DNB Working Paper
No 791 / September 2023

Homeowners and flood risk: A disconnect between awareness and actions?

David-Jan Jansen

DeNederlandscheBank
EUROSYSTEEM

Homeowners and flood risk: A disconnect between awareness and actions?

David-Jan Jansen*

* Views expressed are those of the author and do not necessarily reflect official positions of De Nederlandsche Bank.

Working Paper No. 791

September 2023

De Nederlandsche Bank NV
P.O. Box 98
1000 AB AMSTERDAM
The Netherlands

Homeowners and flood risk:
A disconnect between awareness and actions?

David-Jan Jansen

This version: September 22, 2023
First draft: April 2023

Abstract

For homeowners, climate change can have implications through physical as well as transition shocks. Based on two surveys among Dutch homeowners, we find evidence for a disconnect between awareness and intentions to mitigate. Owners of at-risk properties are ten percentage points more likely to see floods as the main threat to their home. However, at-risk owners are also five percentage points less likely to consider improving their property's energy efficiency. Trust in flood protection turns out to be a relevant factor. In particular, at-risk owners with high levels of trust are less likely to consider improvements in energy efficiency. We discuss implications for risk communication.

JEL codes: Q54, Q56, D14

Keywords: homeownership, floods, mitigation, risk communication

---

Acknowledgements: With thanks to Wilko Bolt, Wouter Botzen, Maurice Bun, Carin van der Cruijsen, Maarten van Rooij, and participants in a DNB seminar for constructive feedback. Miquelle Marchand, Natalia Kieruj, and Stein Jongerius (Centerdata) were very helpful in arranging the surveys. Any errors and omissions remain my own responsibility. Views expressed in this paper do not necessarily coincide with those of de Nederlandsche Bank or the Eurosystem. Disclosures: none.

Affiliations: De Nederlandsche Bank, Amsterdam, The Netherlands, e-mail: d.jansen@dnb.nl; Vrije Universiteit Amsterdam, Amsterdam, The Netherlands, e-mail: d.jansen@vu.nl; Tinbergen Institute, Amsterdam, The Netherlands.

1 Introduction

Climate change is increasingly seen as a source of financial risk. In line with the seminal speech by Mark Carney (2015), various policymakers and academics have discussed how transition shocks (such as more stringent carbon pricing) or physical shocks (such as floods or heatwaves) can have financial impacts. The focus of the debate has been, to a large extent, on expert stakeholders. For instance, Battiston et al. (2017) find that climate policy risk can affect large banks from the euro area. Also focusing on implications for financial institutions, Vermeulen et al. (2021) analyse EUR 2.3 trillion in assets and find that disruptive transition paths can decrease portfolio values by up to 11%. Based on a survey of 861 finance professionals, Stroebel and Wurgler (2021) report that experts identify regulatory risk as the top climate risk to businesses and investors over the next five years.

This paper shifts the focus from financial experts to households, in particular homeowners. Homeownership has important macrofinancial implications, for instance when housing wealth affects private consumption (Mian et al., 2013; Graham and Makridis, 2023) or when credit-driven housing booms lead to financial crises (Jordà et al., 2013; Jordà et al., 2015).

Climate change can affect homeowners in various ways. The threat of rising sea levels may affect the value of at-risk properties (Beltrán et al., 2018; Hino and Burke, 2021; Fuerst and Warren-Myers, 2021). In addition, extreme weather events can lead to property damages (Pistraka and Jonkman, 2010; Beltrán et al., 2019). From the perspective of transition risk, homeowners need to consider the energy efficiency of their property. Relatively inefficient properties could imply higher energy bills or lower sales values (Allcott and Greenstone, 2012).

This paper first studies whether homeowners are aware of climate hazards to begin with. Then, it considers whether climate risk awareness goes hand in hand with a greater propensity to act. There is prior evidence that

homeowners have difficulty in assessing climate-related risks. Botzen et al. (2013) report that for a sample of New York residents only a minority have accurate perceptions of their flood probability, damage and risk. Likewise, Mol et al. (2020) find that Dutch residents overestimate the probability of floods and underestimate the maximum expected flood depth.

Given that this paper uses surveys of Dutch homeowners, we also focus on flood risk. Close to one quarter of the Dutch land mass lies below sea level, and around 80% of the population lives in areas at risk from flooding.[1] The last major flood to hit the Netherlands took place in 1953, when a storm caused a range of dike breaches in the province of Zeeland. Over 1,800 people lost their lives in this flood. More recently, in the summer of 2021 local floods caused large damages in the south of the Netherlands.

This paper uses two survey waves, one from spring 2021 and one from spring 2023. Both waves asked respondents to indicate which climate-related hazard would be most damaging to their property. Our first test is whether owners of properties located in at-risk areas are more likely to report floods as the number one threat.

