Public perceptions of local flood risk and the role of climate change

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Abstract

The IPCC reports that climate change will pose increased risks of heatwaves and flooding. Although survey-based studies have examined links between public perceptions of hot weather and climate change beliefs, relatively little is known about people's perceptions of changes in flood risks, the extent to which climate change is perceived to contribute to changes in flood risks, or how such perceptions vary by political affiliation. We discuss findings from a survey of long-time residents of Pittsburgh, Pennsylvania, USA, a region that has experienced regular flooding. Our participants perceived local flood risks as having increased and expected further increase in the future; expected higher future flood risks if they believed more in the contribution of climate change; interpreted projections of future increases in flooding as evidence for climate change; and perceived similar increases in flood risks independent of their political affiliation despite disagreeing about climate change. Overall, these findings suggest that communications about climate change adaptation will be more effective if they focus more on protection against local flood risks, especially when targeting audiences of potential climate sceptics.

Keywords

Flood risk perceptions   Climate change beliefs   Public perception surveys

1 Introduction

1.1 Climate change concerns and local flood risks

In its recent report, Working Group 1 of the IPCC Fifth Assessment notes that global mean surface temperature (GMST) “warmed strongly over the period 1900–1940, followed by a period with little trend, and strong warming since the mid-1970s” and that “more than half of the observed increase in GMST from 1951 to 2010 is very likely due to the observed anthropogenic increase in greenhouse gas concentrations” (Stocker et al. 2013). Recent publications also considered changes in the frequency and intensity of other extreme weather events such as heavy rainfall and flooding (Kunkel et al. 2013; Peterson et al. 2012), and evaluated the extent to which past weather changes may be attributed to human influence (Kunkel et al. 2013; Peterson et al. 2012; Stocker et al. 2013).

Despite these efforts by climate experts to identify the role of climate change in past and future weather changes, climate change remains a psychologically distant concept to many nonexperts, due to its effects manifesting in the future rather than in the present (temporal distance) and globally rather than locally (geographic distance) (Spence et al. 2012; Weber and Stern 2011). Nevertheless, many nonexperts seem to equate “climate” and “weather,” suggesting that perceived local weather changes may make the concept of climate change more concrete (Bostrom et al. 1994; Read et al. 1994; Reynolds et al. 2010). Indeed, public perception studies in different countries have demonstrated that people’s concerns about climate change are stronger when actual or perceived local temperatures are unusually high (Deryugina 2013; Donner and McDaniels 2013; Egan and Mullin 2012; Hamilton and Stampone 2013; Krosnick et al. 2006; Ratter et al. 2012). People also report stronger beliefs in climate change when they are surveyed on an unseasonably hot day (Krosnick et al. 2006; Ratter et al. 2012) or in a hot room (Li et al. 2011).

Although most US research on the link between perceptions of climate change and weather has focused on local temperature perceptions, there is initial evidence from the UK that local flood risk perceptions may also play a role in forming climate change beliefs. A recent study reported that UK residents’ climate change beliefs are associated with their perceptions of lifetime changes in increased rainfall and flooding—more so than with their perceptions of lifetime changes in hot temperatures (Taylor et al. 2014). Perhaps due to increased flooding in the UK, public concerns about climate change are associated with flood experience (Spence et al. 2011), even though previous work in the UK did not find that relationship (Whitmarsh 2008). Evidence from the USA shows that residents of areas with higher local flood risk are more concerned about climate change, suggesting that perceptions of heightened local flood risk would also inform Americans’ climate change concerns (Brody et al. 2008).

