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Individual and local flooding experience are differentially associated with subjective attribution and climate change concern

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Abstract

While several studies show an association between flooding experience and climate change engagement, a few show no evidence of such a link. Here, we explore the potential that this inconsistency relates to the measurement of flooding experience in terms of individual versus local experience, and the subsumption of multiple distinct constructs within composite indicators of climate change engagement. Using national survey data from Norway, we show that individual and local flooding experiences differentially predict subjective attribution and climate change concern. People with individual flooding experience reported significantly greater climate change concern than those with local, or no, flooding experience. Subjective attribution of flooding to climate change did not differ significantly between people with individual versus local flooding experience, except among those with a right-wing political orientation where individual experience was associated with greater subjective attribution. Our findings highlight the need for careful operationalisation of flooding experience and climate change engagement in subsequent research.

Keywords: Flooding, Climate Change, Experience, Attribution, Psychology.

1. Introduction

Flooding is the most common and wide-reaching natural hazard occurring across the globe. Between 1995 and 2015, over two billion people were adversely affected by floods (CRED 2015). The costs associated with flood damage worldwide are estimated at around US\$40 billion dollars annually (OECD 2016). While there is robust evidence that climate change affects factors, like snowmelt and precipitation, which are key contributors to flooding (Seneviratne et al. 2012), projections for climate change-induced changes in the frequency and magnitude of flooding remain uncertain (Kundzewicz et al. 2014). Nonetheless, over the past decade, there has been sustained scholarly interest in understanding how flooding experiences affect public engagement with climate change (Whitmarsh 2008; Spence et al. 2011; Demski et al. 2017). This interest is premised on the potential that exposure to flooding events may operate as a channel for experiential processing of climate change information.

Scientific information about climate change often takes the form of statistics that require cognitive effort and a degree of technical analytic competence to process. Such information is easily overshadowed by experiential information when non-experts make judgments about the risks associated with climate change (Weber 2006). In contrast to learning from statistical descriptions of climate change, learning from experience is intuitive and involves rapidly-occurring affective and associative processes (Weber 2010). The evidence for people's ability to accurately detect changes in climatic trends from experience is inconclusive (Hamilton and Keim 2009; Marlon et al. 2018), but 'weather' appears to be commonly conflated with 'climate' (Reynolds et al. 2010). Through experiential processing, negative affect triggered by extreme weather experiences may become

intuitively associated with climate change and salient memories of such experiences can contribute to heightened perceptions of climate change risk (Marx et al. 2007).

Research on the link between flooding experience and climate change engagement¹ is strongly framed by the experiential processing perspective, but empirical evidence for this link is mixed. This article explores a potential source of inconsistency in findings regarding flooding experience and climate change engagement by contrasting individual and local flooding experience. Here, individual flooding experience refers exclusively to direct experiences of personal impacts from flooding (e.g., flood-damage to personal property), while local experience refers to direct and vicarious experiences of diffuse impacts across a local area. In other words, local flooding experience includes direct experiences of flood damage to public infrastructure (such as roads and bridges), and damage to spatially-proximate private property belonging to others (such as neighbouring properties), as well as vicarious experiences of local flood damage conveyed via news and media coverage. We examined how individual and local flooding experiences are differentially associated with subjective attribution of the flooding event to climate change and climate change concern.

1.1. Flooding experience and climate change engagement: findings, inconsistencies and conceptual considerations

Flooding experience has been positively linked with climate change beliefs (Taylor et al. 2014; Albright and Crow 2019), climate change concern (Hamilton-Webb et al. 2017), perceived vulnerability to climate change (Shepard et al. 2018) and willingness to engage in climate change mitigation and adaptation behaviours (Spence et al. 2011; Demski et al. 2017). Conversely, some studies show no association between flooding experience and climate change concern (Whitmarsh 2008), climate change risk perception (Boon 2016), and climate change beliefs (Lyons et al. 2018)².

This inconsistency may be partly due to socio-political differences across population sub-groups. For example, Ogunbode et al. (2017) observed that the link between flooding experience and willingness to mitigate climate change by reducing energy use is contingent on political affiliation, with a significant relationship between the two factors only present for politically left-leaning individuals. Differences in social interpretations of flooding, especially heterogeneity in subjective attribution³ of specific flooding events to climate change, may also explain some of these inconsistent findings. Recent research indicates that flooding experiences may fail to translate to perceived threat from

¹ Climate change engagement encompasses cognitive, affective and behavioural indicators including awareness, concern and motivation to act (Lorenzoni et al. 2007).

