2018). However, despite decades of research on protective behaviour and perception, predicting the actual behaviour of individuals, homeowners, citizens still is a major challenge (Bubeck et al. 2012, Milman et al. 2019). Uncertainty derives from many areas and results in fragmented understanding of risk perception and behaviour (Davids et al. 2019, Lechowska 2018). An especially broad gap can be observed between risk perception and behaviour, leading to a disconnection between decision-makers and affected people with respect to risk communication and risk knowledge (Whitmarsh 2008; Höppner et al. 2012; Wachinger et al. 2013). The main sources of uncertainty include the following:

- Difficulty connecting the results of risk perception research within flood risk management research (Birkholz et al. 2014);
- Lack of knowledge about the roles of place attachment (De Dominicis et al. 2015) and a person's previous experience;
- The numerous intra-psychic processes interacting with social and economic processes, for example, individual's belief in their efficacy is important in triggering action (Witte, 1994), and belief in individual and response efficacy are influenced by the amount of resources people have (Bamberg et al. 2017);
- The challenge of disentangling the connections of risk perception with the underlying demographic, social, environmental, and place of residence backgrounds (Rufat 2015);
- Lack of clarity about how risk perception is influenced by the complex relationships that may exist between individual citizen and decision makers, especially at the local level (Taylor et al. 2014).

3. WHERE DO WE STAND: BRIDGING THE KNOWLEDGE-ACTION GAP

The current fragmentation stems from the interdisciplinary nature of the field, informed and shaped by different sets of assumptions, theories and methodologies (Lechowska 2018), and leading in turn to diverging results (Rufat et al. 2015, Kuhlicke et al. 2020). A central question is why people are still failing to act in an adaptive manner to reduce future losses even when there are ever richer risk information provided by ever more communication channels, such as websites, social media, mobile applications, television and print news. One answer is that the very question is misleading because it is based on a pragmatic understanding of risk communication focused on a specific objective (e.g. “inform people to allow them to make better decisions”) (Rickard 2019). This view is based on the so-called “deficit model” that assumes a “knowledge-action gap” that can be overcome if only more and better information is provided to an ignorant public (Demeritt and Nobert, 2014, Suldovsky, 2017).

We argue that the “deficit” model is simplistic. There are many reasons why at-risk people may not act on risk information (Eriksen et al. 2010). In the first place, the coexistence of contradictory results (Wachinger et al. 2013) still makes it a challenge to distil a clear-cut message from available science to stakeholders. Appreciating why official risk messages do not always result in the intended behaviour requires bridging knowledge-making and decision-making (Fünfgeld et al. 2019).

Secondly, elevated awareness of flood hazard does not always translate into adaptive actions because individuals may not have access to the necessary resources (Begg et al. 2017). We observe that when national authorities transfer more tasks and duties to the local level, there are rarely matching resources and power devolved to carry out these responsibilities (Thaler & Priest 2014). Such “localism” encourages a privatisation or “hollowing-out” (McCarthy et al. 2004) of flood risk management as local authorities are not able to cover the new tasks (Driessen et al. 2018).

In the third place, effective flood risk management, reduction of damages and fatalities, also depends on individual aspirations and choices (Slomp et al. 2017). Here, personalised risk messages might help to overcome the individual reluctance to act in an adaptive manner (Mildenberger et al. 2019, Snel et al. 2019). However, first responders and decision-makers usually lack the means to identify and target the most vulnerable groups for whom a blanket individual responsibility policy may put more pressure (Klinenberg 2015), and therefore such people are often considered to be non-compliant, “irrational”, or at best “hard to reach”(IFRC 2018).

But it is precisely people in vulnerable situations that it is essential to reach despite the challenges (Roth et al. 2017). These challenges include a distrust of government or outsiders. For others, the message does not resonate with their lived reality or they are too preoccupied with daily needs (Wisner 2020). While progress has been made in characterization of situations in which vulnerability is most likely to be found (Wisner 2016), mapping them remains difficult because people may slip into or out of vulnerable situations depending on many contingent factors such as seasonality and life cycle (Wisner et al. 2004) and due to the complexity of other responses that may partly offset or worsen vulnerability (Tierney 2014). Whilst the importance of social and behavioural determinants of vulnerability and resilience has been addressed by a wide range of approaches (Fekete et al. 2019), their multidimensionality makes it difficult to represent them with a universal set of metrics across scales and hazards (Birkmann 2014). As a result, not only do most mapping, models and indicators fail to capture intersectionality (Rufat et al. 2015), but most of them fail to consistently explain the flood outcomes (Rufat et al. 2019).

