Journal of Environmental Studies and Sciences (2020) 10:242–254
https://doi.org/10.1007/s13412-020-00617-6

ORIGINAL ARTICLE

Public risk perception of climate change in Egypt: a mixed methods study of predictors and implications

Hayam Elshirbiny[1] · Wokje Abrahamse[1]

Published online: 20 May 2020

Abstract

Understanding public risk perception of climate change is vital in informing policy and developing effective risk communication strategies. There is a lack of research on public risk perception of climate change in developing countries. Yet, these countries are among the most susceptible to the impacts of climatic changes. The current research provides a novel contribution to the literature by using mixed methods (an online survey and semi-structured interviews) to examine climate change risk perceptions in a sample of the Egyptian public. Findings show that the Climate Change Risk Perception Model (CCRPM) explained 19.2% of the variance in risk perception. Experiential factors (affect and personal experience) were the strongest predictors of climate change risk perception, while socio-cultural factors (value orientations) were the weakest predictors. Interviews highlighted that negative feelings featured prominently when people spoke about personal experiences with the impacts of climate change, in particular experience with flash floods. Results also showed that while participants were concerned about climate change, they appeared to have misconceptions about its causes. These quantitative and qualitative results offer important recommendations for policy and for climate science communication.

Keywords Climate change · Risk perception · Public opinion · Egypt · Risk communication

Introduction

Risk perception refers to people's beliefs, attitudes, judgments and feelings towards hazards, which threaten things people value (Pidgeon 1998). Risk perception research examines how people perceive hazards and the factors influencing these perceptions. These insights can help understand and predict the public's response to new hazards and help decision makers develop more effective policies (Slovic et al. 1982).

People have a tendency to underestimate environmental risks (Gifford et al. 2009; Pahl et al. 2005). Climate change is usually perceived as a temporally, socially and geographically distant risk that happens in the future to other people in faraway places (Brügger et al. 2015; Leviston et al. 2014; Lorenzoni et al. 2007; Markowitz and Shariff 2012; McDonald 2016; Spence et al. 2012). Climate change is also a unique and complex environmental hazard because of its magnitude: its effects are felt on a global scale and its timeline spans several centuries (van der Linden 2015; Weber 2016).

The vast majority of studies exploring public risk perceptions of climate change have been conducted in North America and Europe. In a recent review of studies on public perceptions of climate change, Nielsen and D'haen (2014) point out that all populated regions of the world were well-represented in these studies, except for North Africa. This presents a clear need to study climate change risk perceptions in developing nations, in particular because IPCC findings indicate that these countries will likely be impacted the hardest by the effects of climate change (IPCC 2014a). To fill this gap, this study used a mixed-methods approach to examine public risk perceptions of climate change in one such nation: Egypt. In doing so, it complements and extends existing research on public risk perceptions of climate change in the context of a developing region.

Public risk perception of climate change

Researchers have used different theoretical frameworks to examine factors associated with risk perception of climate

✉ Hayam Elshirbiny
hayam.elshirbiny@gmail.com

Wokje Abrahamse
wokje.abrahamse@vuw.ac.nz

[1] School of Geography, Environment and Earth Sciences, Victoria University of Wellington, Wellington, New Zealand

change. The Climate Change Risk Perception Model (CCRPM) is a model recently proposed by van der Linden (2015) and is based on a comprehensive review of the literature. The CCRPM suggests that climate change risk perception is a function of cognitive factors (i.e. knowledge about climate change), experiential factors (i.e. affect and personal experience with extreme weather events), socio-cultural factors (i.e. social norms and values) and demographic factors (i.e. age, gender, income and education level). Other studies have shown that there are additional factors influencing risk perception of climate change such as cultural worldviews (Akerlof et al. 2013), political ideology (Kellstedt et al. 2008) and confidence in science (Milfont 2012). However, the CCRPM was tested empirically on a nationally representative sample of the British population and was able to explain nearly 70% of the variance in climate change risk perception which is the highest percentage of explained variance in the literature (van der Linden 2015). Hence, the CCRPM was employed and tested in the current research but was adapted to the Egyptian context. Figure 1 shows the CCRPM adapted from van der Linden (2015) and employed in the current research.

Socio-demographic factors

Studies have consistently shown that women express more concern than do men when it comes to environmental issues, including climate change (Blocker and Eckberg 1997; Bord and O'Connor 1997; Davidson and Freudenburg 1996; Mohai 1997). Studies in Sweden, Germany, Norway and the US have shown that gender was the only socio-demographic factor that predicted climate change risk perception, with women worrying significantly more than men about climate change (Lujala et al. 2015; Marlon et al. 2018; McCright 2010; Menny et al. 2011; Sundblad et al. 2007). The research findings regarding the relationship between age and concern about climate change are inconsistent (Agho et al. 2010; Kvaløy et al. 2012; Mumpower et al. 2016). Some studies have observed a positive relationship between age and climate change risk perception (see, for example Mumpower et al. (2016)), whereas others observe a negative relationship (Pew Research Center 2015). Yet, other researchers have found no relationship between age and concern about climate change (Sundblad et al. 2007; van der Linden 2015).

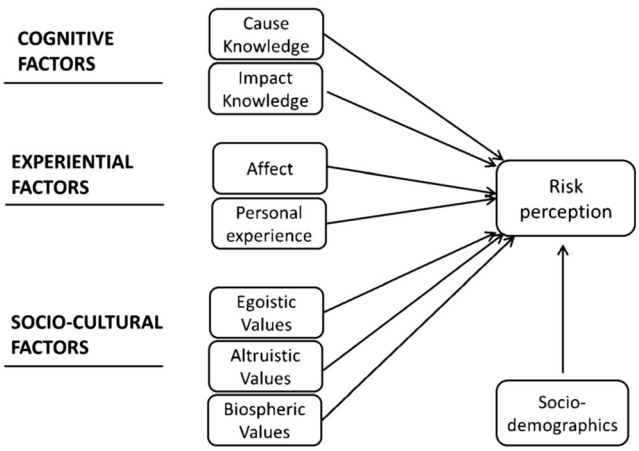

Fig. 1 The Climate Change Risk Perception Model (CCRPM) employed in this study, adapted from van der Linden (2015; p. 117)

Cognitive factors

Knowledge is the main cognitive factor related to public perceptions of climate change. Two different types of climate change knowledge are distinguished in the literature: knowledge of the causes of climate change (i.e. burning fossil fuels and deforestation) and knowledge of the impacts of climate change (i.e. sea level rise and the increase in global average temperature). Both knowledge of the causes and knowledge of the impacts of climate change appear to predict risk perception, including in Sweden (Sundblad et al. 2007), Switzerland (Tobler et al. 2012 and the UK (van der Linden 2015. In some studies, knowledge predicts risk perception indirectly, via beliefs in anthropogenic climate change (Stevenson et al. 2014. The present study examined to what extent knowledge of the causes and the impacts of climate change could predict public risk perceptions of climate change in Egypt.