Secondly, this paper studies intentions to act. We focus on mitigation, i.e. actions that households could undertake to counter climate change. For homeowners, a key step here would be improving the energy efficiency of their property.[2] However, a meta-analysis by Hornsey et al. (2016) concludes that climate change beliefs have, at best, only a moderate effect on people's willingness to act. Nauges and Wheeler (2017) find that economic

[1] The details in this paragraph are from `https://themasites.pbl.nl/o/flood-risks/` URL last accessed on 18 April 2023.

[2] Households could also adapt, that is take actions to deal with the consequences of climate change. Noll et al. (2022) find that perceived flood probability and damage have nearly no effect on motivating households' adaptation actions. However, Endendijk et al. (2023) find that timely warnings before flooding can help households in taking emergency actions like placing sandbags.

incentives can at least somewhat affect decisions of non-environmentally-motivated households. Our survey also asked respondents to report on their willingness to invest in energy efficiency.

Turning to results, this paper finds evidence for a disconnect between climate awareness and mitigation. On the upside, we find that owners of at-risk properties are ten percentage points more likely to see floods as the main threat to their home. We also find awareness of flood risk increased over time. However, at-risk owners are not more likely to think often about ways to improve their property's energy efficiency. Trust in flood protection turns out to be an important reason behind this disconnect. Owners of at-risk properties who have trust in the Dutch system of flood protection are significantly less likely to consider improvements in energy efficiency.

This paper proceeds as follows. Section 2 discusses the set-up of the two surveys and also outlines the empirical methodology. Section 3 presents the evidence for a disconnect between awareness and action, while Section 4 explores the role of trust in flood protection. Section 5 concludes and discusses implications for climate risk communication.

2 Data and methods

This paper draws on two surveys among Dutch households. The first wave of the survey was conducted in spring 2021. The survey was then repeated in spring 2023. The survey was held among the members of the Centerpanel. Centerdata, a research centre affiliated to the University of Tilburg, has been operating this survey since the 1990s. Other studies using survey data from the Centerpanel include Coibion et al. (2022), Christelis et al. (2020), Van der Cruijsen et al. (2015), and Van Rooij et al. (2012). The fact that we can study two survey waves is helpful in light of recent events. First, we can study whether the 2021 summer floods have affected the awareness of flood risk. Second, we can study whether the strong increase in energy inflation

since end-2021 has affected homeowners readiness to invest in improving energy efficiency.

We use five questions that focus on climate change and energy efficiency. All panel members aged 16 or older were invited to fill in the questionnaire. In this paper, we focus on the responses by homeowners. Section 1 of the Appendix lists the questions as they were available for the panel members.

For the first question, participants could indicate which risk they saw as the largest threat to their current place of residence. We provided the survey participants with nine options. Most of these options related to climate-related physical risks, such as extreme rain, high wind speeds, or floods. Even though there is no link with climate change, we also included earthquakes as an option, as there have been an increasing number of quakes in the northern part of the country in recent decades. These earthquakes are linked to the exploitation of the Groningen gas field.[3]

Two further questions focused on energy efficiency. First, we asked the participants to report how often they considered improving the energy efficiency of their property. We used a three-point scale ranging from *never* to *often*. Second, we asked participants about the current energy label of their residence. Here, we group the possible energy labels into four categories. These four categories range from high (label A or better) to low (label F or G).

Two final questions focused on damages and flood protection. First, we asked participants to indicate whether their place of living had been damaged by nature-related events. Here, we focused on four possibilities: damages from earthquakes, wind, floods, and precipitation. Second, we asked about participants' trust in flood protection. Survey participants could indicate, on a five-point scale, how much protection they thought was offered

[3]For background, see `https://dataplatform.knmi.nl/dataset/aardbevingen-cijfers-1`. URL last accessed on 24 April 2023.

by Dutch dikes.

Using the survey responses, we estimate various linear probability models. To facilitate the interpretation, we use dependent variables that are binary dummies.[4] The first of these models uses the answers to the first survey question and studies whether owners of at-risk properties are more likely to rank floods (either from rivers or the sea) as the most relevant risk. Based on the second survey question, another probability model studies whether owners of at-risk properties are more likely to think often about improving energy efficiency.

We estimate panel regressions, where $T = 2$ and $n = 2{,}144$. The panel is unbalanced: only 1,301 respondents filled in both questionnaires.[5] Given that the vast majority of respondents ($\geq 97\%$) did not move houses between the two survey dates, we have opted for a random effects specification of the individual specific effects. The panel regressions have the following general form:

$$y_{it} = \mu + \beta_1 AtRisk_{it} + \boldsymbol{x}'_{it}\boldsymbol{\beta} + \omega_t + \alpha_i + \epsilon_{it} \tag{1}$$

where i is an index for survey respondents, and t indexes years (2021/2023). The dependent variable y is a binary dummy indicating, respectively, awareness of flood risk (Q1) or thinking often about improving energy efficiency (Q2). The vector $\boldsymbol{x}$ has two types of variables. First, we include a range of socio-economic covariates, such as age, gender, and education. Second, we include information on the energy label (Q3) and experience with nature-related damage to the property (Q4). Using ω_t, which is a dummy for the 2023 survey wave, we can study changes in awareness and intentions to act over time. Lastly, α_i and ϵ_{it} are i.i.d. error terms.