Fourthly, and even more challenging, some groups of people are simply excluded from research and policy discourse such as the homeless, migrants, prisoners and people in mobile homes (Gaillard et al. 2019) or people who transgress hetero-normal norms (Wisner et al. 2016). Accuracy may suffer as well as moral authority be eroded by studies that do not systematically ask for consent from research participants (if not for their active participation and co-production of knowledge), especially for more vulnerable groups (such as undocumented migrants, homeless, etc.), and are prepared to face dissent and even rejection. Such reflexivity should also lead researchers to focus on other overlooked issues such as corruption and disaster risk creation (Lewis et al. 2012), institutional impacts on vulnerability and resilience (Birkmann et al. 2013), mal-development and unequal power distribution (Wisner 2016).

In the fifth place, an emphasis on individual behaviour challenges what many people experience as established roles and responsibilities (Reghezza et al. 2015). For example, whereas flood protection was earlier seen as a citizen's right to be satisfied by the welfare state (Hartmann et al. 2017), the recent inclusion of "residual risk" in policy implies discrimination in protection against floods (van Ruiten et al. 2016). Such policy approaches are considered necessary to increase resource efficiency as the costs associated with flood protection continue to rise and because floods are increasing with climate change (Blöschl et al. 2019). The IPCC last report (2019) emphasized that climate change has increased surface flooding due to more intense rainfall and recent research drew attention on a high positive correlation between global warming and future flood risk (Winsemius et al. 2016, Alfieri et al. 2017). The implementation of such policy approaches varies from Europe to other continents, reflecting issues of liability, individual responsibility, and the allocation of risk management action (Thaler et al. 2016). However, there is a fine line between feeling responsible, being made responsible, or even having the wherewithal to be responsible (Reghezza et al. 2019). Or to put it in other words: highly exposed and vulnerable people are often left alone, to cope with and adapt to the consequences of flooding.

In all matters of flood risk management, local context matters. Local relations of power shape constraints and opportunities people face (Wisner et al. 2004, De Dominicis et al. 2015), institutional capacities and the degree to which principles of good governance such as transparency, equity, responsiveness, accountability and collaboration are practiced (van Straalen et al. 2018). Kuhlicke and colleagues found these aspects to bear upon the legitimacy of government and to be influential on individual decisions (2011).

Finally, also the academic world has to re-think their approach on research of risk perception in flood risk management. Case study approaches are widely used to understand context- and group-specific differences in risk perception (Bubeck et al. 2012, Wachinger et al. 2013, Lechowska 2018, Hudson et al. 2019). However, so far they fail to establish a convergent or generalizable view of risk perception drivers. They may increase communication efficiency in specific cases (Höppner et al. 2012), but they may not necessarily contribute to building a common baseline, which prevents the development of a panoramic view of what might be socially determined and what might vary from one context to another. At least some shared theoretical constructs and methods to foster comparative studies are therefore necessary to address the knowledge-action gap. This would require combining qualitative and quantitative methods, identifying joint theoretical frames, addressing local demands, tackling dynamic processes, fostering comparability and transferability.

4. WHERE WE'RE GOING NEXT: NOAH BUILT JUST ONE ARK

We believe that knowledge gaps and fragmentation can be addressed by comparing case studies in order to generate converging evidence across different contexts. The recent trend toward combining computer science, experimental design and social science (De Albuquerque et al. 2015, Elsayah et al. 2015) makes such comparative studies possible. These different fields require coordinating theories, concepts and methodological approaches and the approach adopted must encourage co-production of knowledge and should foster more inclusive knowledge-for-action.

However, improvements are necessary and caution is required, as existing big data analyses, longitudinal and replication studies are still not mature enough to address the current knowledge gaps (Vicari et al. 2019, Begg et al. 2017). For example, although social media services such as Twitter and Facebook are ever more used to monitor public reaction to floods (McCallum et al. 2016), and at the same time contain a rich variety of information about people's behaviour, emotions and perceptions (Demuth et al. 2018), the data quality often is not reliable enough to improve modelling (Smith et al. 2017). More importantly, vulnerable communities are digitally left-behind (Wang et al. 2019). Advancements in remote-sensed data, digital social science, computation methods and machine learning have also generated great expectations (Filatova et al. 2013). Data-driven simulation tools such as spatial agent-based models are increasingly used to model human and systems behaviour during or after disaster events. These hold out promise for tackling the complexity of collective behaviour in order to inform disaster management, response activities and policy development (Haer et al. 2019). Data are obtained from quantitative and qualitative approaches (Elsawah et al. 2015). Such data are highly dependent of the quality and consistency of the empirical data on risk perception and behaviour (Aerts et al. 2018). Therefore, far from overcoming the main issues, such new research avenues stumble on the same obstacles.