² None of the studies showing a null or significant effect of flooding experience on climate change attitudes cited here tested an interaction between flooding experience and ideological or political orientation. Lyons et al. (2018) found that self-reported polar vortex and drought experiences significantly interacted with party affiliation in predicting climate change beliefs in the United States.

³ Subjective attribution refers to a personal understanding that an extreme weather event is causally connected to, or is a sign of, climate change (Ogunbode et al. 2019b).

climate change or intentions to enact climate change mitigation behaviours among individuals who do not subjectively attribute their experience(s) of flooding to climate change (Ogunbode et al. 2019b).

A third potential source of inconsistency may relate to the use of self-reports versus objective indicators in assessing flooding experience. Most studies that assess flooding experience using self-reported measures have found a significant relationship with climate change attitudes, whereas most studies using objective indicators, such as precipitation records and spatial data, have identified little to no association with climate change attitudes (See Howe et al. 2019 for a review). A particularly stark inconsistency is reflected in Norway, where one study reports a significant association between self-reported flooding experience and climate change concern (Lujala et al. 2014), while another indicates that exposure to extreme precipitation events at the county level negatively predicts climate change concern (Ogunbode et al. 2020).

The current study addresses a fourth, previously unexplored, potential cause of inconsistent findings which relates to the assessment of flooding experience in terms of individual versus local experience. Multiple studies measuring individual flooding experience (Demski et al. 2017), local flooding experience (Spence et al. 2011), or a combination of the two (Hamilton-Webb et al. 2017), have reported significant associations with climate change engagement. However, there are indications that individual flooding experience is less predictive of climate change engagement than local experience. Taylor et al. (2014) found that local flooding experience, but not experience of flooding in the home, was positively correlated with climate change beliefs among a representative UK sample. Similarly, Albright and Crow (2019) found that experience of flood damage at neighbourhood and community level, but not experience of flood damage to personal property, predicted climate change beliefs among flood-affected communities in the US. A proposed explanation for these findings is that local flooding experiences are more likely to be associated with climate change than individual flooding experience since the effects of climate change are usually observed and discussed at expansive scales (e.g., regional and global) rather than at household level (Albright and Crow 2019). This explanation bears a degree of plausibility, but it is also necessary to consider whether the observed distinction between individual and local flooding experience is a methodological artefact.

The two studies, to our knowledge, that report this distinction employed composite measures of 'climate change beliefs' comprising multiple different constructs, which may have varying degrees of association with the different categories of flooding experience. Taylor et al.'s (2014) index of climate change beliefs included measures of cognitive and affective climate change risk judgments, while Albright and Crow (2019) subsumed measures of climate change risk judgment and subjective attribution of flooding to climate change within their index of climate change beliefs. We focus on Albright and Crow's (2019) study because only they proposed an explanation for the purported distinction between individual and local flooding experiences that could potentially generalise beyond their study.

There is little theoretical or empirical indication that any variety of flooding experience *inherently* shapes subjective attribution (cf. Albright and Crow 2019). Attribution science has seen a remarkable growth in capabilities for quantifying the contribution of climate change to extreme weather. There are indications that the ‘fingerprint’ of climate change can now be detected from a single day of globally observed temperature and moisture (Sippel et al. 2020). Nonetheless, establishing the contribution of climate change to specific weather events is a complex task requiring advanced technical expertise and a huge amount of data. In a survey of UK residents conducted after severe nationwide flooding (Capstick et al. 2015), a larger proportion of respondents (45%) agreed with a statement indicating that it is impossible to link a single weather event with climate change than disagreed (33%). Similarly, a recent US study revealed strong scepticism among participants about the credibility of attributing the 2011-2017 California drought to anthropogenic climate change (Osaka and Bellamy 2020). These findings suggest that people widely intuit that they cannot form reliable subjective judgments of the degree to which climate change has contributed to an extreme weather event. Therefore, there is little reason to expect a difference in subjective attribution of individual versus local flooding experiences to climate change based on the information intrinsically conveyed by these experiences. To understand subjective attribution of flooding events, we need to look at how extraneous influences such as values, identity, pre-existing beliefs and the media environment shape the way people interpret their personal experiences (Hamilton et al. 2016; Shepard et al. 2018; Lyons et al. 2018; Ogunbode et al. 2019a; Al-Saqaf and Berglez 2019).

