Erasmus University Rotterdam

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MS Policy Economics

Rising tides: Understanding the effect of coastal flooding on household-level adaptation outcomes in the United States

RESEARCH PROPOSAL

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Abstract

This proposal outlines a study to explore the effect of coastal flooding on household-level adaptation outcomes in the United States. While existing literature addresses various determinants of flood adaptation, the role of direct flood experiences remains unclear.

The study will utilize data from FEMA's (Federal Emergency Management Agency) National Household Survey, which captures adaptation measures like insurance take up, and community engagement as well as binary reporters on flood experience and socioeconomic covariates. We propose several study designs including pseudo-panel regression and DiD with repeated cross-sections.

Besides addressing a gap in the literature, the findings can guide policymakers in designing more targeted interventions in an effort to increase societal resilience to climate change-induced coastal floodings.

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1. Introduction

Global climate change is systematically driving scale and frequency of natural disasters (Coronese et al., 2019). Coastal regions around the world are bracing for a new wave of storm surges (Sauerborn & Ebi, 2012). With rising sea levels, efforts to mitigate floodings are proving evermore challenging (Haggag et al., 2021). The global change community is shifting focus from mitigation to adaptation (BOTZEN & VAN DEN BERGH, 2009; Wilby & Keenan, 2012). Many of such adaptation measures are implemented on the household level, for instance, elevating housing units, floodproofing foundations, and seeking out flood insurance. The literature is increasingly exploring the determinants of adaptation outcomes. But **what is the effect of flood experience on household-level adaptation outcomes?**

Multiple hypotheses are possible: Firstly, we expect flood experience to heighten individual flood risk perception and awareness, leading to an uptick in household-level adaptation (Pasquier et al., 2020). Secondly, we expect psychological mechanisms like adaptation fatigue and learned helplessness to have an offsetting effect on household-level adaptation (Harries & Penning-Rowsell, 2011). Thirdly, we expect community-level spillovers to affect household-level decision making. A household should be more likely to opt for a certain adaptation measure if that measure is widespread in the household's neighborhood. Vice versa, adaptation measures should be less likely in neighborhoods with low initial adaptation levels (Wilby & Keenan, 2012). Finally, we expect financial constraints and socioeconomic context to play a role in adaptation outcomes (Storbjörk, 2007).

The effect of disaster experience on preparedness is understudied, especially in the case of coastal flood adaptation. This thesis thus aims at filling a small but potentially insightful gap in the literature. This research can help guiding policy in times of unforeseen systemic upticks in coastal floodings. Understanding emergent behavioral responses to ever more severe catastrophes is key to successful climate adaptation.

2. State of the Art

The climate science community is exploring various types and determinants of household-level flood adaptation. A key-word search on science direct and google scholar identified one publication, specifically relevant to our research question. The search string deployed in this initial literature sighting was "flood AND household AND adaptation". Five publications were selected, four were dropped. The remaining paper is a literature review by Koerth et al. (2017), published in Risk Analysis, in 2016.

Koerth et al. (2017) analyze 28 selected publications on household-level coastal flood adaptation for the most predominant types of adaptation measures and their respective determinants of implementation. They distinguish between structural adaptation like house-elevation, elevation of valuables, flood barriers, and usage of flood proof materials on one hand, and non-structural adaptation measures like flood insurance, collecting information, storage, and participation and communication on the other (see

table 2). In the US, households are reported to stock up on nonperishable food and battery-powered radio.

Determinants of adaptation implementation are found to be mainly socioeconomic and cognitive variables, but non-personal variables play a role too (see Table 1). The authors note that age, income, and number of people in the household exhibit ambiguous effect directions. Whereas perceived risk and damage are having a positive effect on disaster preparedness, their effect on the implementation of structural adaptation measures seems to be weak. The meta-study did not mention flood experience as a determinant that has been studied in the community.

Determinant	Determinant type
Age	Socioeconomic variable
Income	
Gender	
Education	
Family status	
House ownership	
Employment status	
Perceived risk	Cognitive variables
Perceived severity	
Perceived likelihood	
Perceived damage	
Perceived efficacy	
Perceived responsibility	
Experience	
Awareness	
Governmental assistance	Situational variables
Social norms	
Style of occupation	
Distance to water	Geographic variables
Living in a high-risk area	

Table 1: Determinants of adaptation implementation. Selected variables from Koerth et al. (2017).