Meanwhile, a complementary research approach would be to explore whether bottom-up, people-centred and participatory processes encourage inclusive decision-making (Scolobig et al. 2015), while ensuring that the collection, analyses and modelling of data is done in a transparent and ethical way. Scientific efforts and decision-making processes should better reflect local individual and collective knowledge, participatory processes and inclusive decision-making (Patterson et al. 2018). Here, too, however, is caution is called for. Local flood risk reduction activities by more exclusive and affluent groups and the organizations representing them might have adverse impacts on other, less privileged groups of risk-bearers, thus potentially increasing inequality (Thaler et al. 2016). It is important to identify how peers, community groups, and institutions influence individuals' decisions, behaviour and response (De Dominicis et al. 2015). Individual capacity and resources to reduce losses caused by future flood events are highly influenced by the individual knowledge, resources and power to undertake active actions (Chowdhury et al. 2011). Often, many households can neither afford nor are willing to engage themselves, it is necessary to disaggregate population groups and socially vulnerable situations (Wisner 2019).

Understanding how exposed households can "swim together" rather than individually comply with or evade risk communication can strengthen the evidence base to engage with decision-makers. It is important to move beyond analytic and descriptive identifications of risk to a more propositional approach that provides decision-makers not only with empirical evidence but also with solution options, not only with rules of thumb but ways of deepening knowledge-for-action in specific places (Eiser et al. 2012). These solutions may not take the form of "products" but advice about "processes" such as engagement with citizen-scientists, co-production of knowledge with local residents,

including children and youth, or the risk perception knowledge “quadrangle” (connecting higher education, research, policy-making and communities) (Snel et al. 2019, Davids et al. 2019).

Public communication must be further investigated. For example, how people react to communication and take action, be it by belief in the effectiveness of a particular measure or in their own capacity to implement it (Witte 1994). Some research argues communication should not be fear-based, but rather make use of positive messages based from positive psychology (e.g., “Yes, we can” slogan) that can support response behaviour and community resilience efforts (Kellens et al. 2013). Policy-relevant research requires careful consideration of practitioners’ needs and should understand the language of policy-makers to better integrate research results in operational flood risk management. At the same time, research needs to step back and take a more distanced view in order to unravel the information-gaps and hidden conflicts between flood risk management and decision-making silos.

The key social science contribution remains identification of communities of interest, of the triggers and barriers to risk-reduction behaviour. To achieve this, more systematic and recurrent assessments of risk perception at different political levels (e.g., national, regional, and local) are necessary, and should be complemented by longitudinal studies whenever possible. Assessments should be carried out among many stakeholders, including policy-makers, communities, educators and researchers themselves. Longitudinal studies remain relatively rare in the field of disaster studies (Wisner 2011), just as smaller disasters are too often overlooked (Satterthwaite et al. 2017). The measurement of welfare disruptions during even small floods has the potential to reveal new cross-disciplinary insights that bridge daily needs and disaster needs. Similarly, moving toward scenario-based approaches and identifying communities of interest and engagement, such as social media groups, can provide direct input into the communication of targeted and impact-based warnings (Weyrich et al. 2018). Asking direct questions like *“If your house got damaged by a flooding that reaches X height, can you expect help of any kind from neighbours, family, other community groups?”* will help to make concrete such abstract concepts as “social cohesion” and “social capital” and support improved communication based on experiences (Scrivens et al. 2013).

5. CONCLUSION

The bedrock assumption in risk communication that positively links risk perception to flood risk-mitigating behaviour is still challenged. We have shown that it must be nuanced by factoring in individual risk perception drivers, how perceptions might change when exposed to a group perspective, the influence of power relations, and the feasibility of response behaviour. The current trend that heavily emphasises (or even legislates) individuals responsibility, as well as downscaling flood management, is based on flawed assumptions – that stakeholders are aware of flood risk, that they have the capacity to engage in risk reduction, and that their actions can be effective – turning a blind eye on social and spatial justice issues.

The unchallenged circulation of these assumptions results in policies that have negative consequences. Firstly, individuals are left alone with the consequences of being made responsible for reducing flood damages, a burden they often cannot support. Secondly, people are treated as isolated units acting for themselves: the standard perspective by policy-making (*“it’s the individual, stupid”*) is simply taken over, overlooking how households exposed to floods “swim” collectively.