1.2 Climate change concerns and core political values

One common finding is that climate change beliefs tend to vary by political affiliation. In the USA, Democrats tend to be more concerned about climate change than non-Democrats—including both Republicans and Independents (Guber 2013). The political controversy about climate change is boosted by the media (Boykoff 2008; Corbett and Durfee 2004). However, extreme weather experiences may potentially narrow the political gap in climate change beliefs, due to making climate change more concrete. Individuals who are relatively uncertain about their climate change beliefs tend to become more convinced after recent temperature increases (Donner and McDaniels 2013; Hamilton and Stampone 2013; Krosnick et al. 2006). Such findings are in line with the psychological “construal level” theory, which posits that psychologically distant concepts (such as climate change) are more likely than psychologically closer concepts (such as weather change) to be judged on the basis of core values (reflected in political affiliation) (Locke and Latham 1990).

Although it has been well established that political affiliation is associated with concerns about climate change (Guber 2013), relatively little is still known about how political affiliation relates to perceptions of local weather changes. We focus on public perceptions of changes in local flood risk, because floods are emotionally salient (Siegrist and Gutscher 2008) and heighten flood risk awareness (Bradford et al. 2012; Burningham et al. 2007). As a result, individuals who live in areas with regular flooding should find less room for political disagreement about changes in local flood risks than about the abstract construct of climate change.

Here, we present the findings of an initial study that aims to understand perceptions of changes in flood risks (i.e., from the past and into the future) and associations with beliefs about climate change. In a survey of long-time residents of an area that has seen regular flooding, we examined:

1. 1.

   Are flood risks perceived as increasing?

2. 2.

   Are perceptions of changes in flood risks associated with perceiving a larger role of climate change?

3. 3.

   Is the role of climate change perceived to be larger in increasing flood trend predictions than in stable or decreasing flood trend predictions?

4. 4.

Do individuals varying in political affiliation agree about changes in flood risks despite disagreeing about climate change?

2 Methods

2.1 Participants

In November–December 2012, we conducted a survey with a diverse community sample of 200 people who had lived in the greater Pittsburgh metropolitan area for at least the past 15 years.[1] In 6 of the previous 15 years, the Ohio river reached the flood stage at Point State Park in downtown Pittsburgh (1998, 2003, 2004, 2005, 2010, and 2011), with the most major flood occurring in 2004 (National Oceanic and Atmospheric Administration's Weather Service 2014). The Pittsburgh flood of 2004 "captured most of the headlines in the final few months of the year, with the devastation [being] difficult to ignore" (Pittsburgh Post Gazette 2004). Although all participants had lived for at least 15 years in an area that experienced regular flooding, not all had been directly affected. In our sample, 27.2 % had personally experienced flooding, with an additional 33.3 % reporting "someone close to me" with flood experience.

The average age of our participants was 45.3 (SD = 18.5) with 58.9 % being female and 32.5 % being nonwhite, 49.7 % having a college degree, and 63.3 % reporting their political affiliation as Democrat (i.e., relatively progressive). By comparison, population statistics show that Pittsburgh residents have an average age of 45.5,[2] with 51.6 % being female, 34.0 % being nonwhite, 35.0 % having a college degree, and 60.9 % of the county's registered voters being registered as Democrat (Pennsylvania Department of State 2014; US Census Bureau 2014). One-sample *t* tests that compared each sample demographic variable with the relevant population statistic found no significant differences between our sample and the Pittsburgh population, except that our sample was more likely to have a college degree, $t(194) = 4.11$, $p < .001$). Participants with (vs. without) a college degree showed no significant differences in the focal variables of perceived changes of flood risk, climate change concerns, flood experience, or political affiliation ($p >= .05$).[3] Yet, we control for demographic variables in our concluding regression analysis (see 3.4).

2.2 Procedures and measures

We aimed to recruit a diverse community sample through advertisements that were posted at a wide range of local community organizations, as well as online advertisements targeting the greater Pittsburgh metropolitan area. Individuals were eligible if they were of age 18 or older, and had been living in or around Pittsburgh for at least 15 consecutive years. Paper-and-pencil surveys were administered in survey sessions at the community organizations through which participants were recruited. Individuals who signed up through the online advertisements came to survey sessions led by the second author at the university campus. Participants completed the survey individually and at their own pace. The first section of the survey asked about the perceived risks and causes of "floods" (henceforth: "typical floods") and the second section of the survey repeated these questions for "extreme floods" (see 2.2.1 and 2.2.2).[4] The third section asked participants to interpret projected flood trends (see 2.2.3).