Experiential factors

The two main experiential factors addressed in climate change risk perception research are affect and personal experience with extreme weather events. According to Leiserowitz (2006), affect refers to "a person's good or bad, positive or negative feelings about specific objects, ideas, or images." (p. 48). Leiserowitz (2006) found that negative affect was a stronger predictor of global warming risk perception than cultural worldviews or socio-demographic variables in a sample of the American public. This finding was replicated in a subsequent study (N. Smith and Leiserowitz 2012). Studies from Sweden (Sundblad et al. 2007) and the United Kingdom (van der Linden 2015) also show that negative affect is an important predictor of climate change risk perception.

The experience of extreme weather events refers to the extent to which people have personally experienced climate-related events, such as flash floods and heat waves. Akerlof et al. (2013) found that perceived personal experience of changes in seasonal weather, lake levels and snowfall positively predicted risk perceptions of global warming, even when controlling for demographics, political affiliation and cultural beliefs. In the UK, several studies have also found that personal experience with extreme weather events is a predictor of climate change risk perception (Capstick et al. 2013; Demski et al. 2017; Spence et al. 2011; van der Linden 2014).

Socio-cultural factors

Socio-cultural factors include social norms, value orientations and cultural worldviews. One of the most commonly used classifications of values divides them into three broad clusters: (1) egoistic values, which emphasize maximizing individual outcomes, (2) biospheric values, which emphasize the importance people attach to the environment and the biosphere, and (3) altruistic values, which reflect a concern for the welfare of others (De Groot and Steg 2007; Stern et al. 1999; Stern et al. 1993). In the UK, Corner et al. (2011) found that individuals with stronger biospheric and altruistic values were more likely to report concern about climate change, and van der Linden (2015) found that biospheric values were a strong predictor of climate change risk perception, whereas egoistic and altruistic values were not. The vast majority of the studies exploring value orientations and their relationships with perceptions of climate change were done in Western countries that share similar cultural backgrounds (i.e. the US and Europe). Given that value orientations are contextual and culture specific, different findings might be expected in Egypt.

The present research

Egypt is the most populated country in North Africa and the Middle East with a population of over 95 million people. Egypt's main cities are greater Cairo (which includes Cairo and Giza governorates) and Alexandria, with populations of approximately 20 and 5.5 million people, respectively (Central Agency for Public Mobilisation and Statistics 2019). The IPCC ranked the Nile Delta to be among the three most vulnerable deltas to sea level rise in the world and most projections also suggest a decline in the Nile flow in the future (Bohannon 2010; El-Nahry and Doluschitz 2010; IPCC 2007; McCarl et al. 2015; Sušnik et al. 2015). The Nile Delta is the most important agricultural region in Egypt, and its coastal area hosts 70% of Egypt's industrial and commercial activities (Attaher et al. 2009; Hasan et al. 2015). Alexandria is expected to be the most vulnerable coastal city in the world by 2050, with more than one million people potentially displaced (Hallegatte et al. 2013; IPCC 2014b). Egypt's coastal areas are also threatened by increases in flash floods and extreme weather events, causing serious damages to coastal structures and fatalities (El-Raey 2010; IPCC 2013; Malm 2013; Williams and Ismail 2015). Climate change is also expected to have indirect socio-economic impacts, as variations in rainfall and loss of agricultural land will start to affect water and food security (El-Nahry and Doluschitz 2010; El-Raey 2010; Hassaan and Abdrabo 2013; Kilroy 2015; Sušnik et al. 2015).

Despite these alarming predictions, there is limited public awareness and concern for climate change in Egypt. The earliest data available for Egypt is from a 1999 Globescan survey of 25 countries, which showed that 43% of Egyptian respondents did not know the main cause of the greenhouse effect, the highest percentage among the surveyed countries (Leiserowitz 2007). In 2006, the Pew Global Attitudes survey of 15 countries found that 53% of respondents from Egypt had never heard of global warming (Pew Research Center 2006). Gallup World Poll data from 2007 to 2008 showed that 65% of respondents from Egypt had never heard of climate change (Lee et al. 2015). In a Pew 2007 survey, 32% of Egyptians thought global warming was a very serious problem, which was the lowest percentage among 47 surveyed countries; however, this percentage rose to 54% in 2009 (Pew Research Center 2007, 2009). It would seem that public concern about climate change in Egypt does not align with scientific findings, which point to widespread negative impacts of climate change. It therefore seems pertinent to examine the determinants of public risk perception of climate change in the Egyptian context.

Aims of the study

The present research provides a novel contribution to the literature by examining predictors of risk perception in the context of a developing country, Egypt, where the impacts of climate change are projected to be serious. The research also provides the first test of the CCRPM in a non-Western country. The study aims to answer two main research questions: (1) How do Egyptians perceive and understand climate change? and (2) What are the predictors of climate change risk perception in Egypt?

Methodology

This research employed a mixed methods approach, which allows for the exploration of a breadth of perceptions of a large number of people, while also investigating individual perceptions, feelings and personal experiences (Creswell 2014; Tashakkori and Teddlie 2010). There is a clear value in using mixed methods to understand risk perception (Capstick et al. 2015; Pidgeon 2012). However, there is an apparent lack of mixed methods studies in the climate change literature (Nielsen and D'haen 2014). The present research followed a sequential explanatory design in which quantitative data was collected first through an online survey. The initial analysis of the survey responses was then used to develop semi-structured interview questions for the qualitative data collection. As such, the qualitative component was used to further explain the quantitative data and gain in-depth insights into specific areas of interest (Creswell 2014; Creswell and Plano Clark 2011).

Study 1: quantitative study

Surveys are ideal for exploring general trends in public opinion and comparing a wide range of attitudes, levels of understanding and concern in large samples (Fowler 2009). Study 1 used an online survey and participants had the option of taking it in English or Arabic. According to the Egyptian Ministry of Communication and Information Technology (2019), there were 40.9 million internet users in Egypt as of July 2019, with a 48% internet penetration. Hence, administering the survey online seemed to be an efficient way of collecting data and sharing the survey quickly and across a large number of people. However, this also meant that the survey included people with higher education levels and access to the internet.

Survey design

A pilot phase of the online survey was conducted between the 10th and 21st of June 2017 ($N = 12$). Based on generous feedback from the pilot survey participants, some questions were reworded and more detailed descriptions were added for improved clarity. The final survey was divided into seven sections with a total of 30 closed ended questions. Participants were first asked demographic questions; this was followed by sets of questions about values, feelings about climate change, experience with extreme weather events, knowledge of climate change and climate change risk perception.

Data collection and participants

The survey was active online from July 2nd to September 1st 2017 and it took on average of 15 min to complete. Participants were recruited through a snow ball sampling strategy where the researcher reached out to her contacts through phone calls, emails, messages and posts on various social media platforms and they were asked to send on the survey to others. This resulted in a convenience sample that was large enough to explore correlations and conduct regression analyses. The final data set for the survey is based on a sample size $N = 726$ with approximately 70% response rate from the people who started the survey; 113 participants took the survey in Arabic and 613 took it in English. The detailed demographic characteristics of the sample are shown in Table 1.