The key variable in equation (1) is $AtRisk$. This variable is a binary

[4] Section 2 of the Appendix shows that conclusions are comparable when using a multinomial logit model instead.

[5] The conclusions remain comparable when using a balanced sample. Results available upon request.

dummy that indicates whether a respondent's property is located in a postal-code area (measured at the four-digit level) that is at risk from floods. To measure flood risk, we use official flood maps provided by the Dutch government.[6] When *AtRisk* takes the value of zero, this means that the property is not at risk. A value of 1 indicates that the property can be at risk from floods, either from rivers or the sea.[7]

Table 1 provides descriptive statistics for respondents to both survey waves. Per wave, the table shows a split between owners of properties that are either at risk from floods (columns 2 and 5) or not (columns 1 and 4). In both survey waves, most respondents were men, older than 50, and responsible for the financial decisions of the household.

(insert Table 1 around here)

3 Main results

We begin with an overview of the key patterns in terms of awareness and intentions to act. Figure 1 summarizes key patterns separately for the 2021 survey wave (the left four bars) and the 2023 wave (the right four bars). The black bars denote the fraction of respondents who see floods as the main risk to their property. The grey bars denote the fraction of homeowners that often consider improving energy efficiency. Per year, the responses are broken down by whether or not the respondent's home lies in a part of the Netherlands that is at risk from floods.

(insert Figure 1 around here)

[6] Source: `https://basisinformatie-overstromingen.nl`. URL last accessed on 30 April 2023.

[7] Given the very low number of observations involved, we exclude respondents who live in areas unprotected against floods from the analysis.

A few points stand out in Figure 1. First, owners of at-risk properties are more likely to mention floods as the main threat. In 2021, for instance, 10% of the at-risk owners mentioned floods as the main threat (Figure 1, second black bar). In comparison, less than 3% of the owners of not-at-risk properties thought floods were the main risk (first bar). Second, at-risk owners have become more aware of flood risk between 2021 and 2023. In the second survey wave, 17% of at-risk owners indicated that floods were the main risk (second-to-last bar). Most likely, this is a reflection of the 2021 summer floods, which underlined the inherent risk to the Netherlands. In contrast, the risk assessment of not-at-risk owners did not change over time. Also in 2023, less than 3% of this not-at-risk group saw floods as the main threat to their property (third black bar). Third, over time, homeowners thought more about improving energy efficiency. For the not-at-risk group, the percentage of owners thinking often about improvements increased from 21% to 29% (first and third grey bar). For the at-risk group, the percentage also increased. However, the increase was less strong, namely from from 19% to 21% (second and fourth grey bar). Most likely, this is a reflection of the strong increase in energy inflation since late-2021.

Overall, Figure 1 also suggests a disconnect between awareness and intentions to act. Owners of at-risk properties are more likely to see floods as the main risk to their property. However, there are no indications that these at-risk owners think more actively about improving energy efficiency. In fact, there are indications that at-risk owners think *less* often about energy efficiency. This is in particular the case for the 2023 wave: 21% of at-risk owners think often about energy efficiency compared to 29% of not-at-risk owners.

Turning to regression results, Table 2 presents selected coefficients and standard errors (in brackets, clustered by household) for linear probabil-

ity models.[8] In column 1, the dependent variable is a dummy indicating whether homeowners see floods as the main threat to their property. In column 2, the dependent variable is a dummy indicating whether homeowners often consider making an investment in energy efficiency of their property.[9]

(insert Table 2 around here)

The regression models confirm the disconnect suggested in Figure 1. Owners of a property located in Dutch flood zones are ten percentage points more likely to perceive floods as the main threat to their property (Table 2, column 1). In contrast, these owners are not more likely to think often about improving energy efficiency. The point estimate suggests, in fact, that owners of at-risk properties are five percentage points less likely to think often about improving energy efficiency (column 2).[10]

In terms of the covariates, a few points stand out. Starting with column 1, we find that having experienced earthquake damage makes it nine percentage points less likely that owners see floods as the main risk (Table 2, column 1). Most likely, this result is indicative of the experience of respondents living in the northern provinces of the Netherlands, in particular the province of Groningen. This is a part of the country that is, in principle, at risk from floods. However, floods have not occurred there recently. In contrast, the area has been affected by various earthquakes related to the exploitation of nearby gas fields. Also, we find a significant coefficient for the 2023 year dummy, indicating that awareness of flood risk has in-

[8] A full set of estimation results is available upon request.