3. Research Gap

Various determinants of household-level flood adaptation exist. Their effect direction and size seem to be dependent on regionality and other case-specific, non-individual factors. Interdependencies between determinants are possible. The literature on these determinants is still sparse. We recognize that personal experience of past floodings as a determinant for flood adaptation has not been studied yet – neither in the US nor elsewhere. We thus derive the following research question:

What is the effect of flood experience on household-level flood adaptation?

4. Research approach

Given the theories outlined in the introduction, there is no consensus on an underlying mechanism that explains the effect of flood experience on adaptation behavior. Some mechanisms even propose a negative effect direction. **We will perform a second-round literature review to form a robust hypothesis.**

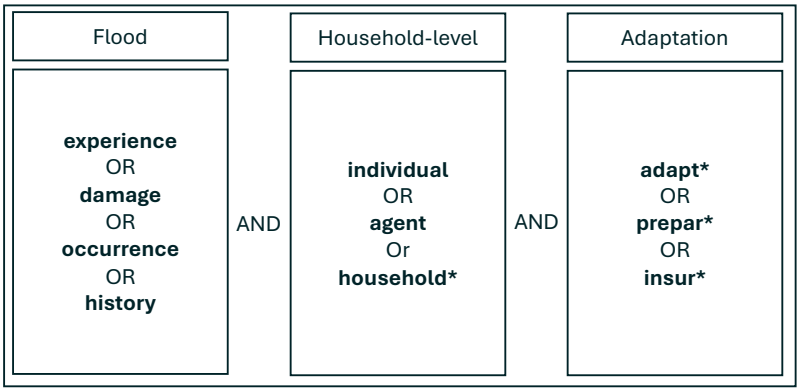

Figure 1: Search String

The Federal Emergency Agency publishes results from their annual survey on disaster preparedness in the National Household Survey (*National Household Survey | FEMA.Gov*, 2023). The data sets reach back to 2017 and capture the relevant variables such as past flood experience, selected adaptation measures, and selected determinants. However, **since the data is anonymized, we cannot trace back single households and their (changes in) behavior over time**. Two approaches are thus feasible: Pseudo panel-analysis and difference in difference with repeated cross sections.

In a pseudo panel design, we will group the data into cohorts of similar covariates. This approach allows us to analyze cohort-level behavior with time-fixed effects. With several hundred data points per year, data sparsity might limit explanatory power, depending on the variance in the covariates.

In a difference in difference approach, we will capture adaptation behavior in the treatment group post treatment. Here, treatment refers to having experienced flood damage and control refers to having had no such experience. Note, however, that cross-contamination between treatment and control might be possible. Adaptation behavior might be influenced by neighbors, as noted in the aforementioned hypothesis on community spillovers. If relationships that are not necessarily geographically bounded, such as family and friendships across the country are sufficiently influencing adaptation behavior, a geographic separation between treatment and control group might fail to sufficiently rule out cross-sample contamination. The literature revie will provide more clarity.

We rule out random effects, spatial regression discontinuity, and synthetic control designs. A dynamic pseudo-panel approach comes with high demands for data quality and causal identification but is generally possible. Depending on the outcome variable,

we will combine the aforementioned analysis designs with a binary outcome model such as logit or probit.

To prevent "Hypothesizing After the Results are Known" (Kerr, 1998), we will decide on a specific outcome variable a priori. Table 2 is listing the possible outcome variables. Structural adaptation measures, as described by Koerth et al. (2017), are not included in the data. The dataset also contains a candidate input variable. "cfld_exp" captures, whether a household member has experienced flood damage in the past. See table 4 in appendix for a full list of relevant variables, including covariates.

Adaptation type	**Adaptation measure**	**Variable**
Structural measures	House elevation	Not in the data
	Valuables elevation	Not in the data
	Flood barriers	Not in the data
	Flood-proof materials	Not in the data
Non-structural measures	Flood insurance	**Cfld_prepactions_b**: "Documented and insured property"
	Collecting information	**Clfd_awareness**: "…have you read… about how to get better prepared for coastal flooding?"; **cfld_prepactions_d**: "learned my evacuation routes"
	Storage	**Cfld_prepactions_a**: assembled or updated supplies"
	Participation and communication	**Cfld_prepactions_c**: "got involved in the community"

Table 2: Adaptation measures and corresponding variables in the dataset

5. Timeline

I am currently **interning as an asset allocation analyst with Rothschild & Co in Zurich**. The internship will last until June 31, 2025, with a possibility to prolong my employment until September 30, 2025. **I am also currently writing my thesis for the MS Engineering and Policy Analysis at TU Delft**, for which I have been granted a submission deadline. I am going to work on this thesis during the weekends and plan on handing in a full thesis proposal by the given deadline. I am aware of that hard deadline for my final thesis submission on November 1,2025.