It remains important to link flood risk perception with behaviour, but we have argued that context is critical to adequately understand the complexity of such links. The current fragmentation of the field

makes it an uphill battle to cross-validate the results of the current collection of independent case studies, hindering comparability and transferability across scales and contexts. Whilst the academic community has long played a pivotal role in supporting practical flood risk management, future research should take a more critical perspective on the underlying assumptions and focus on improving coordination across theories, methods and variables. Social and technological changes have been arousing great expectations, but before embarking on ever fancier methods, we need first and foremost to find common ground between methodologies, build a baseline for risk perception, adaptation behaviour and social vulnerability, and foster comparative studies across disciplines and scales.

The first step to building such cumulative knowledge is to define a common list of minimal requirements in order to compare surveys from one case study to another. Such list should include a set of shared theories, specification of the variables, even a selection of decisive questions allowing for comparability and long-term monitoring, and means for making results operational in specific case study contexts in ways that are useful to decision-makers.

Acknowledgement

This paper has been supported by and contributes to the EU COST Action network LAND4FLOOD: Natural Flood Retention on Private Land, CA16209.

References

- Aerts, J. C. J. H., Botzen, W. J., Clarke, K. C., Cutter, S. L., Hall, J. W., Merz, B., & Kunreuther, H. (2018). Integrating human behaviour dynamics into flood disaster risk assessment. *Nature Climate Change*, 8(3), 1-8.
- Alfieri, L., Bisselink, B., Dottori, F., Naumann, G., de Roo, A., Salamon, P., & Feyen, L. (2017). Global projections of river flood risk in a warmer world. *Earth's Future*, 5(2), 171-182.
- Bamberg, S., Masson, T., Brewitt, K., Nemetschek, N. (2017) Threat, coping and flood prevention – A meta-analysis. *Journal of Environmental Psychology* 54, 116-126.
- Begg, C., Ueberham, M., Masson, T., & Kuhlicke, C. (2017). Interactions between citizen responsabilization, flood experience and household resilience: insights from the 2013 flood in Germany. *International journal of water resources development*, 33(4), 591-608.
- Birkholz, S., Muro, M., Jeffrey, P., & Smith, H. M. (2014). Rethinking the relationship between flood risk perception and flood management. *Science of the Total Environment*, 478, 12-20.
- Birkmann, J. (2014). Conceptual Frameworks and Definitions. In *Measuring vulnerability to natural hazards: towards disaster resilient societies*. United Nations University Press, Tokyo: 9-79.
- Birkmann, J., Cardona, O. D., Carreño, M. L., Barbat, A. H., Pelling, M., Schneiderbauer, S., & Welle, T. (2013). Framing vulnerability, risk and societal responses. *Natural hazards*, 67(2), 193-211.
- Blöschl, G., Hall, J., Viglione, A., Perdigão, R. A., Parajka, J., Merz, B., ... & Boháč, M. (2019). Changing climate both increases and decreases European river floods. *Nature*, 573(7772), 108-111.
- Bogliacino, F., Codagnone, C., & Veltri, G. A. (2016). An introduction to the special issue on the behavioural turn in public policy: new evidence from experiments, *Economia Politica*, 33(3), 323-332.
- Bubeck, P., Kreibich, H., Penning-Rowsell, E. C., Botzen, W. J. W., De Moel, H., & Klijn, F. (2017). Explaining differences in flood management approaches in Europe and in the USA—a comparative analysis. *Journal of Flood Risk Management*, 10(4), 436-445.
- Bubeck, P., Botzen, W. J. W., Kreibich, H., Aerts, J. C. J. H. (2012). Long-term development and effectiveness of private flood-risk reductions: an analysis for the German part of the river Rhine. *Natural Hazards and Earth Schemes Science* 12, 3507-3518.
- Chowdhury, P. D., & Haque, C. E. (2011). Risk perception and knowledge gap between experts and the public: issues of flood hazards management in Canada. *Journal of Environmental Research And Development*, 5(4), 1017-1022.

