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Do perceptions of climate change influence precautionary measures?

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Purpose

The need to adapt to the effects of climate change requires the sharing of responsibility between the authorities and the public. It has been shown before, that private building precautionary measures are able to significantly mitigate flood losses. This study has been undertaken to investigate which factors are motivating people to undertake mitigation measures, with a particular focus on the perceptions of climate change.

Design/methodology/approach

605 households in Dresden have been interviewed and their answers statistically analysed.

Findings

Correlation and principal component analysis show a slight influence of the perception about consequences of climate change on the motivation to undertake flood emergency measures. However, other socio-economic factors like the ownership of the residential building and the size of the household are much more important.

Practical implications

In order to improve the uptake of flood mitigation and climate change adaptation measures, public awareness raising campaigns and schemes utilizing financial and non-financial incentives should be undertaken. Such campaigns should particularly focus on specific social-groups, like tenants or singles. Awareness rising campaigns focusing on the causes and consequences of climate change are expected to have little effect on the peoples' motivation to act.

Originality/value

This study has discovered very weak links between perceptions of climate change and the motivation of households to undertake precautionary measures, which is important for the design of awareness rising campaigns.

Key words

Adaptation, flood damage, households, mitigation, motivation, resistance

1. Introduction

Damages due to disasters have dramatically increased during the last few decades and floods generate the largest economic losses (Munich Re, 1997; 2004). For example, the floods in 1993 and 1995 in the Rhine catchment area caused altogether a loss of €10 Mio., the 1997

flood at the Odra river lead to losses of €30 Mio., the Whitsun flood in 1999 in the Danube catchment caused losses of €12 Mio., the loss of the extreme flood event of August 2002 in the Elbe and Danube catchment summed up to €1600 Mio. (Kron, 2004) in Germany, while the flood in August 2005 in the Danube catchment resulted in €189 Mio. losses in the federal state of Bavaria alone (LfU Bayern, 2006). It is expected that flood risk will continue to rise due to a combination of an increase in vulnerability, e.g. due to increasing flood plain occupancy, changes in the terrestrial system, e.g. land cover changes, river regulation, and a changing climate (e.g. Hall et al., 2003; Kundzewicz et al., 2005).

A weakening of the trend of increasing flood losses can only be achieved with significantly improved risk management. For example, an investigation in England and Wales expects a 20 fold increase in the real economic flood risk by the year 2080, if present politics, practice and investment concerning flood management are not improved significantly (Hall et al., 2005). For an efficient, integrated approach, not only public efforts like technical protection measures and an increase in natural retention have to be taken into account. The mitigation potential of private households via flood precautionary measures and response to early warning also has to be investigated and is being increasingly encouraged (Hayes, 2004; Wynn, 2004). Private risk reduction activities encompass precautionary measures taken in and around risk exposed buildings, or preparatory measures such as collecting information about flood risk, flood protection, and participation in neighbourhood help, or buying flood insurance. Precautionary building measures, like constructing a building without a cellar or with an adapted building structure, shielding properties with water barriers, safeguarding of hazardous substances, i.e. avoidance of oil contamination are able to significantly mitigate losses (ICPR, 2002; ABI, 2003; Kreibich et al., 2005).

Undertaking precautionary measures demands self-reliant behaviour by the potentially affected population. There are few laws stipulating precautionary measures, most measures are therefore voluntary (Heiland, 2002). Previous studies show, that the experience of a flood is a significant factor for motivating people to undertake precautionary measures (Grothmann and Reusswig 2006; Siegrist and Gutscher 2006; 2008; Thielen et al. 2007). However, particularly for promotion campaigns, other drivers for action besides memorable flood experience need to be identified. Therefore, it is the objective of this study to investigate the influence of the perception of climate change on the motivation to undertake flood precautionary and emergency measures. Additionally, conclusions about the implications for campaigns to promote measures to adapt to the effects of climate change are drawn.