Yet, given subjective attribution to climate change, flooding experience can inform climate change risk perceptions (Ogunbode et al. 2019b). The affective component of risk perceptions (i.e., concern or worry) may be particularly influenced by the proximity or magnitude of damage inflicted on individuals by flooding experiences. A primary goal of communicating climate change in the context of extreme weather is to help people connect their concrete experiences of extreme weather impacts with the more nebulous concepts of climate change and global warming. However, the experienced impacts of extreme weather are only valuable as a motivation for acting on climate change to the degree that these impacts resonate emotionally with people. For example, people with greater capacity to cope with flooding have been found to exhibit lower levels of distress after a flooding experience, which in turn translates to lower motivation to undertake climate change mitigation actions, compared with people with less capacity to cope with flooding (Ogunbode et al. 2019a). The magnitude and proximity of flood damage to objects and places that are near and dear to people arguably relate to emotional responses and perceived coping ability, with direct personal impacts being most likely to elicit strong emotional responses. Accordingly, research shows that personal harm, but not community-level harm, from extreme weather events (tornadoes and wildfire) predict concern about climate change (Zanocco et al. 2018). Therefore, individual flooding experiences can be expected to have a greater influence on climate change concern than local flooding experiences.

1.2. The current study

This study examines how individual and local flooding experiences differentially predict subjective attribution and climate change concern. Irrespective of whether adverse impacts from flooding are experienced individually or locally, personal experience alone provides an insufficient basis for making reliable judgments about the role of climate change in discrete flooding events. Public discourse regarding flood attribution is often deeply coloured by local politics and contextual factors, including attitudes toward the performance of government agencies and representatives (Griffin et al. 2008). Political values and identity appear to be particularly powerful influences on individuals' propensity to attribute their flooding experiences to climate change, and they shape subjective attribution in the same pattern as more general beliefs about climate change. This is illustrated by UK research showing that right-leaning voters, who tend to exhibit greater levels of climate change scepticism on average, are also less likely to attribute flooding to climate change (Ogunbode et al. 2019b). Interestingly, recent research has also revealed that support for climate change policies among US conservatives strengthened with greater perceived personal harm from extreme weather events (Zanocco et al. 2019). The role of subjective attribution in this finding was not directly assessed. Nonetheless, Zanocco et al. (2019) speculate that, with increasing psychological proximity of the impacts of extreme events presumably associated with climate change, reliance on 'abstract notions' like political ideology in interpreting these events may decline in favour of reliance on concrete experiences (pg. 8). Therefore, in the current study, we also explored interactions between political orientation and individual versus local flood experiences in predicting subjective attribution and climate change concern.

There is some evidence that flood-risk perception and worry are significantly determined by perceived and actual proximity to flood hazard sources (O'Neill et al. 2016). In addition, prior experience of flooding in the home has a significant effect in predicting flood-risk perceptions and worry, over and above the effect of mere residence in a flood zone. Based on this, we anticipate that individual flooding experience uniquely predicts climate change concern compared with local flooding experience, given subjective attribution of the flooding event to climate change.

The current study is based on data obtained from a sample of the Norwegian population in early 2019. A series of flooding events were recorded across Norway in Spring and Autumn 2018 (Norwegian Water Resources and Energy Directorate 2019). Previous research in Norway shows that extreme weather experience is positively related to concern about personal consequences from climate change (Lujala et al. 2014). Paradoxically, direct individual experiences with extreme weather are also purportedly associated with a lower likelihood of perceiving climate change as a major national challenge (Lujala and Lein 2020). Motivation to mitigate climate change among Norwegians does not

appear to be significantly predicted by individual or local experiences of adverse impacts from extreme weather (Lujala and Lein 2020). The main difference observed between the two categories of extreme weather experience in Norway is that people who have experienced direct personal impacts from extreme weather are more likely to invest in weatherproofing their property against future impacts from natural hazards (Lujala and Lein 2020).

By some accounts, Norway has a comparable proportion of climate change-sceptics as Australia and the USA (Tranter and Booth 2015). There is also a comparable ideological divide on climate change in Norway, whereby politically left-leaning citizens report stronger climate change belief and support for climate policies than their politically right-leaning compatriots (Lujala and Lein 2020). Right-wing political orientation has been linked to a failure to perceive ongoing changes in local climatic conditions in Norway (Howe 2018), but there has yet to be an explicit assessment of how political orientation shapes subjective attribution of extreme weather events to climate change. These factors make Norway an appropriate geographical context for the current study.