[9] Table 2 also includes respondents who answered 'I do not know' to survey questions 1 or 2. Section 3 of the Appendix shows results are similar when excluding these respondents from the analysis.

[10] Another test is whether respondents who see floods as the main threat think more often about energy efficiency. As Section 4 of the Appendix shows, we find no evidence for such a connection.

creased between 2021 and 2023. Turning to the model in column 2, we find that having experienced prior damages to the property mostly goes hand in hand with thinking more often about improving energy efficiency. For instance, having experienced earthquake damage makes it eight percentage points more likely that the homeowner thinks often about energy efficiency. Interestingly, having experienced flood damage is the exception here, as we find no significant point estimate for this variable. Furthermore, we find (as one would expect) that owners of properties that already have high energy labels are significantly less likely to think about further improvements. Also, we find that owners with high levels of education or socio-economic status are more likely to think often about improving energy efficiency (column 2). Lastly, and somewhat disconcertingly, we find that respondents who make a household's financial decisions are five percentage points less likely to think about improving energy efficiency often.

4 The role of trust in flood protection

Next, we consider how trust in flood protection can be important for explaining the disconnect between climate awareness and mitigation. To that end, Table 3 reports selected results from two additional panel regressions. In these additional regressions, we now include a binary dummy for trust in flood protection. Also, we interact this trust variable with the variable for at-risk properties. The trust dummy indicates whether or not respondents have trust in the Dutch dikes.[11] Starting with views on floods, the inclusion of the trust variable and the interaction term does not materially change the conclusions. The at-risk variable remains positive and significant, while the other coefficients for the other two variables are not significantly different from zero (Table 3, column 1). However, we do find that trust in flood

[11] To be precise, the dummy takes the value 1 if respondents chose either 'a large degree' or a 'very large degree' of trust.

protection is relevant for thinking about energy efficiency. Both the trust variable and the interaction term have coefficients that are significantly different from zero at the 1% level (column 2).

(insert Table 3 around here)

Based on these regressions with interactions terms, Figure 2 shows a visual representation of how trust in flood protection matters. The figure shows conditional means for four different groups of homeowners. The top panel focuses on views on flood risk, while the bottom panel shows conditional means for thinking about energy efficiency. In both panels, the horizontal axis indicates whether the homeowner's property is at risk from floods, while the lines differentiate between the level of trust in flood protection. The solid lines in Figure 2 represent replies by homeowners with a large degree of trust in flood protection.

(insert Figure 2 around here)

Trust in flood protection turns out to be relevant for intentions to mitigate, but not for awareness of flood risk. The top panel of Figure 2 shows that owners of at-risk properties are more likely to see floods as the main threat to their property, irrespective of their level of trust in flood protection. Both for owners with low (grey line) and high (solid line) trust, the difference is around ten percentage points. Turning to energy efficiency (Figure 2, bottom panel), the level of trust does become a significant factor. For low levels of trust, owners of at-risk properties are around four percentage points more likely to think often about improvements in energy efficiency than owners of properties that are not at risk (grey dashed line). For high levels of trust, the effect is reversed. Owners of at-risk properties are now six

percentage points *less* likely to consider improvements in energy efficiency than owners who are not at risk (solid line).

5 Conclusions

When it comes to the challenges posed by climate change, it is not always easy for members of the general public to see what one can do. This paper has focused on homeowners, who could contribute to climate change mitigation by improving the energy efficiency of their property.

On the upside, this paper finds evidence for a basic level of awareness concerning climate physical risks. Based on two surveys among the Dutch general public, conducted in 2021 and 2023, we find that owners of at-risk properties are more likely than not-at-risk owners to see floods as the main threat to their property. We also find that awareness of flood risk has increased over time. Most likely, this increased awareness is reflective of the 2021 summer floods, which strongly underlined the inherent vulnerability of the Netherlands to extreme weather.

This paper's second main finding focuses on trust. High levels of trust in flood protection mean that steps towards mitigation are not necessarily taken. In particular, we find that owners of at-risk properties who have trust in the Dutch dikes are significantly less likely to consider improvements in energy efficiency.

As in other settings where complex issues are at stake (Blinder et al., 2023), reaching and convincing households may be fraught with challenges. The growing awareness of vulnerability to floods could be seen as a positive finding, as it can be used as a basis for further climate risk communication. In terms of such climate risk communication, one suggestion is to make explicit that ensuring adequate levels of flood protection will also require continued investments, in particular if climate change continues unabated. Starting with improving energy efficiency today could, therefore, offer a more

direct route to counter the potentially damaging effects of floods.

References

Allcott, Hunt, and Michael Greenstone (2012). Is there an energy efficiency gap? *Journal of Economic Perspectives* 26(1): 3-28.

Battiston, Stefano, Antoine Mandel, Irene Monasterolo, Franziska Schütze, and Gabriele Visentin (2017). A climate stress-test of the financial system. *Nature Climate Change* 7: 283-288.