2.2.1 Perceived changes in flood risks

Questions asked about perceived flood risks, for both typical and extreme floods, for three specific years focusing in the present, the past and the future: (a) "It is now 2012. How likely do you think it is that there will be at least one [extreme] flood in the Pittsburgh area in the year 2013?"; (b) "Imagine that it is now 2062, which is 50 years from now. How likely do you think it is that there will be at least one [extreme] flood in the Pittsburgh area in the year 2063?"; (c) "Imagine that it is now 1962, which was 50 years ago. How likely do you think it is that there will be at least one [extreme] flood in the Pittsburgh area in the year 1963?"[5] Doing so allowed us to compute perceived changes in flood risks as compared to the past (by subtracting reported flood risks for 1963 from reported flood risks for 2013) and expected changes into the future (by subtracting reported flood risks for 2013 from reported flood risks for 2063)—which should show increases if participants are concerned about the role of climate change in flooding.[6]

Each flood risk perception question was presented with a probability response scale that ranged from 0 % (=no chance) to 100 % (=certainty), following established national surveys such as the Health and Retirement Study and the National Longitudinal Study of Youth (for a review, see Hurd 2009). Indeed, findings from these national surveys demonstrate that participants can report valid probabilities for a wide range of events (Bruine de Bruin et al. 2007; Hurd and McGarry 2002). The validity of risk perceptions reported on a 0–100 % probability scale is no different from the validity of risk perceptions reported on a 1–7 rating scale, but it facilitates comparisons to actual risks (Weinstein and Diefenbach 1997).

2.2.2 Perceived role of climate change

Participants were also asked to "rate how much you think each of the following helps to explain the chances of [extreme] floods happening in the Pittsburgh area." For typical and extreme floods, participants rated 18 potential causes, including climate change, which were generated in pilot interviews with 15 long-time Pittsburgh area residents. Each of the 18 potential causes was followed by "and that helps to explain the chances of [extreme] floods" and rated on a response scale ranging from 1 (=contributes nothing to flooding) to 7 (contributes a lot to flooding). Examples of potential causes were as follows: "there are poorly maintained dams in the Pittsburgh area," and "there are storms with heavy rains or snow in the Pittsburgh area." Those were included to reduce perceived pressures to indicate a role of climate change. Our analyses focus on participants' ratings of "climate change (global warming) affects the Pittsburgh area."

2.2.3 Perceptions of the role of climate change in increasing, decreasing, and stable flood trend predictions

In the third part of the survey, participants received a set of three graphs (Fig. 1) that showed flood trend predictions that were relatively stable (Prediction A), increasing (Prediction B), and decreasing (Prediction C). The set was presented on the same page. Each graph showed water levels that periodically crossed a line referred to as the "historic flood stage" with instructions indicating that "a period of flooding is when the water level is above the flood stage." We also noted that some variability is to be expected because "most rivers have high water levels in the spring and low levels in the summer."