2. Method

The data presented in this article were obtained from the Norwegian Citizen Panel (NCP). The NCP is an internet-based survey of public opinion on political and social issues in Norway. Participants (aged 18+) are randomly selected from a register of all Norwegian residents and the survey is conducted in triannual waves. This study uses data from NCP Wave 14, gathered between January and February 2019, in which 2400 participants received a question about their flooding experience (Ivarsflaten et al. 2019). Participants were asked: “Have you experienced flooding near where you live in the past year?”. The response options were “No” ($N = 1937$), “Yes, but I was not directly affected” ($N = 311$), and “Yes, I was directly affected – e.g., damage to personal property, power outages, loss of internet access” ($N = 53$). The two ‘Yes’ options were converted into dummy variables with the first ‘Yes’ option representing local flooding experience versus no flooding experience, the second ‘Yes’ option representing individual flooding experience versus no flooding experience. Two sets of analysis were conducted. The first set examined the effects of individual and local flooding experiences on climate change concern compared with having no flooding experience (Table 1: Column 1).

Participants who indicated that they had experienced flooding either individually or locally were further asked: “How likely do you think it is that climate change contributed to the flooding near where you live?” (Response: 1 = very unlikely, 7 = very likely; $M = 4.26$, $SD = 1.79$, $N = 363^4$). This item was adopted as an indicator of subjective attribution of the flooding experience to climate change. Respondents who answered ‘No’ to the flooding experience question did not receive the attribution question. To contrast the effects of the two flood experience categories on subjective

⁴ One case had missing data.

attribution and climate change concern, a dummy variable was created with individual flooding experience as the indicator and local flooding experience as the reference category.

Climate change concern was measured with one item: “How concerned are you about climate change?” (Response: 1 = not at all concerned, 5 = extremely concerned; $M = 3.29$, $SD = 1.07$, $N = 2302$). Political orientation ($M = 6.10$, $SD = 2.32$) was measured by asking participants to rate themselves on an 11-point scale with ‘0’ representing the *left-wing* and ‘10’ representing the *right-wing* end of the political spectrum. The exact wording of this question was: “*In politics people often talk about the “left wing” and the “right wing.” Below is a scale where 0 represents those who are on the far left politically, while 10 represents those who are on the far right. Where would you place yourself on such as scale?*” Demographic attributes (age, gender and education) were included as covariates in the analysis. Following previous research indicating that political attributes predict subjective attribution of flooding to climate change (Ogunbode et al. 2019b), and moderate the relationship between extreme weather experience and climate change threat perceptions (Cutler 2016), we explored interactions between political orientation and both flooding experience categories. The analysis was conducted using weighted least squares regression, with the weighting factor addressing sampling biases relating to age, gender, education and geography.

3. Results

Individual flooding experience significantly predicted climate change concern, but local flooding experience did not. This means that only individuals who had been personally affected by negative impacts from flooding reported a significantly greater level of climate change concern, on average, than those with no flooding experience (Table 1; column 1). Political orientation negatively predicted climate change concern, but it did not significantly interact with individual or local flooding experience in predicting climate change concern. Focusing on the contrast between individual and local flooding experience, we found that people who were individually affected by flooding reported significantly greater levels of climate change concern than those who only experienced flooding in their local area. This effect remained significant after controlling for subjective attribution, which suggests that the difference in climate change concern between individual and local flooding experience is not simply a function of subjective attribution. There was no significant interaction between political orientation and individual flooding experience in predicting climate change concern; meaning that people with direct personal experience of negative impacts from flooding reported higher levels of climate change concern than those with local flooding experience irrespective of their political orientation.

Individual flooding experience did not differ significantly from local flooding experience in predicting subjective attribution to climate change. Political orientation significantly predicted subjective attribution; whereby subjective attribution of flooding to climate change was negatively

associated with right-leaning political orientation. A graphical illustration of subjective attribution across the political spectrum is presented in Figure 1. There was also a significant interaction between political orientation and individual flooding experience in predicting subjective attribution. Pick-a-point analysis (Tan 2015) was used to illustrate the interaction; it shows the regression weight of predicting subjective attribution from individual – as compared to local – flooding experience (Figure 2). The interaction was probed at the 10th, 25th, 50th, 75th and 90th percentiles⁵ of political orientation scores (Figure 2). Participants with individual flooding experience reported significantly greater subjective attribution to climate change than those with local flooding experience at the 75th ($B = .74$, $SE = .32$, $p = .022$, 95% CI [.11, 1.37]) and 90th percentiles ($B = .98$, $SE = .39$, $p = .012$, 95%CI [.22, 1.74]); the right-ward end of the political spectrum. There was no significant difference in subjective attribution between respondents with individual and local flooding experience at the centre or left-ward end of the political spectrum. This means that among people with a right-leaning political orientation, individual flooding experience was more strongly linked to subjective attribution than local flooding experience.