Beltrán, Allan, David Maddison, and Robert J. R. Elliott (2018). Is flood risk capitalised into property values? *Ecological Economics* 146: 668-685.

Beltrán, Allan, David Maddison, and Robert J. R. Elliott (2019). The impact of flooding on property prices: A repeat-sales approach. *Journal of Environmental Economics and Management* 95: 62-86.

Blinder, Alan S., Michael Ehrmann, Jakob de Haan, and David-Jan Jansen (2023). Central bank communication with the general public: Promise or false hope? *Journal of Economic Literature*, forthcoming.

Botzen, Wouter J., Howard Kunreuther, and Erwann Michel-Kerjan (2013). Divergence between individual perceptions and objective indicators of tail risks: Evidence from floodplain residents in New York City. *Judgment and Decision Making* 10(4): 365-385.

Carney, Mark J. (2015). Breaking the tragedy of the horizon—climate change and financial stability. Speech at Lloyd's of London, 29 September 2015.

Christelis, Dimitris, Dimitris Georgarakos, Tullio Jappelli, and Maarten van Rooij (2020). Consumption uncertainty and precautionary saving. *The Review of Economics and Statistics* 102 (1): 148–161.

Coibion, Olivier, Dimitris Georgarakos, Yuriy Gorodnichenko, and Maarten van Rooij (2022). How does consumption respond to news about inflation? Field evidence from a randomized control trial *American Economic Journal: Macroeconomics*, forthcoming.

Endendijk, Thijs, Wouter J. Botzen, Hans de Moel, Jeroen Aerts, K.

Slager, and M. Kok (2023). Flood vulnerability models and household flood damage mitigation measures: An econometric analysis of survey data. *Water Resources Research* 59.

Fuerst, Franz, and Georgia Warren-Myers (2021). Pricing climate risk: Are flooding and sea level rise risk capitalised in Australian residential property? *Climate Risk Management* 34(100361).

Graham, James, and Christos A. Makridis (2023). House prices and consumption: A new instrumental variables approach. *American Economic Journal: Macroeconomics* 15(1): 411-443.

Hino, Miyuki, and Marshall Burke (2021). The effect of information about climate risk on property values. *PNAS* 118(17).

Hornsey, Matthew J., Emily A. Harris, Paul G. Bain, and Kelly S. Fielding (2016). Meta-analyses of the determinants and outcomes of belief in climate change. *Nature Climate Change* 6: 622–626.

Jordà, Òscar, Moritz Schularick, and Alan M. Taylor (2013). When credit bites back: Leverage, business cycles, and crises. *Journal of Money, Credit and Banking* 45(S2): 3-28.

Jordà, Òscar, Moritz Schularick, and Alan M. Taylor (2015). Betting the house. *Journal of International Economics* 96 (Supplement 1): S2-S18.

Mian, Atif R., Kamalesh Rao, and Amir Sufi (2013). Household balance sheets, consumption, and the economic slump. *Quarterly Journal of Economics* 128(4): 1687-1726.

Mol, Jantsje M., Wouter J. Botzen, Julia E. Blasch, and Hans de Moel (2020). Insights into flood risk misperceptions of homeowners in the Dutch river delta. *Risk Analysis* 40(7): 1450-1468.

Nauges, Céline, and Sarah Ann Wheeler (2017). The complex relationship between households' climate change concerns and their water and energy mitigation behaviour. *Ecological Economics* 141: 87-94.

Noll, Brayton, Tatiana Filatova, Ariana Need, and Alessandro Taberna

(2022). Contextualizing cross-national patterns in household climate change adaptation. *Nature Climate Change* 12: 30-35.

Pistraka, Aimilia and S. N. Jonkman (2010). Damage to residential buildings due to flooding of New Orleans after hurricane Katrina. *Natural Hazards* 54: 413-434.

Stroebel, Johannes and Jeffrey Wurgler (2021). What do you think about climate finance? *Journal of Financial Economics* 142: 487-498.

Van der Cruijsen, Carin A. B., David-Jan Jansen, and Jakob de Haan (2015). How much does the general public know about the ECB's monetary policy? Evidence from a survey of Dutch households. *International Journal of Central Banking* 11(4): 169-218.

Van Rooij, Maarten C. J., Annamaria Lusardi, and Rob J. M. Alessie (2012). Financial literacy, retirement planning and household wealth. *Economic Journal* 122(560): 449–478,

Vermeulen, Robert, Edo Schets, Melanie Lohuis, Barbara Kölbl, David-Jan Jansen and Willem Heeringa (2021). The heat is on: A framework for measuring financial stress under disruptive energy transition scenarios. *Ecological Economics* 190(107205).