Table 1 Survey sample characteristics

Characteristics	Categories	Number	Percentage
Age	(18–24)	74	10.2%
	(25–34)	344	47.5%
	(35–44)	224	30.9%
	(45–54)	53	7.3%
	(55–64)	25	3.4%
	(65–74)	4	0.6%
Gender	Male	222	69.3%
	Female	502	30.6%
Educational level	High school degree	27	3.7%
	Diploma	15	2.1%
	Bachelor's degree	446	61.6%
	Postgraduate degree	235	32.5%
City of residence	Cairo	393	54.5%
	Giza	242	33.6%
	Alexandria	65	9%
	Others	21	2.9%

Measures

Since this research uses the CCRPM as a conceptual framework, survey questions were largely based on the measures used by van der Linden (2015), but some questions were adapted to be aligned with the local Egyptian context. In addition, the version of the CCRPM used in this study deviates from the original model in three ways. Three of the original CCRPM variables were excluded (i.e. social norms, climate change response knowledge and political ideology). The main reason for the decision to exclude social norms and response knowledge is that these variables are typically measured and operationalized in terms of climate change mitigation actions and these are not very relevant in the Egyptian context, where the focus is much more on climate change adaptation. Moreover, unlike Western populations, the Egyptian public is generally not familiar with or exposed to climate change mitigation policies or responses. We did not want to confuse participants by asking them questions about perceived social norms regarding mitigation measures that they may not be familiar with or have been exposed to. A focus on climate change adaptation throughout the survey aimed to avoid respondents' confusion and/or misinterpreted responses. Regarding political ideology, it was included in the original CCRPM as part of the socio-demographics to determine whether respondents were conservative or liberal. In the Egyptian context, this was not applicable as the vast majority of Egyptians do not follow a specific political party, and the existing Egyptian parties' political views cannot be easily classified as "Liberal" and "Conservative" which are classifications defined by Western cultures. Political ideology in Egypt is more complicated and requires multiple questions to determine; hence, a decision was made by the authors to exclude it despite its possible impact on climate change risk perception which could be explored in future research. As shown in Table 1, standard demographic measures were adopted (i.e. age, gender, educational level and city of residence).

Values

Broad value orientations (i.e. biospheric, socio-altruistic and egoistic values) were measured using a scale developed by De

Groot and Steg (2007), which is based on previous work by Schwartz (1992) and Stern et al. (1999). Respondents were asked to rate the importance of 12 randomly ordered statements corresponding to the three values on a 9-point scale ranging from *opposed to my values* (=− 1) to *of supreme importance to me* (= 7). Reliable scales were obtained for biospheric values ($\alpha = 0.87$) and socio-altruistic values ($\alpha = 0.83$), while egoistic values had a lower value ($\alpha = 0.62$). Other researchers (De Groot and Steg 2007; Schwartz et al. 2001) have suggested that values can have relatively low internal reliability scores, because only a few items corresponding to each value orientation are included and because values have conceptually broad definitions that encompass multiple components. Based on these prior studies, we retained the three value constructs in spite of the somewhat lower reliability score of the egoistic values construct.

Affect

Affect, described by Leiserowitz (2006) as people's positive or negative feelings about climate change, was measured using three questions. Each question asked people to rate how they felt about climate change on a 7-point bi-polar scale with the two poles being *very unpleasant-pleasant*, *unfavourable-favourable* and *negative-positive*. The scales were developed by van der Linden (2015) and were based on previous research by Peters and Slovic (2007). An acceptable reliability scale was obtained for affect ($\alpha = 0.83$).

Personal experience with extreme weather events

Four questions were used to examine people's experience with specific extreme weather events that are relevant to Egypt. Respondents were asked to recall how often they had experienced flash floods, heat waves, droughts and storms in the last 5 years, and the choices given were: never, once, twice and three or more. The reliability measure indicated a low alpha ($\alpha = 0.44$). This might be because the four questions measured varying experiences with extreme weather events of which respondents might have experienced one but not the others. Given the low reliability measure, experience with flash floods was used as a measure of the experience with extreme weather events, which is in line with what was used in the original CCRPM model (van der Linden 2015).

Knowledge of the causes and impacts of climate change

Two different types of knowledge of climate change were measured in the survey, which were adopted from van der Linden (2015). Knowledge of the causes of climate change was measured by asking people to choose whether each of six items (burning fossil fuels, the hole in the ozone layer, nuclear power plants, cows raised for meat consumption, deforestation and natural processes) was a cause or not a cause of climate change. The number of correct answers (ranging from 0 to 6) was used as the measure of cause knowledge, where more correct answers indicated a higher knowledge score. The majority of respondents correctly thought that the burning of fossil fuels and deforestation were causes of climate change (90.4% and 84.8%, respectively), while only 17.1% thought raising cows for meat consumption was a cause of climate change. A majority of respondents (85.1%) thought that the hole in the ozone layer was a cause of climate change. On average, respondents' scores for knowledge of the causes of climate change were relatively low (mean = 2.43, maximum = 6). As for knowledge of the impacts of climate change, respondents were asked to indicate whether each of eight possible climate change impacts (global sea level, melting of glaciers and polar ice caps, areas experiencing droughts, spread of infectious disease, global average temperature, extreme weather events, global biodiversity and the hole in the ozone layer) was likely to increase, decrease or not change at all as a result of climate change. The answers for the eight items were classified as either right or wrong and the number of correct answers (ranging from 0 to 8) was used as the measure of impact knowledge.

Risk perception

Climate change risk perception was measured using eight questions using a 7-point Likert scale adapted from van der Linden (2015), Bord et al. (2000) and Leiserowitz (2006). People were asked, for example, how concerned they were about climate change (*not concerned at all* = 1 to *very concerned* = 7) and how likely they thought it was that they would personally experience serious threats to their well-being from climate change (*very unlikely* = 1 to *very* likely = 7). A reliable measure was obtained for risk perception ($\alpha = 0.83$).

Quantitative results

Correlation analysis

Correlation analyses were conducted to explore relationships between the variables in the CCRPM, as detailed in Table 2. In both the correlation and regression analyses, a p value of 0.01 has been used to adjust for the fact that multiple tests were performed. All variables (except age, egoistic values and experience with flash floods) were significantly correlated with risk perception, with r ranging from $r = 0.11$ to $r = -0.33$. Risk perception was most strongly (negatively) correlated with affect: the more respondents saw climate change as negative, unpleasant and unfavourable, the higher their risk perception was. Knowledge of the causes of climate change had the weakest correlation with risk perception.