4. Discussion

This study explores how different categories of flooding experience may be differentially associated with different aspects of climate change perceptions. Contrary to indications that individual flooding experiences (i.e. experiences with direct personal impact) are less predictive of climate change engagement than local flooding experiences (Taylor et al. 2014; Albright and Crow 2019), we observed that individual flooding experience, but not local flooding experience, produced significantly greater climate change concern within our sample, compared with no flooding experience. Further, we found that people with individual flooding experience did not differ significantly from those with local flooding experience in the subjective attribution of their flooding experience to climate change, on average, and that the difference in climate change concern across the two categories persists after controlling for subjective attribution. Among politically right-leaning individuals, subjective attribution of flooding to climate change was significantly greater for people with individual flooding experience than those with local flooding experience. These findings contradict the notion that local flooding experiences are more likely to be associated with climate change (cf. Albright and Crow 2019), and points at a need to explore alternative perspectives on the differential effects of individual and local flooding experiences on climate change engagement.

4.1. Implications

Other authors have similarly reported that personal harm, and not community-level harm, from extreme weather events (tornado and wildfire) predicts climate change concern (Zanocco et al. 2018).

⁵ The interaction was probed at percentiles of political orientation scores, as opposed to one standard deviation above and below the mean, to avoid the risk of selecting values outside the range of the data (Aiken and West 1991).

This pattern of association between extreme weather experiences and climate change concern makes the most sense from an experiential processing perspective because direct individual experiences generate stronger emotional responses (Vasileiadou and Botzen 2014), and emotional responses are an integral component of experiential processing of climate change information (Weber 2006; Marx et al. 2007). While local flooding experiences that do not encompass direct personal harm may nonetheless heighten climate change concern, they are unlikely to match, much less surpass, the visceral impact of individual flooding experiences on affective judgments of climate change risk. The importance of experiences of personal impacts from flooding on responses to climate change is further highlighted in this study by our observation that individual flooding experiences were associated with a significantly greater level of climate change concern regardless of political orientation.

People tend to conform their judgment with social or group normative standpoints in uncertain situations (Cialdini and Goldstein 2004), and may be less certain about cognitive than affective judgments (Janssen et al. 2018). In line with this view, we observed that political orientation moderated the link between individual flooding experience and subjective attribution of flooding to climate change but not the link between individual flooding experience and climate change concern. Climate change scepticism is more prevalent among people with a right-wing political orientation in Norway (Lujala et al. 2014; Krange et al. 2019). Yet, individual flooding experience was only linked to significantly greater subjective attribution than local flooding experience among people with a right-wing political orientation. This supports previous indications by Zanocco et al. (2019) that, with increasing proximity of adverse extreme weather impacts, experiential processing may supersede motivated reasoning and reduce politically-driven discounting of a plausible causal involvement of climate change in extreme weather. Further research is necessary to substantiate this finding.

4.2. Limitations

This study is limited by a lack of data to explore potential differential associations of individual and local flooding experience with cognitive (perceived impact) climate change risk judgments. Further, we were only able to employ a coarse delineation between individual and local flooding experiences that may not capture important differences in degrees of proximity of local flooding experience. For example, local experience includes direct witness of flood damage to local public infrastructure and impacts on other individuals in respondents' locale, as well as exposure to media coverage of local flooding impacts. Directly observed flooding impacts may have a greater impact on climate change perceptions than exposure to news about local flooding impacts but we were unable to explore this in the current study. Therefore, there is still a need for additional research to examine how different degrees of exposure to local flooding impacts affect climate change perceptions.

Further, it is also important to consider that our findings are only based on self-reported flooding experiences. Recent research in Norway showed that objective exposure to extreme precipitation events at the county level is inversely related to individual climate change concern (Ogunbode et al. 2020). Research involving objective indicators of extreme weather experience commonly find weak or no associations with climate change attitudes (see Howe et al. 2019 for a review). However, a recent study using objective indices of experiences of flood damage from the 2013 floods in Germany demonstrates a positive causal effect of flooding experience on climate change engagement (Osberghaus and Demski 2019). Further research is needed to determine if our current findings are replicable with objective indicators of individual and local flooding experience.