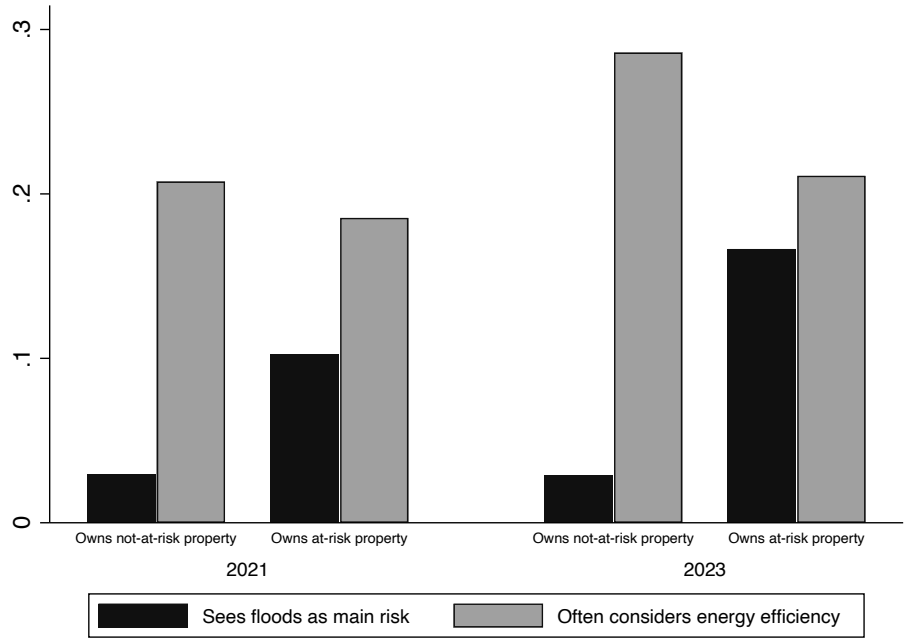

Fig 1. Homeowners' climate awareness and intentions to act

Notes: Based on two surveys among Dutch homeowners. The first four bars summarize information for a survey in spring 2021 (n = 1,696), the right four bars summarize information for a survey in spring 2023 (n = 1,749). The dark bars indicate the fraction of homeowners that see floods as the main climate-related risk threatening their property. The grey bars show the fraction of homeowners that often consider making an investment in improving the energy efficiency of their main residence. Per year, answers are split based on whether or not the respondent is the owner of a property that is located in a part of the Netherlands that is at risk from floods.

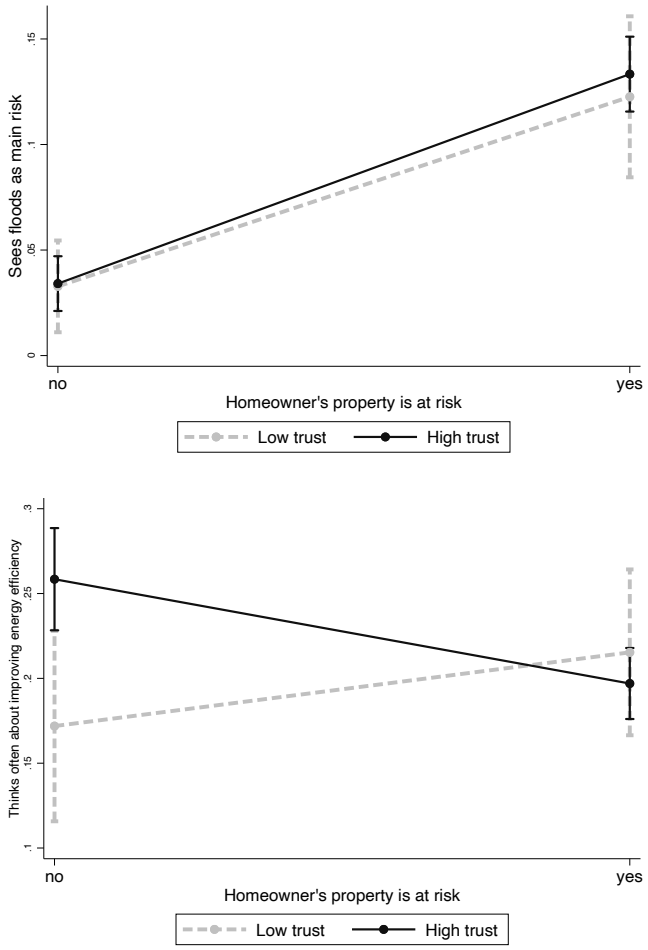

Fig 2. The role of trust in flood protection

Notes: The two panels show conditional means for four different groups of Dutch homeowners based on the estimation results in Table 3. The top panel shows as dependent variable the fraction of homeowners who see floods as main risk. The bottom panel shows the fraction of homeowners who often think about improving energy efficiency. In both panels, the horizontal axis shows whether or not the homeowner's property is located in a part of the Netherlands that is at risk from floods. In each panel, the two lines indicate whether or not the homeowner has a large degree of trust in flood protection. Here, the solid lines denote homeowners who have a large degree of trust in the Dutch flood protection system.