Table 2 Correlation analysis for all variables tested in the CCRPM

Variables	Scale	M	SD	N	1	2	3	4	5	6	7	8	9
1. Gender	1–2	1.69	0.46	724									
2. Age	1–7	2.48	0.93	724	− 0.053								
3. Biospheric values	1–9	7.29	1.43	691	0.021	0.097							
4. Altruistic values	1–9	7.82	1.34	691	0.037	0.071	0.702**						
5. Egoistic values	1–9	5.88	1.27	692	− 0.087	0.113**	0.335**	0.402**					
6. Cause knowledge	1–6	2.43	1	726	− 0.067	− 0.003	0.119**	0.066	− 0.052				
7. Impact knowledge	1–8	4.98	1.82	726	− 0.021	− 0.014	0.219**	0.199**	0.036	0.292			
8. Affect	1–7	2.32	1.27	722	0.02	0.016	− 0.236**	− 0.192**	0.022	− 0.162**	− 0.319**		
9. Experience with flash floods	1–4	2.31	0.56	682	0.074	− 0.084	− 0.03	− 0.04	0.003	− 0.034	− 0.05	0.094	
10. Risk perception	1–7	5.46	0.93	696	0.132**	0.080	0.243**	0.199**	0.05	0.110**	0.219**	− 0.330**	0.069

Note: For all variables, a higher score is a higher level of agreement. For affect, a higher score means more positive affect

**Correlation is significant at the 0.01 level (two-tailed)

Regression analysis

Hierarchical multiple regression analysis was used to evaluate to what extent cognitive, experiential, socio-cultural and demographic factors could predict public risk perception of climate change in Egypt. In line with van der Linden (2015)'s regression approach, linear regression including ordinal variables was used. Four models were introduced in the regression analysis as shown in Table 3. Model 1 included demographic factors and results showed that age and gender together explained a total of 2.5% of the variance in risk perception (F (2,625) = 8.012, $p < 0.001$, $R^2 = 0.025$). Being female ($\beta =$ 0.144, $p < 0.001$) was associated with higher risk perception, while age was not a significant predictor of risk perception. In model 2, cognitive factors (knowledge of the causes and impacts of climate change) explained an extra 6.2% of the variance in risk perception while controlling for demographic factors (F (2,623) = 21.104, $p < 0.001$, R^2 $\Delta = 0.062$). The regression weights in this model showed that knowledge of the impacts of climate change was a significant predictor of risk perception ($\beta = 0.218, p < 0.001$), while knowledge of the causes was not significant. This suggests that higher knowledge of the impacts of climate change is associated with higher risk perception.

Model 3 tested whether experiential factors (affect and personal experience with flash floods) explained any additional variance in risk perception while controlling for demographic and cognitive factors. Results revealed that experiential factors explained a further 8.4% of the variance (F (2,621) = 31.594, $p < 0.001$, R^2 $\Delta = 0.084$). Regression weights showed that negative affect ($\beta = -0.3$, $p < 0.001$) and personal experience with flash floods ($\beta = 0.105$, $p < 0.01$) were significant predictors of climate change risk perception. This indicates that negative feelings towards climate change and personal experience with flash floods were associated with increased risk perception. In the final model, the explanatory power of value orientations was explored while controlling for all other factors and it explained a further 2.1% of the variance in risk perception (F (3,618) = 5.337, $p < 0.01$, R^2 $\Delta = 0.021$). None of the value orientations were a significant predictor of climate change risk perception.

The model including all factors explained 19.2% of the variance in risk perception. The predictors of risk perception in order of the size of regression weights were: affect ($\beta = -$ 0.271, $p < 0.001$), gender ($\beta = 0.151$, $p < 0.001$) and experience with flash floods ($\beta = 0.108$, $p < 0.01$), when all other factors were controlled for.

Study 2: qualitative study

Semi-structured interviews were conducted to help explore in greater depth specific themes that emerged from the online survey results. Semi-structured interviews provide deeper insights into how people process and understand climate change, something that closed-ended survey questions do not fully capture (Kitchin and Tate 2013; Wolf and Moser 2011).

Interview structure

Based on the initial survey results, an interview schedule was developed with carefully worded questions and prompts. At the end of each interview, participants were given the opportunity to add any further comments and elaborate on any of their answers. Instead of analysing the interviews to identify themes, specific themes were selected based on the quantitative results. Given that affect and personal experience with flash floods were the strongest predictors of climate change risk perception, they were among the selected themes. In

Table 3 Regression analysis with risk perception as the dependent variable

Model	Independent variable	R^2	R^2 Δ	*B*	*t*
1	Age	0.025	0.025	0.079	1.999
	Gender			0.144	3.630***
2	Age	0.087	0.062	0.078	2.024
	Gender			0.160	4.158***
	Cause knowledge			0.074	1.856
	Impact knowledge			0.218	5.464***
3	Age	0.171	0.084	0.091	2.486
	Gender			0.159	4.308***
	Cause knowledge			0.056	1.452
	Impact knowledge			0.124	3.074**
	Affect			− 0.300	− 7.653***
	Experience with flash floods			0.105	2.843**
4	Age	0.192	0.021	0.081	2.194
	Gender			0.151	4.104***
	Cause knowledge			0.048	1.262
	Impact knowledge			0.099	2.447
	Affect			− 0.271	− 6.841***
	Experience with flash floods			0.108	2.954**
	Biospheric values			0.102	1.949
	Altruistic values			0.069	1.306
	Egoistic values			− 0.016	− 0.399

Note: Dependent variable is risk perception, entries are standardized beta coefficients, $^{**}p < 0.01$, $^{***}p < 0.001$

addition, since the quantitative results showed a lack of knowledge about the causes of climate change, this was chosen as another theme to be explored further. The interviews were reviewed in light of these themes and only relevant statements that fell under one of these themes were coded for analysis.

Data collection and participants

Participants who took the survey were asked if they would be willing to volunteer for an interview. Eight audio-recorded interviews were conducted in Arabic through face-to-face meetings in July and August 2017 in Cairo. The interview duration ranged from 24 to 50 min. Participants were selected to be as demographically diverse across age and gender as possible and to be residing in one of the three main cities in Egypt (i.e. Cairo, Giza and Alexandria). Table 4 provides details on the characteristics of the sample.

Qualitative analysis

The interviews were audio recorded and were then transcribed verbatim as soon as they were finished, as recommended by Hay (2010). As the original language of the interviews was Arabic, translation into English was done during the transcribing by the first author who is a native Arabic speaker. Annotations were made during transcribing to add information about the context of the interview and the intentions and meanings associated with the interviewees' actions, words and references. Furthermore, notes taken by the researcher during the interviews were added as annotations during transcription for further clarification.

Qualitative results

Feelings about climate change (affect)

All interviews started by asking participants to mention the first thing or image that came to their mind when they think about climate change. This allowed the respondents to share their unprompted thoughts, feelings and images relating climate change (Capstick et al. 2013; Leiserowitz 2006; Lorenzoni et al. 2006). All responses to this question reflected negative thoughts and feelings about climate change. When talking about global impacts, participants would often refer to catastrophic images about the end of the world, such as the melting of icebergs. On the other hand, when talking about climate impacts for Egypt, participants would discuss rising temperatures, sea level rise and coastal erosion. And in doing so, participants would describe these local impacts in terms of their own experience, as something they had already observed:

Table 4 Characteristics of the interview sample

Participant	Interview date	Age	Gender	City of residence	Education level
1	19th July 2017	30	Female	Cairo	Bachelor in Architecture
2	24th July 2017	63	Female	Cairo	Bachelor in Arts
3	27th July 2017	24	Male	Giza	MBA
4	4th August 2017	57	Male	Giza	Bachelor in Commerce
5	5th July 2017	34	Male	Alexandria	Bachelor in Commerce
6	9th July 2017	32	Female	Alexandria	MBA
7	21st August 2017	40	Male	Cairo	Bachelor in Engineering
8	23rd August 2017	22	Female	Giza	Bachelor in Business Information Systems

> "Coastal erosion. Because from experience, the coasts are totally different in the old days than they are now even in Alexandria. This is something that I have seen a lot in many beaches." – Participant 4

Others described the image they associated with climate change as if it was a 'scene' from a movie or an imaginary situation, almost as if these impacts were happening in another time and another place.