Finally, both of our outcome variables, climate change concern and subjective attribution, were assessed with single-item measures. This approach accords a benefit of ensuring clarity of measurement at the expense of disallowing an opportunity to determine measurement reliability. Consequently, our findings have to be viewed as preliminary indications on the current topic requiring further substantiation with more robust measures.

5. Conclusion

Irrespective of the limitations, our study indicates that subjective attribution and climate change concern differ in their relationship with individual and local flooding experience; whereby individual flooding experience is associated with greater climate change concern. However, individual flooding experience is not significantly different from local flooding experience in predicting subjective attribution, except among politically right-leaning individuals. Our findings provide some preliminary support for the notion that combining multiple distinct dimensions of climate change-related judgments can obfuscate the unique roles of individual and local flooding experiences as predictors of climate change engagement. Rigorous research is needed to achieve a coherent understanding of how exposure to extreme weather events shapes societal engagement with climate change. Our findings suggest that careful operationalisation of climate change-related psychological outcomes may be an important step toward minimising inconsistencies in research addressing this topic.

References

- Aiken LS, West SG (1991) Multiple regression: Testing and interpreting interactions. Sage Publications, Inc.
- Al-Saqaf W, Berglez P (2019) How do social media users link different types of extreme events to climate change? A study of Twitter during 2008–2017. *J Extrem Events* 06:1950002. doi: 10.1142/s2345737619500027
- Albright EA, Crow D (2019) Beliefs about climate change in the aftermath of extreme flooding. *Clim*

- Change 1–17. doi: 10.1007/s10584-019-02461-2
- Boon HJ (2016) Perceptions of climate change risk in four disaster-impacted rural Australian towns. *Reg Environ Chang* 16:137–149. doi: 10.1007/s10113-014-0744-3
- Capstick SB, Demski C, Sposato RG, et al (2015) Public perceptions of climate change in Britain following the winter 2013/2014 flooding
- Cialdini RB, Goldstein NJ (2004) Social influence: Compliance and conformity. *Annu Rev Psychol* 55:591–621. doi: 10.1146/annurev.psych.55.090902.142015
- CRED (2015) The human cost of natural disasters: a global perspective. Centre for Research on the Epidemiology of Disasters, Brussels
- Cutler MJ (2016) Class, ideology, and severe weather: how the interaction of social and physical factors shape climate change threat perceptions among coastal US residents. *Environ Sociol* 1042:1–11. doi: 10.1080/23251042.2016.1210842
- Demski C, Capstick SB, Pidgeon NF, et al (2017) Experience of extreme weather affects climate change mitigation and adaptation responses. *Clim Change* 140:149–164. doi: 10.1007/s10584-016-1837-4
- Griffin RJ, Yang Z, Ter Huurne E, et al (2008) After the flood: Anger, attribution, and the seeking of information. *Sci Commun* 29:285–315. doi: 10.1177/1075547007312309
- Hamilton-Webb A, Manning L, Naylor R, Conway J (2017) The relationship between risk experience and risk response: a study of farmers and climate change. *J Risk Res* 20:1379–1393. doi: 10.1080/13669877.2016.1153506
- Hamilton LC, Keim BD (2009) Regional variation in perceptions about climate change. *Int J Climatol* 29:2348–2352. doi: 10.1002/joc.1930
- Hamilton LC, Wake CP, Hartter J, et al (2016) Flood realities, perceptions and the depth of divisions on climate. *Sociology* 50:913–933. doi: 10.1177/0038038516648547
- Howe PD (2018) Perceptions of seasonal weather are linked to beliefs about global climate change: evidence from Norway. *Clim Change* 148:467–480. doi: 10.1007/s10584-018-2210-6
- Howe PD, Marlon JR, Mildenerberger M, Shield BS (2019) How will climate change shape climate opinion? *Environ Res Lett* 14:113001. doi: 10.1088/1748-9326/ab466a
- Ivarsflaten E, Dahlberg S, Løvseth E, et al (2019) Norwegian Citizen Panel Wave 14, 2019. [doi:10.18712/NSD-NSD2689-V1](https://doi.org/10.18712/NSD-NSD2689-V1)
- Janssen E, Verduyn P, Waters EA (2018) Don't know responses to cognitive and affective risk perception measures: Exploring prevalence and socio-demographic moderators. *Br J Health*