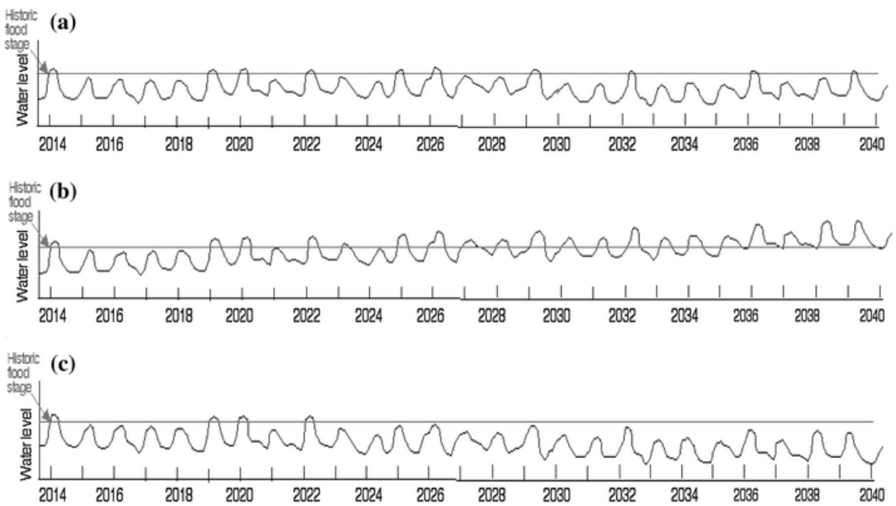

Fig. 1

Presented graphs of (**a**) stable, (**b**) increasing, and (**c**) decreasing flood trend predictions over the next 28 years

To encourage participants to carefully examine the graphs, we asked them to count the number of periods of flooding, seen in the number of times the predicted water level crossed the historic flood stage. More importantly, we also assessed whether participants were able to recognize the direction of the flood trend prediction in each graph—as staying the same, going up, or going down.[7]

After seeing each graph again, participants rated their agreement with the contribution of potential flood causes on a scale from 1 (=completely disagree) to 7 (=completely agree). Our analyses focus on the one item that noted "[this] happened because climate change (global warming) affects the Pittsburgh area." Two additional items noted: "[this] happened because climate change causes less rain than in the past" and "[this] happened because climate change causes more intense rainstorms than in the past."

3 Results

3.1 Are flood risks perceived as increasing?

We conducted a repeated-measures analysis of variance (ANOVA) to test for increases in reported flood risks for different periods of time (1963 vs. 2013 vs. 2063) and by flood type (typical vs. extreme). Figure 2 shows that, for the three time periods, the mean reported flood risks were, respectively, .59 (SD = .45), .63 (SD = .45), and .69 (SD = .43) for typical flood risks, and .44 (SD = .45), .46 (SD = .46), and .52 (SD = .46) for extreme floods. We found that there was a significant main effect of time across both flood types, $F(2, 356) = 5.56$, $p < .01$, with a linear contrast indicating that, across both flood types, participants on average perceived flood risks to have increased over time, $F(1, 178) = 8.44$, $p < .01$. Additionally, a significant main effect for flood type, $F(1, 176) = 40.86$, $p < .001$, showed that typical floods were perceived as more likely than extreme floods. There was no significant interaction between flood type and time, suggesting a similar increasing pattern over time for typical and extreme floods ($p > .05$). Subsequent analyses focus on perceived changes in flood risk as compared to the past and expectations for flood risks into the future. As noted, we computed difference scores to reflect past perceptions (flood risk 2013–flood risk 1963) and future expectations (flood risk 2063–2013).