- Dai, L., van Doom-Hoekveld, W. J., Wang, R. Y., & van Rijswijk, H. F. M. W. (2019). Dealing with distributional effects of flood risk management in China: Compensation mechanisms in flood retention areas. *Water International*, 2(4), 1–15. <https://doi.org/10.1080/02508060.2019.1620014>
- Davids, P., Boelens, L., & Tempels, B. (2019). The effects of tailor-made flood risk advice for homeowners in Flanders, Belgium. *Water International*, 1-15. doi: 10.1080/02508060.2019.1614251
- De Albuquerque, J. P., Herfort, B., Brenning, A., & Zipf, A. (2015). A geographic approach for combining social media and authoritative data towards identifying useful information for disaster management. *International journal of geographical information science*, 29(4), 667-689.
- De Dominicis, S., Fomara, F., Cancellieri, U. G., Twigger-Ross, C., & Bonaiuto, M. (2015). We are at risk, and so what? Place attachment, environmental risk perceptions and preventive coping behaviours. *Journal of Environmental Psychology*, 43, 66-78.
- Demeritt, D., Nobert, S. (2014) Models of best practice in flood risk communication and management. *Environmental Hazards* 13, 313-328.
- Demuth, J. L., Morss, R. E., Palen, L., Anderson, K. M., Anderson, J., Kogan, M., & Henderson, J. (2018). “Sometimes da# beachlife ain’t always da wave”: Understanding people’s evolving hurricane risk communication, risk assessments, and responses using Twitter narratives. *Weather, climate, and society*, 10(3), 537-560.
- Driessen, P., Hegger, D., Kundzewicz, Z., van Rijswijk, H., Crabbé, A., Larrue, C., ... & Raadgever, G. (2018). Governance strategies for improving flood resilience in the face of climate change. *Water*, 10(11), 1595.
- Eiser, J.R., Bostrom, A., Burton, I., Johnston, D.M., McClure, J., Paton, D., Van Der Pligt, J. and White, M.P., 2012. Risk interpretation and action: A conceptual framework for responses to natural hazards. *International Journal of Disaster Risk Reduction*, 1, pp.5-16.
- Elsawah, S., Guillaume, J.H.A., Filatova, T., Rook, J., Jakeman, A.J. (2015). A methodology for eliciting, representing, and analysing stakeholder knowledge for decision making on complex socio-ecological systems: From cognitive maps to agent-based models. *Journal of Environmental Management* 151, 500-516.
- Emrich, C. T., Tate, E., Larson, S. E., & Zhou, Y. (2019). Measuring social equity in flood recovery funding. *Environmental Hazards*, 30(2), 1–23. <https://doi.org/10.1080/17477891.2019.1675578>
- Eriksen, C. and Gill, N., 2010. Bushfire and everyday life: Examining the awareness-action ‘gap’ in changing rural landscapes. *Geoforum*, 41(5), pp.814-825.
- Fekete, A., Hartmann, T. & Jüpner, R. (2019). Resilience: On-going Wave or Subsiding Trend in Flood Risk Research and Practice? *WIRES Water*. doi: 10.1002/wat2.1397.
- Ferdous, M. R., Wesselink, A., Brandimarte, L., Di Baldassarre, G., & Rahman, M. M. (2019). The levee effect along the Jamuna River in Bangladesh. *Water International*, 44(5), 496–519. <https://doi.org/10.1080/02508060.2019.1619048>
- Filatova T., P.H. Verburg, D.C. Parker, C.A. Stannard (2013). Spatial agent-based models for socio-ecological systems: challenges and prospects, *Environmental Modelling & Software*, 45: 1-7.
- Fünfgeld, H., Lonsdale, K., & Bosomworth, K. (2019). Beyond the tools: supporting adaptation when organisational resources and capacities are in short supply. *Climatic Change*, 153(4), 625-641.
- Gaillard, J. C., Walters, V., Rickerby, M., & Shi, Y. (2019). Persistent Precarity and the Disaster of Everyday Life: Homeless People’s Experiences of Natural and Other Hazards. *International Journal of Disaster Risk Science*, 10 (3), 332-342.
- Haer, T., Botzen, W. W., & Aerts, J. C. (2019). Advancing disaster policies by integrating dynamic adaptive behaviour in risk assessments using an agent-based modelling approach. *Environmental Research Letters*, 14(4), 044022.
- Hartmann, T., & Driessen, P.J. (2017). The Flood Risk Management Plan: Towards spatial water governance. *Journal of Flood Risk Management*, 10(2), 145-154. doi: 10.1111/jfr3.12077.
- Hartmann, T., & Spit, T. (2015). Towards an integrated water management-Comparing German and Dutch water law from a spatial planning perspective. *International Journal of Water Governance*, 3(2), 59-78. doi: 10.7564/14-IJWG68
- Heesen J, Lorenz DF, Nagenborg M, Wenzel B, Voss M (2014). Blind Spots on Achilles’ Heel: The Limitations of Vulnerability and Resilience Mapping, Research. *Int J Disaster Risk Sci*. 5, 74-85.
- Hewitt, K. (1983). *Interpretation of Calamity: From the Viewpoint of Human Ecology*. Boston: Allen & Unwin.
- Höppner, C., Whittle, R., Bründl, M., & Buchecker, M. (2012). Linking social capacities and risk communication in Europe: a gap between theory and practice? *Natural Hazards*, 64(2), 1753-1778.