TABLE 1

Descriptives for covariates

Notes: This table shows descriptives for a range of socio-economic covariates. Results based on two survey waves conducted in, respectively, spring 2021 (columns 1 - 3, n = 1,696) and spring 2023 (columns 4 - 6, n = 1,749). Columns 1 and 4 focus on owners of properties that are not at risk from floods, while columns 2 and 5 focuses on owners of at-risk properties. All entries represent fractions of the total sample, apart from socio-economic status, which is reported in levels on a scale from 1 (very low) to 5 (very high). Columns 3 and 6 indicates significant differences based on two-sided t tests; $^{*}p < 0.05$, $^{**}p < 0.01$.

	2021 wave			**2023 wave**		
	Owns a property that is:			**Owns a property that is:**		
	Not at risk	*At risk*		*Not at risk*	*At risk*	
	(1)	(2)	(3)	(4)	(5)	(6)
Male	0.56	0.54		0.54	0.52	
Age						
- 16 to 34	0.04	0.04		0.08	0.08	
- 35 to 49	0.20	0.24	*	0.20	0.24	*
- 50 to 64	0.30	0.33		0.32	0.34	
- 65+	0.47	0.39	**	0.40	0.34	**
Income						
- low	0.34	0.27	**	0.27	0.25	
- middle	0.20	0.23		0.22	0.18	*
- high	0.19	0.21		0.17	0.21	
- n.a.	0.27	0.28		0.34	0.37	
Has university degree	0.11	0.15	*	0.15	0.18	*
Makes financial decisions	0.67	0.71		0.67	0.72	*
Socio-economic status	3.63	3.71		3.75	3.75	

TABLE 2

Homeowners' climate awareness and intention to act

Notes: Selected coefficients and standard errors (in brackets, clustered by household) for random-effects panel regressions. Estimates based on 3,455 responses by 2,144 Dutch homeowners to surveys in 2021 and 2023. In column 1, the dependent variable is a dummy indicating whether homeowners see floods as the main threat to their property. In column 2, the dependent variable is a dummy indicating whether homeowners often consider improving their property's energy efficiency. 'Owns at-risk property' indicates whether a respondent owns a property located in a part of the Netherlands that is at risk from floods. The regressions also include respondents' age, gender, and income. $^{*}p < 0.05$, $^{**}p < 0.01$.

	(1)	(2)
	Floods main threat	**Improve efficiency**
Owns at-risk property	0.10**	-0.05**
	[0.01]	[0.02]
Other owner characteristics		
Has university degree	0.01	0.06*
	[0.02]	[0.03]
Makes financial decisions	0.01	-0.05**
	[0.01]	[0.02]
Socio-economic status	0.02*	0.03**
	[0.01]	[0.01]
Prior damages to property		
- By earthquake	-0.09**	0.08*
	[0.01]	[0.04]
- By wind	0.01	0.04**
	[0.01]	[0.02]
- By precipitation	-0.02	0.04*
	[0.01]	[0.02]
- By flood	0.10	0.07
	[0.06]	[0.08]
Energy label of the property		
- Low	-0.05*	0.02
	[0.02]	[0.04]
- High	0.02	-0.07**
	[0.02]	[0.02]
Year dummy		
2023	0.03**	0.03*
	[0.01]	[0.01]

TABLE 3

The role of trust in flood protection

Notes: Selected coefficients and standard errors (in brackets, clustered by household) for random-effects panel regressions. 'Owns at-risk property' indicates whether a respondent owns a property located in a part of the Netherlands that is at risk from floods. 'Trusts flood protection' indicates that the respondents has a (very) high degree of trust in the Dutch flood protection system. See notes to Table 2 for further details. $^{*}p < 0.05$, $^{**}p < 0.01$.

	(1)	(2)
	Floods main threat	**Improve efficiency**
Owns at-risk property	0.09**	0.04
	[0.02]	[0.04]
Trusts flood protection	0.00	0.09**
	[0.01]	[0.03]
At risk*Trust	0.01	-0.10**
	[0.02]	0.04

Appendix

1. Climate-related questions from the survey

This subsection reports the survey questions on climate risks and mitigation. Members of the Centerpanel were invited to answer these questions at two points in time: spring 2021 and spring 2023.

Q1: Which of these following events is, according to you, the largest threat for your current place of residence?

1. Soil subsidence
2. Extreme precipitation (rain and/or hail)
3. Floods (sea)
4. Floods (rivers)
5. Wind speeds
6. Drought
7. Weakening foundations
8. An earthquake
9. I do not know

Q2: Do you ever consider improving the energy efficiency of your current residence?

1. Often
2. Sometimes
3. Never
4. I do not know

Q3: What is the energy label of your current residence?

1. Between A and A++++
2. B or C
3. D or E
4. F or G
5. My residence does not have an energy label
6. I do not know

Q4: Have you ever experienced that the following events in the Nether-

lands caused damage to your residence?