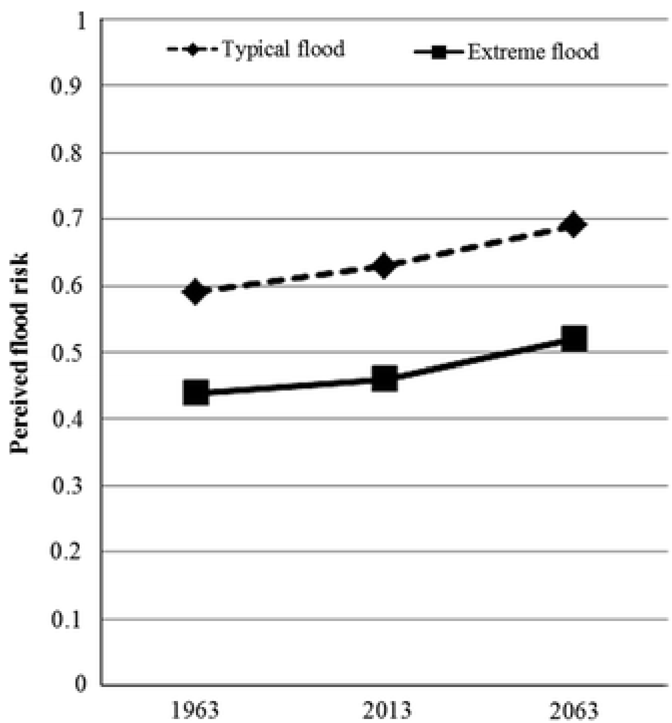

Fig. 2

Perceived flood risks

3.2 Are perceptions of changes in flood risks associated with perceiving a larger role of climate change?

On average, participants' mean ratings of the role of climate change were similar for typical floods and extreme floods ($M = 4.44$, SD = 1.91 vs. $M = 4.45$, SD = 1.98; $t(195) = -.13$, $p > .05$). For typical floods, climate change ratings were significantly correlated with perceived changes from 1963 to 2013 ($r = .15$, $p = .04$) and expected changes from 2013 to 2063 ($r = .25$, $p < .001$). For extreme floods, we found a similar pattern, with climate change ratings being significantly related to expected changes from 2013 to 2063 ($r = .17$, $p = .02$), although significance was not reached for perceived changes from 1963 to 2013 ($r = .11$, $p = .14$).

3.3 Is the role of climate change perceived to be larger in increasing flood trend predictions than in stable or decreasing flood trend predictions?

A repeated-measures ANOVA indicated that climate change was perceived to have a larger role in the increasing (vs. decreasing or stable) flood trend predictions.[8] We found a significant difference in the main comparison of participants' rated agreement with the role of climate change in flood trend predictions that were increasing ($M = 4.80$, SD = 1.84), decreasing ($M = 3.91$, SD = 1.74), and stable ($M = 3.59$, SD = 1.89), $F(2, 386) = 43.34$, $p < .001$. Sidak-corrected post hoc paired comparisons showed that climate change was perceived to play a significantly larger role in the increasing than in the decreasing flood trend predictions ($p < .001$) or in the stable flood trend predictions ($p < .001$).

3.4 Do individuals varying in political affiliation agree about changes in flood risks despite disagreeing about climate change?

As seen in Table 1, Democrats and non-Democrats tended to perceive similar changes in flood risks, even though Democrats did systematically report stronger beliefs about the role of climate change in flooding. As seen in Table 2, the disagreement between Democrats and non-Democrats about the role of climate change in typical and extreme flood risks held even after controlling for other demographic variables and flood experience.

Table 1

Mean (SD) perceptions of flood risks and climate change

Perceptions of change	Democrat	Non-Democrat	Independent-sample *t* test
Mean (SD) perceptions of changes in flood risks			
2013–1963 typical flood	+6.7 % (43.6)	+2.0 % (38.4)	n.s.
2063–2013 typical flood	+2.9 % (44.7)	+10.5 % (39.8)	n.s.
2013–1963 extreme flood	+0.0 % (38.1)	+6.0 % (53.9)	n.s.
2063–2013 extreme flood	+4.1 % (41.6)	+14.1 % (41.5)	n.s.
Mean (SD) perceptions of climate change			
In typical flood risks	4.78 (1.73)	3.83 (2.04)	3.47***
In extreme flood risks	4.86 (1.79)	3.75 (2.11)	3.91***
In stable flood trend prediction	3.92 (1.93)	3.07 (1.70)	3.09**
In increasing flood trend prediction	5.11 (1.68)	4.28 (1.99)	3.07**
In decreasing flood trend prediction	4.15 (1.65)	3.53 (1.82)	2.46*

Perceptions of flood risks were reported on a 0–100 % scale and perceptions of climate change on a 1–7 scale