- Hudson, P., Ruig, L. T. de, Ruiter, M. C. de, Kuik, O. J., Botzen, W.J.W., Le Den, X., Persson, M., Benoist, A., & Nielsen, C. N. (2019). An assessment of best practices of extreme weather insurance and directions for a more resilient society. *Environmental Hazards*, 61, 1–21. <https://doi.org/10.1080/17477891.2019.1608148>
- International Federation of Red Cross and Red Crescent Societies (IFRC) (2018). *World Disasters Report 2018. Leaving no one behind*. <https://media.ifrc.org/ifrc/world-disaster-report-2018/>
- IPCC, 2019: Climate Change and Land: an IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems [online] <https://www.ipcc.ch/srccl>
- Jüpner, R. (2018). Coping with extremes – experiences from event management during the recent Elbe flood disaster in 2013. *Journal of Flood Risk Management*, 11: 15-21. doi:10.1111/jfr3.12286
- Kellens, W., Terpstra, T., & De Maeyer, P. (2013). Perception and communication of flood risks: a systematic review of empirical research. *Risk Analysis: An International Journal*, 33(1), 24-49.
- Klinenberg, E. (2015). *Heat wave: A social autopsy of disaster in Chicago*. University of Chicago Press.
- Kuhlicke C, Scolobig A, Tapsell S, Steinführer A, De Marchi B (2011). Contextualizing social vulnerability: findings from case studies across Europe. *Natural Hazards*, 58, 789-810.
- Kuhlicke, C., (2019) *Risk and Resilience in the Management and Governance of Natural Hazards*. Oxford University Press.
- Kuhlicke, C., Seebauer, S., Hudson, P., Begg, C., Bubeck, P., Dittmer, C., Grothmann, T., Heidenreich, A., Kreibich, H., Lorenz, D.F., Masson, T., Reiter, J., Thaler, T., Thieken, A.H., Bamberg, S. (2020) The behavioral turn in flood risk management, its assumptions and potential implications. *WIREs Water*, e1418
- Lechowska, E. (2018). What determines flood risk perception? A review of factors of flood risk perception and relations between its basic elements. *Natural Hazards*, 94(3), 1341-1366.
- Lewis, J. & Kelman, I. (2012) The Good, The Bad And The Ugly: Disaster Risk Reduction (DRR) Versus Disaster Risk Creation (DRC). *Plos Current Disasters*, [E4f8d4eaec6af8](https://doi.org/10.1371/journal.pcur.1000008).
- McCallum, I., Liu, W., See, L., Mechler, R., Keating, A., Hochrainer-Stigler, S., ... & Szoenyi, M. (2016). Technologies to support community flood disaster risk reduction. *International Journal of Disaster Risk Science*, 7(2), 198-204.
- McCarthy, J., & Prudham, S. (2004). Neoliberal nature and the nature of neoliberalism. *Geoforum*, 35(3), 275-283.
- Mildenberger, M., Lubell, M., Hummel, M. (2019). Personalized risk messaging can reduce climate concerns. *Global Environmental Change* 55, 15-24.
- Milman, A., Wamer, B. P., Chapman, D. A., & Short Gianotti, A. G. (2017). Identifying and quantifying landowner perspectives on integrated flood risk management. *Journal of Flood Risk Management*, 3(4), 330. <https://doi.org/10.1111/jfr3.12291>
- Montgomery, M. C., & Chakraborty, J. (2015). Assessing the environmental justice consequences of flood risk: a case study in Miami, Florida. *Environmental Research Letters*, 10(9), 095010.
- Patterson, J. J., Thaler, T., Hoffmann, M., Hughes, S., Oels, A., Chu, E., ... & Jordan, A. (2018). Political feasibility of 1.5 C societal transformations: the role of social justice. *Current Opinion in Environmental Sustainability*, 31, 1-9.
- O'Neill, E., Brennan, M., Brereton, F., & Shahumyan, H. (2015). Exploring a spatial statistical approach to quantify flood risk perception. *Natural Hazards*, 76(3), 1573-1601.
- Reghezza-Zitt, M., & Rufat, S. (2019). Disentangling the Range of Responses to Threats, Hazards and Disasters. Vulnerability, Resilience and Adaptation in question. *Cybergeo: European Journal of Geography*.
- Reghezza-Zitt, M., & Rufat, S. (2015). *Resilience Imperative: Uncertainty, Risks and Disasters*. Elsevier.
- Rickard, L. N. (2019). Pragmatic and (or) constitutive? On the foundations of contemporary risk communication research. *Risk analysis*.
- Roth, F., Eriksen, C., and Prior, T. (2017). Understanding the root causes of natural disasters. *The Conversation*, June 27. <http://theconversation.com/understanding-the-root-causes-of-natural-disasters-80017>
- Roth, F., Prior, T., Maduz, L., and Wolf, A. (2018). Social Vulnerability in Affluent Contexts: An in-depth analysis of social vulnerability in Zürich. Risk and Resilience Report. Zürich, Switzerland. https://css.ethz.ch/content/specialinterest/gess/cis/center-for-securities-studies/en/publications/risk-and-resilience-reports/details.html?id=s/o/c/i/social_vulnerability_in_affluent_context
- Rufat, S., Tate, E., Emrich, C. T., & Antolini, F. (2019). How valid are social vulnerability models?. *Annals of the American Association of Geographers*, 109(4), 1131-1153.