2. Data and methods

The investigation area is the city of Dresden in Germany, which was affected by floods in August 2002 and spring 2006 (Engel, 2004; Belz et al., 2006; Kreibich and Thielen, 2009). Representative telephone interviews with private households, which are endangered by riverine floods and consecutive high groundwater levels, were undertaken in the city of Dresden in August and September 2007 (Kreibich et al., 2009). Computer-aided telephone interviews were undertaken with the VOXCO software package (www.voxco.com) by the SOKO institute for social research and communication (www.soko-institut.de). The standardised questionnaire comprised around 70 questions, but not all questions were applicable in all cases. For most questions, a list of possible answers was given (with either a single answer or multiple answers possible). Questions about peoples' perceptions were evaluated on a four rank Likert-scale. An interview lasted 32 minutes on average. The questionnaire was structured into the following content oriented question-blocks: general introduction and filtering; flood impact parameters and resulting damage; building and

residence characteristics; damage/risk perception; prevention, precaution and preparation; information and participation; risk management; and socio-demography. The main aim of the survey was the investigation of the extent, perception and mitigation of damage due to high groundwater levels in the city of Dresden (Kreibich et al., 2009). However, also questions about peoples' perception of climate change were included.

The survey resulted in 605 completed interviews with private households of which the majority of 380 had recently experienced simultaneous or consecutive groundwater and other flooding during one event, 54 had no flood experience at all, 97 had experienced various kinds of floods, except for groundwater floods and 74 had experienced groundwater flooding, and had not been affected by other flood types lately. The vast majority of households with (groundwater) flood experience stated that their most recent experience was in 2002 (Kreibich et al., 2009).

To better handle the information of the data set, answers concerning one particular topic were aggregated into one indicator variable for some analysis. This was done for perceptions of climate change, precautionary measures and emergency measures. Peoples' perceptions about causes of climate change were classified into the following four groups: 0) climate change isn't due to any of the mentioned causes, including the "don't know" answers (Table 1); 1) climate change is mainly due to human activities (Table 1); 2) climate change is mainly due to natural fluctuations (Table 1) and 3) climate change is due to both mentioned causes (Table 1). The agreeing answers about the consequences of climate change were summed up, resulting in an indicator ranging from 0 ("rather) disagree" or "don't know" to all three mentioned consequences) to 3 ("rather) agree" to all three mentioned consequences; Table 2). The indicator for the perception about the importance of different scopes of policy is designed as follows: 0 - other scopes of policy; 1 - combat climate change is important; 2 - flood protection is important and 3 - combat climate change and flood protection are both important (Table 3). The indicator for precautionary measures consists of the number of precautionary measures undertaken before and after the latest event, excluding the collection of information (Fig. 1). The indicator for emergency measures consists of the number of emergency measures undertaken before and during the latest event (Fig. 2).

Rank correlations (Spearman's rho) were calculated between the indicators for the perceptions of climate change, precautionary and emergency measures. Principal component analysis (PCA) with varimax rotation was applied in order to reduce the number of variables and to investigate the correlation structure of the precaution influencing variables. That means two or more correlated variables are combined into one component. The significant principal components were extracted on the basis of the Kaiser criterion, i.e. only components with eigenvalues greater than one are retained (Kaiser, 1960). Statistical analyses were undertaken with the software SPSS for Windows, Version 11.5.1.

3. Results and discussion

3.1 Perceptions of climate change

To capture their perception of climate change, the interviewed people were asked about causes and consequences of climate change, and about the importance of different scopes of policy in Dresden. Most interviewed people (39%) believe that climate change is due to both, natural climate fluctuation and human activities (Table 1). Second most people (34%) believe that climate change is mainly due to human activities (Table 1). Far less people (19%) believe

that climate change is mainly due to natural climate fluctuations (Table 1). Only 8% of the interviewed people (rather) disagree to both mentioned causes or “don’t know” (Table 1).

The majority of interviewed people (rather) agrees to the mentioned consequences of climate change (Table 2). The most agreed statement was “climate change will lead to more extreme weather events like torrential rain”, the least agreed statement was “climate change will lead to more intense floods in some decades in Dresden”. Even 62% (rather) agree to all three mentioned consequences, 21% (rather) agree to two of the mentioned consequences and only 7% (rather) disagree (or don’t know) to all three mentioned consequences.