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

Table 2

Linear regressions predicting perceptions of the role climate change in flooding

	Climate change in typical floods	**Climate change in extreme floods**	**Climate change in stable flood trend prediction**	**Climate change in increasing flood trend prediction**	**Climate change in decreasing flood trend prediction**
Democrat	.23***	.23***	.18**	.21**	.16*
Perceived flood risk change 1963–2013	.16*	.06	–	–	–
Expected flood risk change 2013–2063	.31***	.17*	–	–	–
Personal flood experience	.04	.06	−.03	.04	.03
Female	.24***	.28***	.18*	.07	.03
Nonwhite	.14*	.11	.15*	.15*	.17*
Age	−.16*	−.08	−.03	−.26***	−.16*
College	.10	.27**	−.10	.07	−.09
R^2	.27	.24	.13	.16	.10
Model statistic	$F(6, 181) = 6.51$***	$F(6, 171) = 7.43$***	$F(6, 185) = 4.54$***	$F(6, 184) = 5.64$***	$F(6, 184) = 3.33$**

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

In the models predicting ratings of climate change in typical and extreme floods, we also controlled for perceived changes in flood risk from 1963 to 2013 and expected changes in flood risk from 2013 to 2063, each of which showed a significant relationship. A bootstrapping mediation test (Preacher and Hayes 2008) showed that the relationship of political affiliation with climate change beliefs was not significantly changed by adding flood risk perceptions and expectations to the model (from .21 to .23 for typical floods; from .20 to .23 for extreme floods), likely because political affiliation was not significantly correlated with flood risk perceptions. Hence, climate change concerns were independently predicted by political affiliation and by flood risk perceptions and expectations.

4 Discussion

We reported on a survey conducted with long-time residents of Pittsburgh, Pennsylvania, USA, in which floods had occurred 6 out of the previous 15 years with the most major flood occurring in 2004 (National Oceanic and Atmospheric Administration's Weather Service 2014; Pittsburgh Post Gazette 2004). We found that our participants perceived flood risks to have been increasing over time and expected that trend to continue into the future. Those who perceived a stronger role of climate change in flooding perceived larger flood risk changes from the past and into the future. Similarly, when being presented with flood trend projections, participants were more likely to interpret projected future increases (vs. decreases or stable trends) in the frequency of flooding as evidence for climate change. Overall, our findings appear in agreement with a comparison of two studies conducted in 1992 and 2009, which suggested that Americans have become more likely to believe that climate change will cause extreme flooding in the future (Reynolds et al. 2010).

Additionally, we found that self-identified Democrats and non-Democrats perceived similar changes in flood risks despite disagreeing about climate change. Personal flood experience did not alter that pattern, possibly because local flooding is hard to ignore even if one's own home remains unaffected. These findings suggest that individuals with different political affiliations are less likely to disagree about changes in concrete weather events than about the abstract construct of climate change—which leaves more room for political interpretation.

Moreover, our findings suggest that climate change concerns in the context of local flooding may be affected independently by participants' core values (e.g., political affiliation) and more concrete observations (e.g., changes in flood risk). Hence, climate change beliefs seem to be independently formed at abstract and concrete levels varying in psychological distance (Locke and Latham 1990). Thus, even if non-Democrats tend to be less concerned about climate change, prolonged exposure to increasing flood risk may nevertheless raise their concerns. Possibly, similar mechanisms could explain why individuals who are relatively uncertain about climate change tend to become more convinced during unseasonably hot weather (Donner and McDaniels 2013; Hamilton and Stampone 2013; Krosnick et al. 2006).

Like any study, ours has limitations. First, we conducted our survey with a convenience sample in Pittsburgh PA, which may not be representative of other populations at risk for flooding. Pittsburgh PA had seen its last large flood in 2004, which may have made floods less salient. Even among water managers, recent experience with adverse weather events has been associated heightened feelings of risk and increased attention for climate forecasts (O'Connor et al. 2005). Perceptions of flood risk may be reduced when the most recent flood is more than 5 years or so in the past (Marx et al. 2007; O'Connor et al. 2005). Possibly, associations between flood risk and climate change concerns may be stronger when local floods are more recent (Spence et al. 2011).