> "I imagine an iceberg breaking away from another iceberg with a poor polar bear on it who cannot cross to the other part and that ice is melting…so mainly ice melting and sea level rise." – Participant 3

> "A scene where there is heat or really hot weather." – Participant 6

Throughout the interview, participants used words such as fear, panic and a feeling of being scared. It seems then that participants expressed negative affect, which they connected to a general concern and worry about the future consequences of climate change on Egypt and the world.

> "I have concerns and fears of the consequences of all of this…It is clear that something is wrong with how we are living…I suddenly get these concerns that we are moving towards something that is totally unpleasant and that is close." – Participant 1

Some participants linked their negative feelings about the consequences of climate change to an inability to do something about it and to prevent loss of life, which was why it felt scary to them. For others, the consequences of climate change were so scary and negative that they consciously chose to avoid reading or knowing more about the topic.

> "I am very very very scared of a natural disaster that never happened in Egypt before…I really fear this…I feel that this might cause serious problems and paralyze the whole country and we will not be able to control the toll of victims." –Participant 3

> "Maybe it is scary for me so that is why I do not like reading much about it…whenever I read I feel like the world is coming to an end soon. So, I do not like going much into it. The more I know the scarier it is and the more terrified I am." – Participant 6

Overall, the analysis of the interviews showed that participants had negative feelings about climate change and associated it with negative images of harmful consequences. In some instances, the negative feelings evoked by climate change seemed to result in people not wanting to engage with the issue.

Personal experience with flash floods

All interview participants—without exception—talked about experiences with flash floods. Interestingly, none of the participants had a direct personal experience with flash floods, but they all knew at least one person who had had a direct negative experience. Participants seemed to talk about other people's experiences as if they were their own, using other people's stories to reflect on how they saw the negative impacts of flash floods.

> "I never felt it (flash floods) personally but there are definitely stories that I will never forget about other people experiencing it. One of our neighbours in our old house had a relative whose whole family died in floods in Sinai and only a little girl survived and they got her and raised her. This is a story that I keep remembering. But I know others too. I know someone who works with me who lost his car because of the floods, he was in the Red Sea area." – Participant 4

Some participants referred to social media platforms, such as Facebook, as a source of stories about flash floods happening to people they did not know personally. It seemed that seeing videos and photos of the damage caused by flash floods on social media had an influence on the interview participants and how they viewed experiences with flash floods.

> "I do not remember I have seen this while I was living in Alexandria before. I have only seen it recently in photos and on Facebook." - Participant 6

All participants were aware of flash floods occurring in Alexandria and their negative consequences. Participants also referred to experiences with flash floods in other cities such as Cairo, Sinai, Red Sea, Port Said and Suez. Participants discussed at length the different impacts, such as damages to homes and infrastructure, loss of private cars and loss of human life.

> "Some of my friends had their cars drown in their garages in Alexandria because of the floods." – Participant 5

> "We all saw a lot…people getting electrocuted by the floods and other disasters happening (Talking about Alexandria)." – Participant 4

Most of the interview participants mentioned that flash floods did not used to happen with the same frequency and made remarks about how flooding events had been increasing in recent years.

> "Uhhh the flash floods, when we were young we never heard of it, the strong floods that damage homes these days, this was not happening before." – Participant 2

Knowledge of the causes of climate change

Similar to the survey results, interview participants' responses showed a lack of knowledge and reflected common misconceptions regarding the causes of climate change. Many participants mentioned the hole in the ozone layer as a cause of climate change. Many participants also admitted that they were unsure of what exactly caused the hole in the ozone layer or that they had incorrect information about it.

> "I haven't really thought of the causes, maybe we take it at face value and that we just learned that emissions are what is causing the hole in the ozone layer which causes climate change." – Participant 6

Some participants (incorrectly) thought that air pollution was a cause of climate change. It seemed that participants were certain that there was a link between the ozone layer, pollution and climate change, but they did not know how this connection worked, so they either tried to guess or they just acknowledged that they did not know.

> "As individuals, we need to protect the things that affect climate change through their damage. I do not know all of it, I do not know what exactly caused the hole in the ozone layer. So, we need to decrease our use of certain things or find an alternative. Things that cause pollution." – Participant 5

Another misconception about the causes of climate change that the participants talked about was the excessive use of air conditioning units. Several participants believed that the hot air coming from an excessive number of air conditioning units in the city made the weather hotter. It seemed that the source of this information was people making incorrect assumptions and then repeating it to others.

> "Years ago since the hot weather started happening, people in their ordinary conversation used to say that the excessive number of air condition units that people are using, the hot air coming out of it all over the city and the fact that buildings are so close to each other, all this makes us feel the heat more." – Participant 2

Despite the many misconceptions regarding the causes of climate change, almost all participants acknowledged the human causation of climate change; only one participant thought it was caused by natural processes and had nothing to do with human actions. Participants used phrases such as human development, human interference, human influence and human intervention to express their belief in the human causation of climate change. However, there seemed to be a lack of knowledge of the exact human activities that caused the change such as the burning of fossil fuels and deforestation.

> "I think it has a lot to do with human development. The air conditioning units and the factories. The human interference with nature." – Participant 4

General discussion and implications for risk communication and policy

The quantitative results showed that experiential factors (affect and personal experience) were the most powerful predictors of climate change risk perception in this sample. These findings are broadly in line with previous studies (e.g. Capstick et al. (2013); Leiserowitz (2006); Smith and Leiserowitz 2012; Spence et al. (2011); Sundblad et al.

(2007); and van der Linden (2014)). The qualitative findings deepen our understanding of the role these experiential factors play. In terms of affect, participants expressed feelings of fear, panic and being scared of the catastrophic consequences of climate change. For some participants, these negative feelings about climate change meant they preferred not to engage with the issue of climate change at all. This has implications for climate change communications, which might need to move away from the use of fear appeals. As noted elsewhere (Moser and Dilling 2011), the use of fear messaging may have unintended outcomes, and as a result, people might feel helpless or powerless and not engage with the issue of climate change.