Table 1: Perceptions about causes of climate change (n=605)

Answers [%]		Climate change is mainly due to natural climate fluctuation				
		agree absolutely	rather agree	rather disagree	disagree absolutely	don't know
Climate change is mainly due to human activities	agree absolutely	12	10	15	9	2
	rather agree	5	12	6	1	0
	rather disagree	6	5	1	1	0
	disagree absolutely	4	1	0	0	0
	don't know	1	1	0	0	3

Table 2: Perceptions about consequences of climate change (n=605)

Answers [%]	agree absolutely	rather agree	rather disagree	disagree absolutely	don't know
Climate change will lead to more intense floods in some decades in Dresden	41	28	13	6	12
Climate change will lead to higher risks due to groundwater floods	54	27	8	3	8
Climate change will lead to more extreme weather events like torrential rain	62	25	5	2	5

Table 3: Perceptions about the importance of different scopes of policy

Name two of the following scopes of policy in Dresden which are particularly important		
	number of entries	% of given answers
combat climate change	127	11
flood protection	139	12
educational policy	245	21
social policy	242	21
crime reduction	188	16
economic promotion	189	16
don't know	34	3

From six mentioned scopes of policy, “combat climate change” was the one least often perceived as important by the interviewed people (Table 3). And also “flood protection” was not very popular. “Educational policy” and “social policy” were the scopes most often perceived as important. Therefore, only 4% of the interviewed people mentioned both, “combat climate change” and “flood protection” as important scopes of policy. 19% mentioned “flood protection” and 17% mentioned “combat climate change” as being important. However, 60% of the people mentioned only other scopes of policy as being important.

3.2 State of private precaution

The most popular precautionary measures which had been undertaken before as well as after their latest flood event by many households were the flood adaptation of the use, the storage of hazardous substances upstairs as well as the adaptation of the interior fitting (Fig. 1). With only 16%, surprisingly few households had collected information about flood precaution before the flood. However, this was the most popular measure undertaken after the flood. Excluding the collection of information and only focussing on precautionary measures which are as such able to mitigate flood losses: 53% of the interviewed households have undertaken 3 or more precautionary measures, 39% have undertaken one or two measures and 8% have not undertaken any precautionary measures before or after their last experienced flood event.

Take in Figure 1

The most popular emergency measures undertaken by more than 50% of the households were neighbourly help, putting moveable contents from the cellar to higher stories, installation of water pumps as well as the safeguarding of documents and valuables (Fig. 2). 66% of the interviewed households have undertaken three or more emergency measures, 24% have undertaken one or two emergency measures before or during their latest flood event. About 10% of the households have not undertaken emergency measures before or during their last experienced flood event.

Take in Figure 2

3.3 Factors influencing private precaution

To get a first impression about the connections between the indicators for the perceptions of climate change, precautionary and emergency measures their correlations were calculated (Table 4). Interestingly, the perception about the consequences of climate change is significantly correlated with the emergency measures indicator. That means, the more consequences are expected due to climate change (e.g. more intense floods and higher risks due to groundwater floods and more extreme weather events), the more emergency measures were undertaken. Additionally, the precautionary indicator is significantly correlated with the emergency measures indicator as well as the perception about the consequences of climate change is significantly correlated with the perceived importance of climate change and flood protection politics. However, the indicators for the perceptions of climate change are certainly not the only factors influencing the motivation to undertake precautionary and emergency measures.

Table 4: Rank correlation (Spearman's rho) between the indicators for the perceptions of climate change, precautionary and emergency measures (n= 454)

	Precautionary indicator	Emergency measures indicator	Importance of climate change and flood protection politics	Perceptions about causes of climate change	Perceptions about consequences of climate change
Precautionary indicator	1.00	0.11*	-0.05	0.01	0.00
Emergency measures indicator		1.00	0.01	-0.04	0.08*
Importance of climate change and flood protection politics			1.00	0.05	0.18*
Perceptions about causes of climate change				1.00	0.06
Perceptions about consequences of climate change					1.00

* coefficients are significant at the 0.10 level (two-sided)

To better understand the interaction between more of the factors that might influence the motivation to undertake precautionary and emergency measures a PCA was performed (Table 5). Six significant principal components were extracted on the basis of the Kaiser criterion (Kaiser, 1960). They account for 58% of the total variance. To assess which components strongly influence the motivation to undertake precautionary and emergency measures, the precautionary and emergency measures indicators were included in the PCA. Additionally, factor scores of each component were calculated by regression, and the correlations between the factor scores and the precautionary and emergency measures indicators were analyzed.