- Rufat, S., Fekete, A. (2019). *Conclusions of the First European Conference on Risk Perception, Behaviour, Management and Response*. University of Cergy-Pontoise, Paris, France.
- Rufat, S., Tate, E., Burton, C. G., & Maroof, A. S. (2015). Social vulnerability to floods: Review of case studies and implications for measurement. *International Journal of Disaster Risk Reduction*, 14, 470-486.
- Rufat, S. (2015). Towards a social and spatial risk perception framework. *Cybergeog: European Journal of Geography*, 725. <https://journals.openedition.org/cybergeog/27010>
- Satterthwaite, D., & Bartlett, S. (2017). The full spectrum of risk in urban centres: changing perceptions, changing priorities. *Environment & Urbanization* 29(1): 3-14.
- Sayers, P., Penning-Rowsell, E. C., & Horritt, M. (2018). Flood vulnerability, risk, and social disadvantage: current and future patterns in the UK. *Regional environmental change*, 18(2), 339-352.
- Scolobig, A., Prior, T., Schröter, D., Jörin, J., and Patt, A. (2015). Towards people-centred approaches for effective disaster risk management: Balancing rhetoric with reality. *International Journal of Disaster Risk Reduction*. 12, 202-212 <https://doi.org/10.1016/j.ijdr.2015.01.006>
- Scrivens, K. and C. Smith (2013), "Four Interpretations of Social Capital: An Agenda for Measurement", *OECD Statistics Working Papers*, 2013/06, OECD Publishing. <http://dx.doi.org/10.1787/5jzbcx010wmt-en>
- Slavikova, L. (2018), Effects of government flood expenditures: the problem of crowding-out. *J Flood Risk Management*, 11: 95-104. doi:10.1111/jfr3.12265
- Slavíková, L., Raška, P., Banasik, K., Barta, M., Kis, A., Kohnová, S., Matczak, P., & Szolgay, J. (2019). Approaches to state flood recovery funding in Visegrad Group Countries. *Environmental Hazards*, 41(3), 1-17. <https://doi.org/10.1080/17477891.2019.1667749>
- Slomp, R., & de Vries, W. (2017). Societal Choices in Flood Risk Management, from Individual Responsibility to National Policy. In *Floods. Volume 2- Risk Management*. Elsevier, 119-140.
- Smith, L., Liang, Q., James, P., & Lin, W. (2017). Assessing the utility of social media as a data source for flood risk management using a real-time modelling framework. *Journal of Flood Risk Management*, 10(3), 370-380.
- Snel, K. A. W., Witte, P. A., Hartmann, T., & Geertman, S. C. M. (2019). More than a one-size-fits-all approach – tailoring flood risk communication to plural residents’ perspectives. *Water International*, 44(5), 554-570. <https://doi.org/10.1080/02508060.2019.1663825>
- Suldovsky, B., McGreavy, B., & Lindenfeld, L. (2017). Science communication and stakeholder expertise: Insights from sustainability science. *Environmental Communication*, 11(5), 587-592.
- Suykens, C. B. R., Tarlock, D., Priest, S. J., Doom-Hoekveld, W. J., & van Rijswijk, H. F. M. W. (2019). Sticks and carrots for reducing property-level risks from floods: an EU-US comparative perspective. *Water International*, 44(5), 622-639. <https://doi.org/10.1080/02508060.2019.1640957>
- Tarlock, D., & Albrecht, J. (2016). Potential constitutional constraints on the regulation of flood plain development: Three case studies. *Journal of Flood Risk Management*, 13(11), 2379. <https://doi.org/10.1111/jfr3.12274>
- Taylor, A. L., Dessai, S., & de Bruin, W. B. (2014). Public perception of climate risk and adaptation in the UK: A review of the literature. *Climate Risk Management*, 4, 1-16.
- Thaler, T., Attems, M. S., Bonnefond, M., Clarke, D., Gatién-Toumat, A., Grapois, M., ... & Servain, S. (2019). Drivers and barriers of adaptation initiatives—How societal transformation affects natural hazard management and risk mitigation in Europe. *Science of the Total Environment*, 650, 1073-1082.
- Thaler, T., & Hartmann, T. (2016). Justice and flood risk management: reflecting on different approaches to distribute and allocate flood risk management in Europe. *Natural Hazards*, 83(1), 129-147. doi:10.1007/s11069-016-2305-1
- Thaler, T., & Priest, S. (2014). Partnership funding in flood risk management: new localism debate and policy in England. *Area*, 46(4), 418-425.
- Tierney, K. (2014). *Social Roots of Disaster: Producing disasters, promoting resilience*. Stanford, CA: Stanford Business Books.
- van Ruiten, L., & Hartmann, T. (2016). The spatial turn and the scenario approach in flood risk management: Implementing the European Floods Directive in the Netherlands. *AIMS Environmental Science*, 3(4), 697-713.
- van Straalen, F., Hartmann, T., & Sheehan, J. (Eds.). (2018). *Property rights and climate change: Land-use under changing environmental conditions*. Oxon: Routledge.