Interestingly, it seemed that direct personal experience was not necessarily needed for people to express worry about the effects of climate change. Indeed, participants would often describe climate change as a "scene" and think of it as distant in time and place (e.g. as polar bears struggling on melting ice sheets in the Arctic). This suggests that iconic images that are used in the media can have an impact on people's perception of climate change. Social media seemed to be another influential source of information. Many participants talked very confidently about the serious negative consequences of flash floods, based on images and videos they had seen online, despite not having had any direct experience with floods. This finding suggests that risk communication messages might be more effective when they highlight the association between personal experiences with extreme weather events and climate change (de Boer et al. 2016; van der Linden et al. 2015). When people start to realize that climate change is affecting them personally, they may then be more willing to engage in activities to address it. Further, climate change risk communication needs to focus more on locally relevant climate change impacts. Research has shown that risk communication strategies that focus on local, personally relevant impacts can be more effective in eliciting public engagement with climate change compared with distant global message frames (Cooper and Wheeler 2017; Scannell and Gifford 2013).

In contrast to prior research (e.g. Lee et al. 2015), knowledge of the causes of climate change was not a significant predictor of risk perception. The qualitative component of this research lends further support to this finding and showed that there is a general lack of knowledge of the causes of climate change, coupled with various misconceptions about it. The notion that ozone depletion is a cause of climate change is a common misconception (Bell 1994; Bostrom et al. 1994; Brechin 2003; Dunlap 1998; Henry 2000; Kempton 1991, 1997; Leiserowitz 2007; Löfstedt 1991; Read et al. 1994). It seems, however, that relative to other countries, as reported by Reynolds et al. (2010), this misconception is particularly prevalent in Egypt. Some participants mentioned that ozone depletion was something that people studied in school, while climate change was not; this might explain why it is a persisting misconception in Egypt. It seems that the education curriculum in Egypt will need to adjust to the new realities posed by climate change.

To improve public understanding of climate change, risk communication should focus on overcoming pre-existing mental models that the public have (e.g. linking climate change to ozone depletion) by highlighting basic facts about the main cause of climate change. Moreover, climate change risk communication should use clear messages and simple imagery and metaphors, given that climate change is difficult to understand for most people (Moser 2010). Interview participants acknowledged the need for awareness campaigns and highlighted that these must be undertaken by good communicators and in ways that are easy to understand in order to reach all levels of society.

The theoretical framework, the CCRPM, seems applicable in an Egyptian context. However, the CCRPM was only able to explain 19.2% of the variance in risk perception. This percentage of explained variance lies at the lower end of the spectrum when compared with the explained variance in Western studies, which ranged from 22 to 55% (van der Linden 2015). Social, cultural and experiential factors are shaped by contextual factors, and it can therefore be expected that the CCRPM generates different findings in different countries. Nevertheless, the omission of social norms from the CCRPM might have weakened the role of cultural factors in this study. Furthermore, it can be assumed that people in Western countries are more used to taking surveys than the Egyptian public and this might have affected the outcomes of the survey. What is more, the Egyptian public is less familiar with scientific terms related to climate change as they are rarely used in the media. It is also possible that in the Egyptian context, other factors might have a stronger influence on climate change risk perception. For example, given that the political context in Egypt has become quite tumultuous following the 2011 revolution, factors such as political ideology and trust in experts and/or social and political institutions (Fortner et al. 2000; Kellstedt et al. 2008; Lorenzoni and Pidgeon 2006; Malka et al. 2009; E. K. Smith and Mayer 2018; Wachinger 2013) and media coverage and exposure (Sampei and Aoyagi-Usui 2009; Wachinger 2013; Wahlberg and Sjoberg 2000) might have an influence on climate change risk perception in Egypt today. Future research can explore these factors in more detail.

This research has some limitations. The sample used in study 1 was urban, with a high representation of females, and included people with higher education levels and access to the internet. This means that some caution is warranted in generalizing the results of this survey to the wider Egyptian population. However, this is not uncommon in studies that use online surveys, and previous studies that included data for Egypt had similar sample compositions, which allowed for useful comparisons. The qualitative interviews took place in

urban areas and it may well be that risk perceptions of climate change are different in rural areas. However, the quantitative and qualitative findings complement each other well and provide a detailed picture of climate change risk perception in a developing nation.

Overall, this work highlights the need to study climate change communication in a local context. Egypt, and other countries in the region, will be among the countries that face serious consequences of climate change. The findings of this research underscore that efforts for climate change mitigation and adaptation will need local solutions, informed by people's perceptions and experiences.

Funding This paper was funded by the Masters Publication Scholarship 2018 offered by the School of Geography, Environment and Earth Sciences in Victoria University of Wellington.

Compliance with ethical standards

Conflicts of interest The authors declare that they have no conflict of interest.

Availability of data and material Not applicable.

Code availability Not applicable.

References

Agho K, Stevens G, Taylor M, Barr M, Raphael B (2010) Population risk perceptions of global warming in Australia. Environ Res 110(8): 756–763

Akerlof K, Maibach EW, Fitzgerald D, Cedeno AY, Neuman A (2013) Do people "personally experience" global warming, and if so how, and does it matter? Glob Environ Chang 23(1):81–91

Attaher S, Medany M, Abou-Hadid A (2009) Possible adaptation measures of agriculture sector in the Nile Delta to climate change impacts. Adv Sci Res 3(1):123–126

Bell A (1994) Climate of opinion: public and media discourse on the global environment. Discourse Soc 5(1):33–64

Blocker TJ, Eckberg DL (1997) Gender and environmentalism: results from the 1993 general social survey. Soc Sci Q 78(4):841–858

Bohannon J (2010) Climate change. The Nile Delta's sinking future. Science 327(5972):1444–1447

Bord RJ, O'Connor RE (1997) The gender gap in environmental attitudes: the case of perceived vulnerability to risk. Soc Sci Q 78(4):830–840

Bord RJ, O'Connor RE, Fisher A (2000) In what sense does the public need to understand global climate change? Public Underst Sci 9(3): 205–218

Bostrom A, Morgan MG, Fischhoff B, Read D (1994) What do people know about global climate change? 1. Mental models. Risk Anal 14(6):959–970

Brechin SR (2003) Comparative public opinion and knowledge on global climatic change and the Kyoto protocol: the US versus the world? Int J Sociol Soc Policy 23(10):106–134

Brügger A, Dessai S, Devine-Wright P, Morton TA, Pidgeon NF (2015) Psychological responses to the proximity of climate change. Nat Clim Chang 5(12):1031–1037

Capstick S, Pidgeon N, Whitehead M (2013) Public perceptions of climate change in Wales: summary findings of a survey of the Welsh public conducted during November and December 2012. Retrieved from http://psych.cf.ac.uk/understandingrisk/docs/C3W%20report%20FINAL.pdf

Capstick S, Whitmarsh L, Poortinga W, Pidgeon N, Upham P (2015) International trends in public perceptions of climate change over the past quarter century. Wiley Interdiscip Rev Clim Chang 6(1): 35–61

Central Agency for Public Mobilisation and Statistics. (2019) Population in governorates now. Retrieved from https://www.capmas.gov.eg/Pages/populationClock.aspx

Cooper SJ, Wheeler T (2017) Rural household vulnerability to climate risk in Uganda. Reg Environ Chang 17(3):649–663