Table 5: Component loadings for factors that might influence the motivation to undertake precautionary and emergency measures (principal component analysis with varimax rotation)

Topics	Items	Components*					
		1	2	3	4	5	6
Perceptions of climate change	Perceptions about causes of climate change	0.19	-0.01	0.16	-0.06	-0.71	-0.07
	Perceptions about consequences of climate change	-0.15	-0.25	0.64	0.31	0.12	-0.32
	Importance of climate change and flood protection politics	-0.03	0.26	0.00	0.63	-0.04	-0.06
Flood experience	Absolute monetary building loss caused by latest event	0.06	0.74	-0.09	0.01	0.11	-0.11
	Absolute monetary contents loss caused by latest event	0.10	0.70	0.06	0.02	-0.05	0.02
	Year of the latest flood event	0.01	-0.02	0.14	-0.18	0.48	0.52
	Number of flood experiences before the latest event	0.00	-0.09	-0.06	0.06	-0.09	0.84
Socio-economic structure of household	Ownership structure: tenant or owner of flat/building	0.71	0.19	0.06	0.07	0.09	0.10
	Number of people in household	0.49	-0.27	-0.19	-0.27	0.02	-0.23
	Number of children below 6 years old in household	0.24	0.05	0.06	-0.02	0.64	-0.14
	Number of persons above 75 years old in household	0.15	-0.22	-0.08	0.75	0.03	0.05
Private precaution	Perception of social rank of interviewee	-0.05	-0.05	-0.79	0.16	0.14	-0.14
	Precautionary indicator (number of precautionary measures undertaken before and after the latest event)	0.65	0.02	-0.02	0.14	-0.08	0.01
Coefficient of correlation (Pearson)	Emergency measures indicator (number of emergency measures undertaken before and during the latest event)	0.53	0.29	0.45	-0.22	0.12	-0.09
	Precautionary indicator	0.65	0.02	-0.02	0.14	-0.08	0.01
	Emergency measures indicator	0.53	0.29	0.45	-0.22	0.12	-0.09

* Six significant principal components were extracted on the basis of the Kaiser criterion, i.e. 6 components had eigenvalues greater than one (Kaiser, 1960). They account for 58% of the total variance. Number of valid cases is 136. The components can be characterised as follows: 1 “socio-economy”; 2 “economic losses; 3 “consequences of climate change and social rank”; 4 “politics and number of elderly”; 5 “causes of climate change and number of children”; 6 “flood experience”. Bold values indicate variables with absolute loadings > 0.5 and correlation coefficients are significant on a level of 0.01 (two-sided), red numbers indicate the highest loading per item.

The first component is marked by high loadings of the precautionary items as well as socio-economic items, specifically the ownership structure of the flat/building and the size of the household (Table 5). The loadings of the items in component one reveal, that the precautionary and emergency measures indicators are higher for larger households and homeowners. The finding that the more persons are in a household, the more precautionary measures were undertaken corresponds with Brenniman (1994), who found out that one-person households spent the least amount of money on flood protection measures, while households with six or more people spent the most. Additionally, it was shown before, that homeowners are more likely to undertake precautionary measures in comparison with tenants (Kreibich et al., 2005; Grothmann and Reusswig, 2006; Thieken et al., 2007).

The second component is marked by high loadings of items representing the direct economic losses of the household during the last experienced flood event. Perceptions about consequences of climate change as well as about the social rank of the interviewee are the dominating items in the third component. Items about the appraisal of the importance of climate change and flood protection politics as well as the number of persons above 75 years old in household dominate the fourth component. The fifth component is marked by high loadings of the perceptions about causes of climate change and the number of children below 6 years old in household. The loadings of the items in components three to five suggest that the perception of climate change is closely linked to the social-economic structure of the household: People who attribute themselves with a higher social rank agree to more of the mentioned consequences of climate change. The less persons above 75 years old in household, the less judge climate change and flood protection politics important. Most households with no children below 6 years old believe that climate change is due to both mentioned causes, most households with one or two children below 6 years old (rather) agree that climate change is mainly due to human activities. The sixth component is marked by high loadings of flood experience items (year of the latest flood event and number of flood experiences before the latest event; Table 5).