A second limitation is that all of our questions were presented to all participants in the same order. Hence, it is possible that our focus on local flood risk may have made climate change seem more concrete and less personally distant than it otherwise would have been (Keller et al. 2006). Associations between perceived changes in flood risk and climate change concerns may have been less strong if climate change concerns had been elicited before mentioning local floods.

Nevertheless, our findings suggest that, in our Pittsburgh sample, political core values are unrelated to local flood risk perceptions even if they do seem to inform climate change concerns. These findings have potential implications for communications about flood risk preparedness, at least in the Pittsburgh area. Whether or not flood risks are deemed to be increasing as a result of climate change, recommended flood preparedness behaviors include getting flood insurance, avoiding building on floodplains, elevating the furnace, water heater and electric panel in one's home, installing "check valves" to prevent flood water from backing up into drains, constructing barriers to stop floodwater from entering the building, and applying external or internal sealants to basement walls (see http://www.ready.gov/floods (http://www.ready.gov/floods)). Yet, if politically conservative audiences are indeed less likely to believe that the increasing flood risks they perceive are due to climate change, it is possible that mentioning climate change in flood preparedness communications will turn them off. As a result, references to climate change in flood preparedness communications may reduce the willingness of climate sceptics to protect themselves against the increasing flood risks they do perceive.

Hence, we suspect that willingness to implement flood preparedness behaviors may be higher across political groups if the term "climate change" is omitted from flood preparedness communications. Omitting references to "climate change" may be ethically defensible if it increases the likelihood that individuals from across the political spectrum will implement flood preparedness behaviors and reduce their personal flood risks. Moreover, focusing communications on flood risk rather than climate change alleviates concerns about inadvertently overstating the degree to which flood risks in a specific locality can defensibly be attributed to climate change. Indeed, the challenge remains that complex statistical analyses are needed to assess the degree to which anthropogenic greenhouse gas emissions are contributing to the occurrence of some extreme events in specific locations (Kunkel et al. 2013; Peterson et al. 2012; Stocker et al. 2013).

Our paper focused on an area exposed to flood risks, with potential implications for communications to promote flood risk preparedness. In other locations, warmer winters, droughts, or other extreme weather events may be more of a concern. Public perception surveys, such as the one reported here, can provide useful insights about the communication needs of these different audiences (Bruine de Bruin and Bostrom 2013; Morgan et al. 2002). Indeed, effective communications build on scientific knowledge from climate experts and from social scientists so as to help recipients to make informed decisions about how to prepare for local weather-related risks.

Footnotes

1. 1.

   A total of 23 of these 200 (11.5 %) had missing values on at least one of the questions analyzed here. Missing values therefore differ across analyses. The 23 incomplete responders showed no significant differences from the 177 complete responders in terms of demographic characteristics, flood experience, or political affiliation ($p > .05$).

2. 2.

   We computed average population age from the age categories reported in the 2000 Pittsburgh Census data (downloaded from http://www.city-data.com/us-cities/The-Northeast/Pittsburgh-Population-Profile.html (http://www.city-data.com/us-cities/The-Northeast/Pittsburgh-Population-Profile.html)). Specifically, we multiplied the proportion of individuals in each age category by the mid-point of that age category and then computed the overall sum.

3. 3.

   One of our nine focal measures (i.e., those listed in Table 1) showed a marginal difference, suggesting that participants with a college education were marginally less likely to interpret the stable flood trend prediction as resulting from climate change ($M = 3.33$, SD = 1.77 vs. M = 3.86, SD = 1.97), $t(191) = 1.98$, $p = .05$.

4. 4.