Corner A, Venables D, Spence A, Poortinga W, Demski C, Pidgeon N (2011) Nuclear power, climate change and energy security: exploring British public attitudes. Energy Policy 39(9):4823–4833

Creswell JW (2014) Research design: Qualitative, quantitative, and mixed methods approaches, 4th edn. Sage publications

Creswell JW, Plano Clark VL (2011) Designing and conducting mixed methods research, 2nd edn. SAGE Publications, Los Angeles

Davidson DJ, Freudenburg WR (1996) Gender and environmental risk concerns: a review and analysis of available research. Environ Behav 28(3):302–339

de Boer J, Botzen WW, Terpstra T (2016) Flood risk and climate change in the Rotterdam area, The Netherlands: enhancing citizen's climate risk perceptions and prevention responses despite skepticism. Reg Environ Chang 16(6):1613–1622

De Groot JI, Steg L (2007) Value orientations and environmental beliefs in five countries: validity of an instrument to measure egoistic, altruistic and biospheric value orientations. J Cross-Cult Psychol 38(3):318–332

Demski C, Capstick S, Pidgeon N, Sposato RG, Spence A (2017) Experience of extreme weather affects climate change mitigation and adaptation responses. Clim Chang 140(2):149–164

Dunlap RE (1998) Lay perceptions of global risk public views of global warming in cross-national context. Int Sociol 13(4):473–498

El-Nahry AH, Doluschitz R (2010) Climate change and its impacts on the coastal zone of the Nile Delta, Egypt. Environ Earth Sci 59(7):1497–1506

El-Raey M (2010) Impacts and implications of climate change for the coastal zones of Egypt. In: Michel D, Pandya A (eds) Coastal zones and climate change. The Henry L. Stimson Center, Washington, DC, pp 31–50

Fortner RW, Lee J-Y, Corney JR, Romanello S, Bonnell J, Luthy B, Figuerido C, Ntsiko N (2000) Public understanding of climate change: certainty and willingness to act. Environ Educ Res 6(2): 127–141

Fowler FJ (2009) Survey research methods, 4th edn. SAGE Publications, London

Gifford R, Scannell L, Kormos C, Smolova L, Biel A, Boncu S et al (2009) Temporal pessimism and spatial optimism in environmental assessments: an 18-nation study. J Environ Psychol 29(1):1–12

Hallegatte S, Green C, Nicholls RJ, Corfee-Morlot J (2013) Future flood losses in major coastal cities. Nat Clim Chang 3(9):802–806

Hasan E, Khan SI, Hong Y (2015) Investigation of potential sea level rise impact on the Nile Delta, Egypt using digital elevation models. Environ Monit Assess 187(10):1–14

Hassaan M, Abdrabo M (2013) Vulnerability of the Nile Delta coastal areas to inundation by sea level rise. Environ Monit Assess 185(8): 6607–6616

Hay I (2010) Qualitative research methods in human geography, 3rd edn. Oxford University Press, Oxford

Henry AD (2000) Public perceptions of global warming. Hum Ecol Rev 7(1):25–30

IPCC (2007) Coastal systems and low-lying areas. In Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the

Intergovernmental Panel on Climate Change (pp. 317-357). Cambridge: Cambridge University Press. Retrieved from http://www.ipcc.ch/pdf/assessment-report/ar4/wg2/ar4-wg2-chapter6.pdf

IPCC (2013) Summary for policy makers. In Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (pp. 1-27). Cambridge and New York.: Cambridge University Press Retrieved from http://www.ipcc.ch/pdf/assessment-report/ar5/wg1/WG1AR5_SPM_FINAL.pdf

IPCC (2014a) Climate change 2014: synthesis report. Contribution of working groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Retrieved from https://www.ipcc.ch/site/assets/uploads/2018/02/SYR_AR5_FINAL_full.pdf

IPCC (2014b) Coastal systems and low-lying areas. In Climate Change 2014: Impacts,Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (pp. 361–409). Cambridge and New York: Cambridge University Press. Retrieved from https://www.ipcc.ch/pdf/assessment-report/ar5/wg2/WGIIAR5-Chap5_FINAL.pdf

Kellstedt PM, Zahran S, Vedlitz A (2008) Personal efficacy, the information environment, and attitudes toward global warming and climate change in the United States. Risk Anal 28(1):113–126

Kempton W (1991) Lay perspectives on global climate change. Glob Environ Chang 1(3):183–208

Kempton W (1997) How the public views climate change. Environ Sci Policy Sustain Dev 39(9):12–21

Kilroy G (2015) A review of the biophysical impacts of climate change in three hotspot regions in Africa and Asia. Reg Environ Chang 15(5):771–782

Kitchin R, Tate N (2013) Conducting research in human geography: theory, methodology and practice. Routledge, New York

Kvaløy B, Finseraas H, Listhaug O (2012) The publics' concern for global warming: a cross-national study of 47 countries. J Peace Res 49(1):11–22

Lee TM, Markowitz EM, Howe PD, Ko C-Y, Leiserowitz AA (2015) Predictors of public climate change awareness and risk perception around the world. Nat Clim Chang 5(11):1014–1020

Leiserowitz A (2006) Climate change risk perception and policy preferences: the role of affect, imagery, and values. Clim Chang 77(1–2):45–72

Leiserowitz A (2007) International public opinion, perception, and understanding of global climate change. Retrieved from https://core.ac.uk/download/pdf/6248846.pdf

Leviston Z, Price J, Bishop B (2014) Imagining climate change: the role of implicit associations and affective psychological distancing in climate change responses. Eur J Soc Psychol 44(5):441–454

Löfstedt RE (1991) Climate change perceptions and energy-use decisions in Northern Sweden. Glob Environ Chang 1(4):321–324

Lorenzoni I, Pidgeon NF (2006) Public views on climate change: European and USA perspectives. Clim Chang 77(1–2):73–95

Lorenzoni I, Leiserowitz A, Doria M, Poortinga W, Pidgeon NF (2006) Cross-national comparisons of image associations with "global warming" and "climate change" among laypeople in the United States of America and Great Britain. Journal of Risk Research 9(03):265–281

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(3):445–459

Lujala P, Lein H, Rød JK (2015) Climate change, natural hazards, and risk perception: the role of proximity and personal experience. Local Environ 20(4):489–509

Malka A, Krosnick J, Langer G (2009) The Association of Knowledge with concern about GlobalWarming: trusted information sources shape public thinking. Risk Anal 29(5):633–647

Malm A (2013) Sea wall politics: uneven and combined protection of the Nile Delta coastline in the face of sea level rise. Crit Sociol 39(6):803–832

Markowitz EM, Shariff AF (2012) Climate change and moral judgement. Nat Clim Chang 2(4):243–247

Marlon JR, van der Linden S, Howe PD, Leiserowitz A, Woo SL, Broad K (2018) Detecting local environmental change: the role of experience in shaping risk judgments about global warming. Journal of Risk Research:1–15

McCarl BA, Musumba M, Smith JB, Kirshen P, Jones R, El-Ganzori A et al (2015) Climate change vulnerability and adaptation strategies in Egypt's agricultural sector. Mitig Adapt Strateg Glob Chang 20(7):1097–1109