The precautionary and emergency measures indicators are significantly correlated with component one. Additionally, the emergency measures indicator is significantly correlated with components two, three and four. Thus, the most important factors influencing private precaution are the ownership structure and the size of the household. Additionally, undertaking emergency measures is influenced by flood experience (specifically the direct economic losses during the last experienced flood), perceptions of climate change (specifically about consequences of climate change and the importance of climate change and flood protection politics) and socio-economic structure of the household (specifically the number of persons above 75 years old in household and the perception of social rank). It is surprising that component 6, which represents flood experience in terms of year of the latest flood event and number of flood experiences before the latest event, is not correlated to precautionary and emergency measures indicators. Many studies have shown that flood experience is a significant factor for the motivation to undertake precautionary measures (Kreibich et al., 2005; Grothmann and Reusswig, 2006; Siegrist and Gutscher, 2006; 2008; Thieken et al., 2007).

4. Conclusions

Despite the fact, that the majority of interviewed people believe in an increase of flood hazard and risk due to climate change, their perception of climate change is only very weakly linked to the motivation to undertake precautionary and emergency measures. Other socio-economic factors like the ownership of the residential building and the size of the household are much more important. In order to improve the uptake of flood mitigation and climate change adaptation measures, public awareness raising campaigns and schemes utilizing financial and non-financial incentives should be undertaken. Such campaigns should particularly focus on specific social-groups, like tenants or singles. For instance, precautionary measures which significantly mitigate contents losses and which are easy to apply by tenants like the flood adapted use of endangered stories (Kreibich et al., 2005) should be promoted in areas where renting is common. Awareness rising campaigns focusing on the causes and consequences of climate change are expected to have little effect on the peoples motivation to act.

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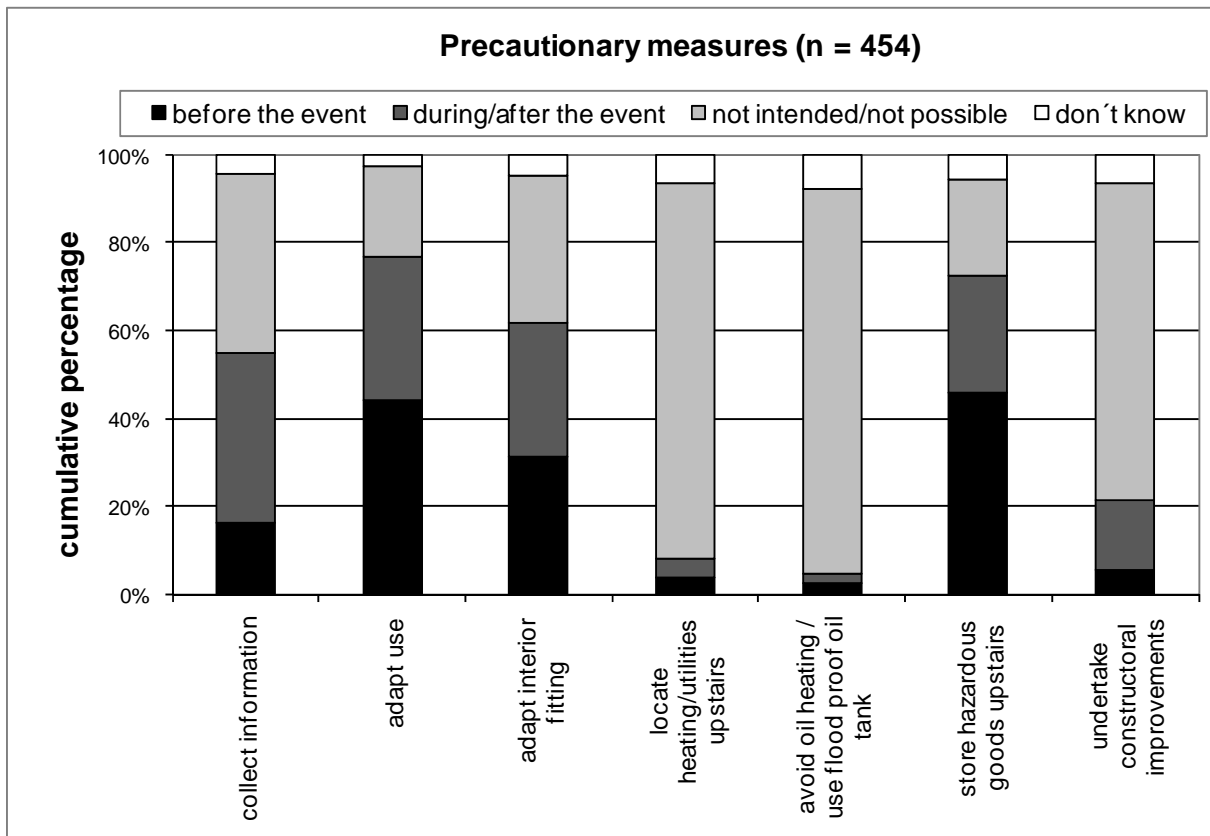