- Psychol 23:407–419. doi: 10.1111/bjhp.12296
- Krange O, Kaltenborn BP, Hultman M (2019) Cool dudes in Norway: climate change denial among conservative Norwegian men. *Environ Sociol* 5:1–11. doi: 10.1080/23251042.2018.1488516
- Kundzewicz ZW, Kanae S, Seneviratne SI, et al (2014) Flood risk and climate change: global and regional perspectives. *Hydrol Sci J* 59:1–28. doi: 10.1080/02626667.2013.857411
- Lorenzoni I, Nicholson-Cole S, Whitmarsh L (2007) Barriers perceived to engaging with climate change among the UK public and their policy implications. *Glob Environ Chang* 17:445–459. doi: 10.1016/j.gloenvcha.2007.01.004
- Lujala P, Lein H (2020) The role of personal experiences in Norwegian perceptions of climate change. *Nor Geogr Tidsskr - Nor J Geogr* 1–14. doi: 10.1080/00291951.2020.1731850
- Lujala P, Lein H, Rød JK (2014) Climate change, natural hazards, and risk perception: the role of proximity and personal experience. *Local Environ* 1–21. doi: 10.1080/13549839.2014.887666
- Lyons BA, Hasell A, Stroud NJ (2018) Enduring extremes? Polar vortex, drought, and climate change beliefs. *Environ Commun* 12:876–894. doi: 10.1080/17524032.2018.1520735
- Marlon JR, van der Linden S, Howe PD, et al (2018) Detecting local environmental change: the role of experience in shaping risk judgments about global warming. *J Risk Res* 1–15. doi: 10.1080/13669877.2018.1430051
- Marx SM, Weber EU, Orlove BS, et al (2007) Communication and mental processes: Experiential and analytic processing of uncertain climate information. *Glob Environ Chang* 17:47–58. doi: 10.1016/j.gloenvcha.2006.10.004
- Norwegian Water Resources and Energy Directorate (2019) Tørke- og flomåret 2018. <https://www.nve.no/nytt-fra-nve/nyheter-hydrologi/torke-og-flomaret-2018/>. Accessed 2 Jul 2019
- O’Neill E, Brereton F, Shahumyan H, Clinch JP (2016) The Impact of Perceived Flood Exposure on Flood-Risk Perception: The Role of Distance. *Risk Anal* 36:2158–2186. doi: 10.1111/risa.12597
- OECD (2016) *Financial Management of Flood Risk*. OECD Publishing, Paris
- Ogunbode CA, Böhm G, Capstick SB, et al (2019a) The resilience paradox: flooding experience, coping and climate change mitigation intentions. *Clim Policy* 19:703–715. doi: 10.1080/14693062.2018.1560242
- Ogunbode CA, Demski C, Capstick SB, Sposato RG (2019b) Attribution matters: Revisiting the link between extreme weather experience and climate change mitigation responses. *Glob Environ Chang* 54:31–39. doi: 10.1016/j.gloenvcha.2018.11.005

- Ogunbode CA, Doran R, Böhm G (2020) Exposure to the IPCC special report on 1.5 °C global warming is linked to perceived threat and increased concern about climate change. *Clim Change* 158:361–375. doi: 10.1007/s10584-019-02609-0
- Ogunbode CA, Liu Y, Tausch N (2017) The moderating role of political affiliation in the link between flooding experience and preparedness to reduce energy use. *Clim Change* 145:445–458. doi: 10.1007/s10584-017-2089-7
- Osaka S, Bellamy R (2020) Natural variability or climate change? Stakeholder and citizen perceptions of extreme event attribution. *Glob Environ Chang* 62:102070. doi: 10.1016/j.gloenvcha.2020.102070
- Osberghaus D, Demski C (2019) The causal effect of flood experience on climate engagement: evidence from search requests for green electricity. *Clim Change* 1–17. doi: 10.1007/s10584-019-02468-9
- Reynolds TW, Bostrom A, Read D, Morgan MG (2010) Now what do people know about global climate change? Survey studies of educated laypeople. *Risk Anal* 30:1520–38. doi: 10.1111/j.1539-6924.2010.01448.x
- Seneviratne SI, Nicholls N, Easterling D, et al (2012) Changes in climate extremes and their impacts on the natural physical environment. In: *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation*. pp 109–230
- Shepard S, Boudet H, Zanocco CM, et al (2018) Community climate change beliefs, awareness, and actions in the wake of the September 2013 flooding in Boulder County, Colorado. *J Environ Stud Sci* 8:312–325. doi: 10.1007/s13412-018-0479-4
- Sippel S, Meinshausen N, Fischer EM, et al (2020) Climate change now detectable from any single day of weather at global scale. *Nat. Clim. Chang.* 10:35–41
- Spence A, Poortinga W, Butler C, Pidgeon NF (2011) Perceptions of climate change and willingness to save energy related to flood experience. *Nat Clim Chang* 1:46–49. doi: 10.1038/nclimate1059
- Tan JC (2015) probemod: Statistical Tools for Probing Moderation Effects. R package version 0.2.1.
- Taylor A, de Bruin WB, Dessai S (2014) Climate change beliefs and perceptions of weather-related changes in the United Kingdom. *Risk Anal* 34:1995–2004. doi: 10.1111/risa.12234
- Tranter B, Booth K (2015) Scepticism in a changing climate: A cross-national study. *Glob Environ Chang* 33:154–164. doi: 10.1016/j.gloenvcha.2015.05.003
- Vasileiadou E, Botzen WJ (2014) Communicating adaptation with emotions: the role of intense experiences in raising concern about extreme weather. *Ecol Soc* 19:36. doi: <http://dx.doi.org/10.5751/ES-06474-190236>