   Floods were defined as involving “water covering some normally useful dry land, where there are several houses or other buildings; water that is more than one foot deep; and water that stays around for a day or more.” Extreme floods were defined as “water covering some useful normally dry land, where there are several houses or other buildings; water that is more than 1 foot deep; and water that stays around days or even weeks.” We followed with a description of the Western Pennsylvania Flood of 2004, which, in pilot interviews, appeared to be well remembered by Pittsburgh residents: “On September 9, 2004, at the tail end of hurricane season, the Pittsburgh region had record-breaking rainfall of 3.6 inches with 5.95 inches falling 9 days later. On September 19, 2004, the rivers crested at 31 feet, 6 feet over flood levels. Extreme flooding and mud slides damaged or destroyed numerous bridges and closed hundreds of roads. Thousands of homes and businesses in Allegheny County and the surrounding counties of Armstrong, Beaver, Butler, Indiana, Washington, and Westmoreland were severely damaged or destroyed by this extreme flooding."

5. 5.

We started by asking about the present, because it is a natural reference point against which to compare changes from the past and into the future. People are willing and able to report probabilities for future events (Bruine de Bruin et al. 2007; Hurd and McGarry 2002). People are also willing and able to report perceived probabilities for past events, although in hindsight they may be overconfident about how much they knew about the likelihood of events happening (Fischhoff 1975). Yet, our sample showed no significant correlation of older age with reported flood risks for 1963 ($r = .05$, $p > .05$ for typical floods; $r = .00$, $p > .05$ for extreme floods). Nor were perceived changes in flood risk from 1963 to 2013 correlated with age ($r = -.04$, $p > .05$ for typical floods; $r = -.03$, $p > .05$ for extreme floods).

6. 6.

We also asked participants direct questions about perceived changes in flood risks, in terms of whether typical and extreme floods would be 'more likely,' 'less likely,' or 'about as likely' in the year 2063 as compared to 2013, and in the year 1963 as compared to 2013. We found significant Spearman rank correlations between these direct responses and the differences between reported flood risks (ranging from .31 to .44, all $p<.001$).

7. 7.

Because the three graphs were initially presented together, we did not counterbalance the order in which graphs were subsequently presented again. Our goal was to examine the perceived role of climate change in the presented flood projections, and not to test whether people could accurately identify the presented trends. Yet, we did assess participants' ability to recognize the trends in the presented flood trend predications and found that the graph of the stable flood trend (Fig. 1a) was correctly identified by 67.2 % as stable, graph of the increasing flood trend prediction (Fig. 1b) was correctly identified by 89.0 % as increasing, the graph of the decreasing flood trend (Fig. 1c) was correctly identified by 82.5 % as decreasing. Limiting analyses to those participants who correctly perceived all three trends had no effect on the reported findings regarding the perceived role of climate change.

8. 8.

As might be expected, the specific role of climate change differed by the type of flood trend prediction. A separate ANOVA on agreement with the statements of specific consequences of climate change (more vs. less rain) by flood trend predictions (increasing vs. stable vs. decreasing), $F(1, 182) = 77.02$, $p < .001$ found that the perceived contribution of more rain due to climate change was highest for the increasing flood trend prediction, showing a linear decline over the three type of flood trend predictions ($M = 5.08$, SD = 1.70 vs. $M = 3.65$, SD = 1.87 vs. $M = 2.74$, SD = 1.68) with the opposite linearly decreasing pattern being found for the perceived contribution of less rain due to climate change ($M = 2.39$, SD = 1.57 vs. $M = 3.05$, SD = 1.72 vs. $M = 4.35$, SD = 1.85). Again, Democrats showed systematically stronger climate change beliefs than did non-Democrats across these questions, $F(1, 182) = 9.63$, $p < .01$, with no additional main effects or interactions for flood experience (yes vs. no) or type of climate change beliefs (more vs. less rain).

Notes

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