Figure 1: Proportion of households, which undertook specific measures of precaution before, or during/after their latest experienced flood event, or which do not intend/for which it is not possible to undertake the measure

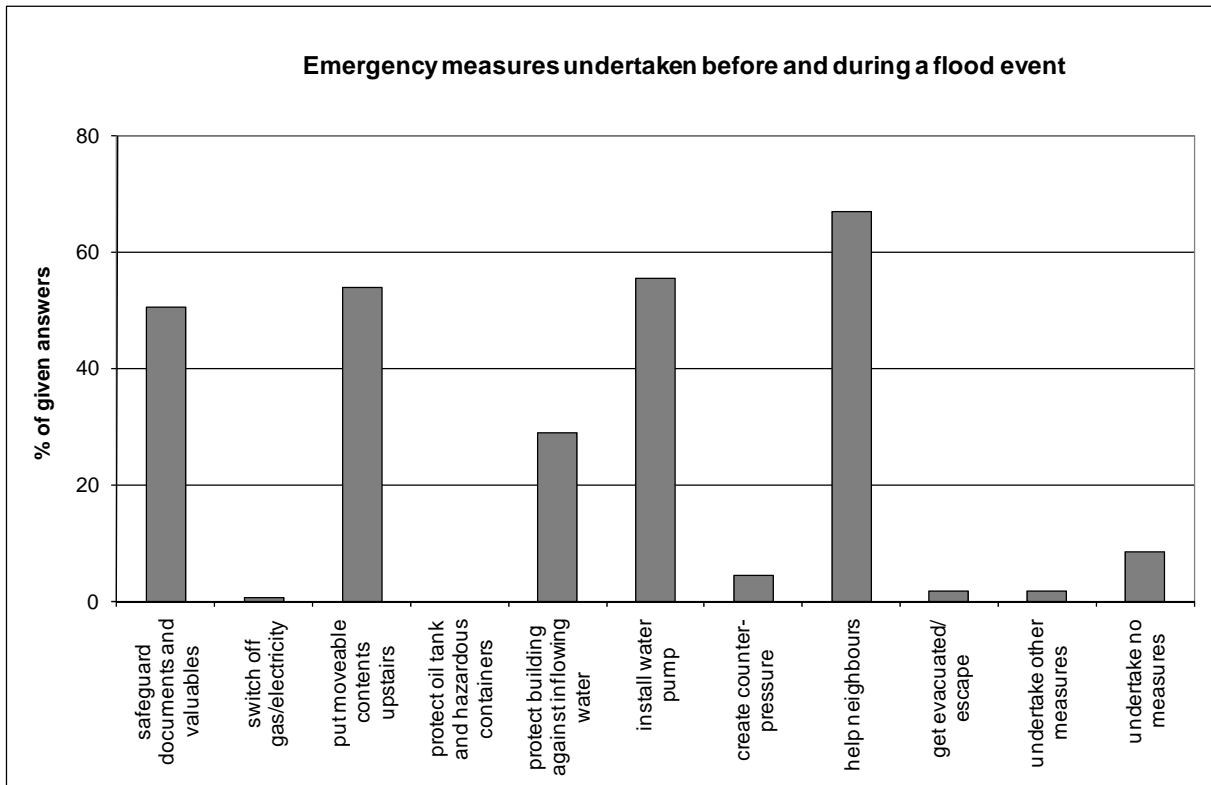


Figure 2: Emergency measures performed by households (n = 454, multiple answers possible)