- Weber EU (2006) Experience-based and description-based perceptions of long-term risk: why global warming does not scare us (yet). *Clim Change* 77:103–120. doi: 10.1007/s10584-006-9060-3
- Weber EU (2010) What shapes perceptions of climate change? *Wiley Interdiscip. Rev. Clim. Chang.* 1:332–342
- 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. *J Risk Res* 11:351–374. doi: 10.1080/13669870701552235
- Zanocco C, Boudet H, Nilson R, et al (2018) Place, proximity, and perceived harm: extreme weather events and views about climate change. *Clim Change* 149:349–365. doi: 10.1007/s10584-018-2251-x
- Zanocco C, Boudet H, Nilson R, Flora J (2019) Personal harm and support for climate change mitigation policies: Evidence from 10 U.S. communities impacted by extreme weather. *Glob Environ Chang* 59:101984. doi: 10.1016/J.GLOENVCHA.2019.101984

Table 1. Climate change concern and subjective attribution regressed on flooding experience

	Flooding experience vs No flooding experience		Individual vs Local flooding experience	
	Concern	Concern	Concern	Subjective attribution
	B(SE)			
Individual flooding experience	.46 (.13)***	.46 (.16)**	.36 (.13)**	.29 (.27)
Local flooding experience	-.03 (.06)			
Subjective attribution			.34 (.03)***	
Political orientation (Right-wing high)	-.14 (.01)***	-.13 (.03)***	-.06 (.02)**	-.19 (.05)***
Political orientation*Individual fld. exp.	.01 (.05)	.01 (.06)	-.07 (.05)	.24 (.10)*
Political orientation*Local fld. exp.	.01 (.03)			
Age	.04 (.01)**	.04 (.04)	.03 (.03)	.01 (.06)
Gender (Female)	.34 (.04)***	.64 (.11)***	.42 (.10)***	.67 (.19)***
Education	.10 (.01)***	.09 (.02)***	.06 (.02)**	.11 (.04)**
R^2	.23	.25	.48	.13
F	82.49***	17.09***	41.11***	7.63***
N	2286	319	319	319

* $p < .05$, ** $p < .01$, *** $p < .001$.

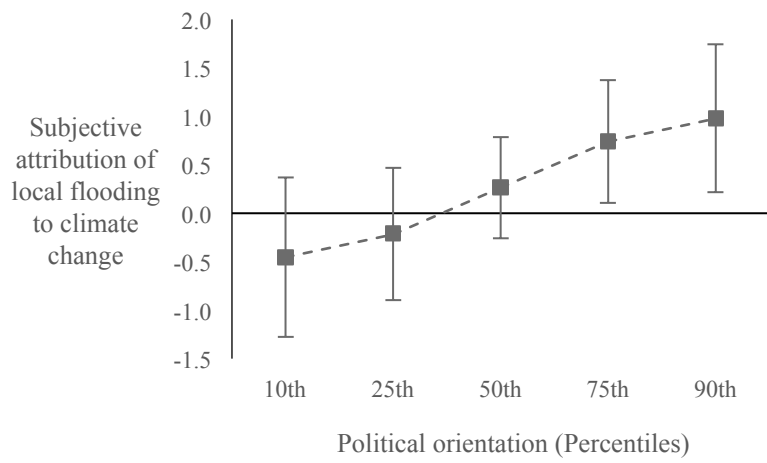


Figure 1. Conditional effects of individual flooding experience on subjective attribution of local flooding to climate change.