- van Valkengoed, A.M., Steg, L. (2019) Meta-analyses of factors motivating climate change adaptation behaviour. *Nature Climate Change* 9, 158-163.
- Vicari, R., Tchiguirinskaia, I., Tisserand, B., Schertzer, D. (2019). Climate risks, digital media, and big data: following communication trails to investigate urban communities' resilience. *Natural Hazards and Earth System Sciences*, 19(7), 1485-1498.
- Wachinger, G., Renn, O., Begg, C., & Kuhlicke, C. (2013). The risk perception paradox—implications for governance and communication of natural hazards. *Risk analysis*, 33(6), 1049-1065.
- Wang, Z., Lam, N. S., Obradovich, N., & Ye, X. (2019). Are vulnerable communities digitally left behind in social responses to natural disasters? An evidence from Hurricane Sandy with Twitter data. *Applied Geography*, 108, 1-8.
- Weyrich, P., Scolobig, A., Bresch, D.N. and Patt, A., 2018. Effects of impact-based warnings and behavioral recommendations for extreme weather events. *Weather, climate, and society*, 10(4), pp.781-796.
- Whitmarsh, L. (2008). Are flood victims more concerned about climate change than other people? The role of direct experience in risk perception and behavioural response. *Journal of risk research*, 11(3), 351-374.
- Wilson, R.S., Zwickle, A., Walpole, H. (2019) Developing a Broadly Applicable Measure of Risk Perception. *Risk Analysis* 39, 777-791.
- Winsemius, H. C., Aerts, J. C., Van Beek, L. P., Bierkens, M. F., Bouwman, A., Jongman, B., & Ward, P. J. (2016). Global drivers of future river flood risk. *Nature Climate Change*, 6(4), 381-385.
- Wisner, B. (2020). Power writ small and large: How disaster cannot be understood without reference to pushing, pulling, coercing and seducing. In : G. Bankoff and T. Hilhorst, eds, *Mapping Vulnerability*.
- Wisner, B. (2019). Wisner, B. (2019). RW Kates, Human Ecologist: The Road More Traveled and the Road Less Traveled. *Environment: Science and Policy for Sustainable Development*, 61(3), 39-44. doi: 10.1080/00139157.2019.1589313.
- Wisner, B., Berger, G. & Gaillard, JC (2016). We've seen the future, and it's very diverse: Beyond gender and disaster in West Hollywood, California, *Gender, Place & Culture*, DOI: 10.1080/0966369X.2016.1204995.
- Wisner, B. (2016). Vulnerability as concept, model, metric, and tool. In B. Gerber et al. (eds). *Oxford Research Encyclopedia of Natural Hazard Science*. New York: Oxford University Press <https://oxfordre.com/naturalhazardscience/view/10.1093/acrefore/9780199389407.001.0001/acrefore-9780199389407-e-25?mediaType=Article>
- Wisner, B. (2011). Are we there yet? Reflections on integrated disaster risk management after ten years. *IDRIM Journal*, 1(1), 1-14. DOI: 10.5595/idrim.2011.0015.
- Wisner, B., Blaikie, P., Cannon, T. and Davis, I. (2004). *At Risk : Natural hazards, people's vulnerability and disasters*. 2nd edition. London: Routledge.
- Witte, K. (1994). Fear control and danger control: A test of the extended parallel process model (EPPM). *Communications Monographs*, 61(2), 113-134.