McCright AM (2010) The effects of gender on climate change knowledge and concern in the American public. Popul Environ 32(1):66–87

McDonald R (2016) Perceived temporal and geographic distance and public opinion about climate change. Oxford Encyclopedia of Climate Change Communication

Menny C, Osberghaus D, Pohl M, Werner U (2011) General knowledge about climate change, factors influencing risk perception and willingness to insure. Retrieved from http://ftp.zew.de/pub/zew-docs/dp/dp11060.pdf

Milfont TL (2012) The interplay between knowledge, perceived efficacy, and concern about global warming and climate change: a one-year longitudinal study. Risk Anal 32(6):1003–1020

Ministry of Communication and Information Technology, M (2019) ICT Indicators in Brief. Retrieved from http://www.mcit.gov.eg/Upcont/Documents/Publications_3092019000_EN_ICT_Indicators_in_brief_July_2019.pdf

Mohai P (1997) Gender differences in the perception of most important environmental problems. Race, Gender & Class 5(1):153–169

Moser SC (2010) Communicating climate change: history, challenges, process and future directions. Wiley Interdiscip Rev Clim Chang 1(1):31–53

Moser SC, Dilling L (2011) Communicating climate change: closing the science-action gap. The Oxford handbook of climate change and society:161–174

Mumpower JL, Liu X, Vedlitz A (2016) Predictors of the perceived risk of climate change and preferred resource levels for climate change management programs. Journal of Risk Research 19(6):798–809

Nielsen J, D'haen SAL (2014) Asking about climate change: reflections on methodology in qualitative climate change research published in Global Environmental Change since 2000. Glob Environ Chang 24:402–409

Pahl S, Harris PR, Todd HA, Rutter DR (2005) Comparative optimism for environmental risks. J Environ Psychol 25(1):1–11

Peters E, Slovic P (2007) Affective asynchrony and the measurement of the affective attitude component. Cognit Emot 21(2):300–329

Pew Research Center (2006) 15-Nation Pew Global Attitudes Survey. Retrieved from http://www.pewglobal.org/files/pdf/252.pdf

Pew Research Center (2007) Pew Global Attitudes Project: Spring 2007 Survey, Survey of 47 Publics Retrieved from http://www.pewglobal.org/files/pdf/258topline.pdf

Pew Research Center (2009) 25-Nation Pew Global Attitudes Survey Retrieved from http://assets.pewresearch.org/wp-content/uploads/sites/2/pdf/264.pdf

Pew Research Center (2015) Global conern about climate change, broad support for limiting emmissions. Retrieved from http://www.pewglobal.org/files/2015/11/Pew-Research-Center-Climate-Change-Report-FINAL-November-5-2015.pdf

Pidgeon N (1998) Risk assessment, risk values and the social science programme: why we do need risk perception research. Reliab Eng Syst Saf 59(1):5–15

Pidgeon N (2012) Public understanding of, and attitudes to, climate change: UK and international perspectives and policy. Clim Pol 12:85–106

Read D, Bostrom A, Morgan MG, Fischhoff B, Smuts T (1994) What do people know about global climate change? 2. Survey studies of educated laypeople. Risk Anal 14(6):971–982

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(10):1520–1538

Sampei Y, Aoyagi-Usui M (2009) Mass-media coverage, its influence on public awareness of climate-change issues, and implications for Japan's national campaign to reduce greenhouse gas emissions. Glob Environ Chang 19(2):203–212

Scannell L, Gifford R (2013) Personally relevant climate change: the role of place attachment and local versus global message framing in engagement. Environ Behav 45(1):60–85

Schwartz SH (1992) Universals in the content and structure of values: theoretical advances and empirical tests in 20 countries. Adv Exp Soc Psychol 25:1–65

Schwartz SH, Melech G, Lehmann A, Burgess S, Harris M, Owens V (2001) Extending the cross-cultural validity of the theory of basic human values with a different method of measurement. J Cross-Cult Psychol 32(5):519–542

Slovic P, Fischhoff B, Lichtenstein S (1982) Why study risk perception? Risk Anal 2(2):83–93

Smith N, Leiserowitz A (2012) The rise of global warming skepticism: exploring affective image associations in the United States over time. Risk Anal 32(6):1021–1032

Smith EK, Mayer A (2018) A social trap for the climate? Collective action, trust and climate change risk perception in 35 countries. Glob Environ Chang 49:140–153

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(1):46–49

Spence A, Poortinga W, Pidgeon N (2012) The psychological distance of climate change. Risk Anal 32(6):957–972

Stern PC, Dietz T, Kalof L (1993) Value orientations, gender, and environmental concern. Environ Behav 25(5):322–348

Stern PC, Dietz T, Abel TD, Guagnano GA, Kalof L (1999) A value-belief-norm theory of support for social movements: the case of environmentalism. Hum Ecol Rev 6(2):81–97

Stevenson KT, Peterson MN, Bondell HD, Moore SE, Carrier SJ (2014) Overcoming skepticism with education: interacting influences of worldview and climate change knowledge on perceived climate change risk among adolescents. Clim Chang 126(3–4):293–304

Sundblad E, Biel A, Gärling T (2007) Cognitive and affective risk judgements related to climate change. J Environ Psychol 27(2):97–106

Sušnik J, Vamvakeridou-Lyroudia LS, Baumert N, Kloos J, Renaud FG, La Jeunesse I et al (2015) Interdisciplinary assessment of sea-level rise and climate change impacts on the lower Nile delta, Egypt. Sci Total Environ 503:279–288

Tashakkori A, Teddlie C (2010) Sage handbook of mixed methods in social & behavioral research. Sage

Tobler C, Visschers VH, Siegrist M (2012) Consumers' knowledge about climate change. Clim Chang 114(2):189–209

van der Linden S (2014) On the relationship between personal experience, affect and risk perception: the case of climate change. Eur J Soc Psychol 44(5):430–440

van der Linden S (2015) The social-psychological determinants of climate change risk perceptions: towards a comprehensive model. J Environ Psychol 41:112–124

van der Linden S, Maibach E, Leiserowitz A (2015) Improving public engagement with climate change five "best practice" insights from psychological science. Perspect Psychol Sci 10(6):758–763

Wachinger G (2013) The risk perception paradox—implications for governance and communication of natural hazards. Risk Anal 33(6): 1049–1065

Wahlberg AA, Sjoberg L (2000) Risk perception and the media. Journal of Risk Research 3(1):31–50

Weber EU (2016) What shapes perceptions of climate change? New research since 2010. Wiley Interdiscip Rev Clim Chang 7(1):125–134

Williams SJ, Ismail N (2015) Climate change, coastal vulnerability and the need for adaptation alternatives: planning and design examples from Egypt and the USA. J Mar Sci Eng 3(3):591–606

Wolf J, Moser SC (2011) Individual understandings, perceptions, and engagement with climate change: insights from in-depth studies across the world. Wiley Interdiscip Rev Clim Chang 2(4):547–569