- An earthquake
- Wind speeds
- Floods (sea/river)
- Extreme precipitation

Options: yes / no / I do not know / I prefer not to say

Q5: How much protection do the Dutch dikes offer according to you?

1. a very small degree
2. a small degree
3. neither small nor large
4. a large degree
5. a very large degree
6. I do not know

2. Results when using logit models

To facilitate the interpretation, the baseline regressions use dependent variables that are binary dummies. This section uses logit models instead, which means the dependent variables now use more of the available information from the various survey questions. Amongst other things, this also means that we can also now consider results for river and sea floods separately.

As Table A.1 indicates, the disconnect between awareness and mitigation is also apparent when using a multinomial logit model. Owners of at-risk properties are more likely to see floods as the main risk. This holds for floods from both the sea (column 1) and rivers (column 2). Owners of at-risk properties are equally likely to think *often* about energy efficiency (column 3) but significantly more likely *never* to think about improving energy efficiency (column 4).

TABLE A.1

Results based on multinomial logit

Notes: Selected coefficients and standard errors (in brackets, clustered by household) for multinomial logit models. $^{*}p < 0.05$, $^{**}p < 0.01$.

	Main threat:		**Improve efficiency:**	
	Sea floods	River floods	Often	Never
	(1)	(2)	(3)	(4)
Owns at-risk property	1.44**	1.87**	-0.18	0.48**
	[0.31]	[0.33]	[0.11]	[0.12]

Turning to the role of trust in flood protection, Table A.2 has coefficients for a multinomial logit model with interactions terms. Here, we focus on mitigation—a comparable model for flood risk awareness would have comparatively few observations per category available to estimate coefficients.

Once again, we find that trust is relevant for thinking about mitigation. Owners of at-risk properties with trust in flood protection are significantly less likely to think often about improving energy efficiency (Table A.2, column 1). At-risk owners are also significantly more likely to never think about improving energy efficiency (column 2).

TABLE A.2

Mitigation: Multinomial logit with interaction terms

Notes: Selected coefficients and standard errors (in brackets, clustered by household) for a multinomial logit model. $^{*}p < 0.05$, $^{**}p < 0.01$.

	Improve efficiency:	
	Often	Never
	(1)	(2)
Owns at-risk property	0.48	0.61*
	[0.28]	[0.30]
Trusts flood protection	0.49*	-0.02
	[0.24]	[0.26]
At risk*Trust	-0.75*	-0.15
	[0.30]	[0.31]

3. Results when dropping 'Do not know' replies

This section shows regression results when dropping respondents who answered 'I do not know' to either survey question 1 or 2. As can be seen in Table A.3, the qualitative conclusions remain unchanged. Owners of at-risk properties are eighteen percentage points more likely to see floods as the main threat (Tabel A.3, column 1). Owners of at-risk homes with a large degree of trust in flood protection are eleven percentage points less likely to think often about energy efficiency (column 4).

TABLE A.3

Regressions w/o 'Do not know' replies

Notes: Selected coefficients and standard errors (in brackets, clustered by household) for linear probability models. The set-up is as in Table 2 of the main text. In this case, we exclude respondents who replied 'Do not know' to either survey question 1 or 2. Columns 1 and 2 are now based on 1,755 observations; columns 3 and 4 on 3,228 observations. $^{*}p < 0.05$, $^{**}p < 0.01$.

	Floods main threat:		**Improve efficiency:**	
	(1)	(2)	(3)	(4)
Owns at-risk property	0.18**	0.18**	-0.05*	0.05
	[0.02]	[0.07]	[0.02]	[0.04]
Trusts flood protection		-0.01		0.08*
		[0.03]		[0.03]
At risk*Trust		0.00		-0.11*
		[0.05]		0.04

4. A direct link between awareness and mitigation?

This section shows regression results for the direct link between seeing floods as the main risk and thinking often about energy efficiency. Table A.4 has results for two regression models where thinking about energy efficiency is the dependent variable. As can be seen, there is no significant coefficient for homeowners who see floods as the main threat (Table A.4, column 1). In this case, there is also no mediating role for trust in flood protection (column 2).

TABLE A.4

Regression results for the link between awareness and mitigation

Notes: Selected coefficients and standard errors (in brackets, clustered by household) for linear probability models. The dependent variable is a binary dummy for homeowners who think often about improving their property's energy efficiency. n = 3,445. $^{*}p < 0.05$, $^{**}p < 0.01$.

	Improve efficiency:	
	(1)	(2)
Sees flood as main risk	0.03	0.10
	[0.03]	[0.08]
Trusts flood protection		0.03
		[0.02]
Flood as main risk*Trust		-0.07
		[0.08]

DeNederlandscheBank

EUROSYSTEEM

De Nederlandsche Bank N.V.
Postbus 98, 1000 AB Amsterdam
020 524 91 11
dnb.nl