Bibliography

BOTZEN, W. J. W., & VAN DEN BERGH, J. C. J. M. (2009). Managing natural disaster risks in a changing climate. *Environmental Hazards*, *8*(3), 209–225. https://doi.org/10.3763/ehaz.2009.0023

Coastal Inundation Dashboard—NOAA Tides & Currents. (n.d.). Retrieved January 7, 2025, from https://tidesandcurrents.noaa.gov/inundationdb_info.html?utm_source=chatgpt.com

Coronese, M., Lamperti, F., Keller, K., Chiaromonte, F., & Roventini, A. (2019). Evidence for sharp increase in the economic damages of extreme natural disasters. *Proceedings of the National Academy of Sciences*, *116*(43), 21450–21455. https://doi.org/10.1073/pnas.1907826116

Haggag, M., Siam, A. S., El-Dakhakhni, W., Coulibaly, P., & Hassini, E. (2021). A deep learning model for predicting climate-induced disasters. *Natural Hazards*, *107*(1), 1009–1034. https://doi.org/10.1007/s11069-021-04620-0

Harries, T., & Penning-Rowsell, E. (2011). Victim pressure, institutional inertia and climate change adaptation: The case of flood risk. *Global Environmental Change*, *21*(1), 188–197. https://doi.org/10.1016/j.gloenvcha.2010.09.002

Kerr, N. L. (1998). HAKing: Hypothesizing After the Results are Known. *Personality and Social Psychology Review*, *2*(3), 196–217.

Koerth, J., Vafeidis, A. T., & Hinkel, J. (2017). Household-Level Coastal Adaptation and Its Drivers: A Systematic Case Study Review. *Risk Analysis*, *37*(4), 629–646. https://doi.org/10.1111/risa.12663

National Household Survey | FEMA.gov. (2023, December 22). https://www.fema.gov/about/openfema/data-sets/national-household-survey

Pasquier, U., Few, R., Goulden, M. C., Hooton, S., He, Y., & Hiscock, K. M. (2020). "We can't do it on our own!"—Integrating stakeholder and scientific knowledge of future flood risk to inform climate change adaptation planning in a coastal region. *Environmental Science & Policy*, *103*, 50–57. https://doi.org/10.1016/j.envsci.2019.10.016

Sauerborn, R., & Ebi, K. (2012). Climate change and natural disasters – integrating science and practice to protect health. *Global Health Action*, *5*(1), 19295. https://doi.org/10.3402/gha.v5i0.19295

Storbjörk, S. (2007). Governing Climate Adaptation in the Local Arena: Challenges of Risk Management and Planning in Sweden. *Local Environment*, *12*(5), 457–469. https://doi.org/10.1080/13549830701656960

Wilby, R. L., & Keenan, R. (2012). Adapting to flood risk under climate change. *Progress in Physical Geography: Earth and Environment*, *36*(3), 348–378. https://doi.org/10.1177/0309133312438908

3 Appendix

Variable	**Description**
Cfld_prepactions_a	Assembled or updated supplies
Cfld_prepactions_b	Documented and insured property
Cfld_prepactions_c	Got involved in the community
Cfld_prepactions_d	Learned my evacuation routes
Cfld_prepactions_e	Made a plan
Cfld_prepactions_f	Made my home safer
Cfld_prepactions_g	Planned with neighbors
Cfld_prepactions_h	Practiced emergency drills or habits
Cfld_prepactions_i	Safeguarded documents

Cfld_prepactions_j	Saved for a rainy day
Cfld_prepactions_k	Signed up for alerts and warnings
Cfld_prepactions_l	Tested family communication plan
Cfld_prepactions_m	None of the above (exclusive)
Cfld_prepactions_n	Don't know (exclusive)

Table 3: Variables of adaptation measures and their corresponding description in the survey

Use	Variable	Description
id	**id**	Unique respondent ID
Spatial id	**state**	What is the name of the state or territory you live in?
	geographic_division	CALCULATED FIELD Geographic division
	census_region	CALCULATED FIELD Geographic region
	zipcode	What is your ZIP Code?
	county	What county in [state] do you live in?
Proxies/ candidates for y	**cfld_awareness**	In the past year, have you read, seen, or heard any information about how to get better prepared for coastal flooding?
	cfld_perception	Thinking about the area you live in, how likely would it be for coastal flooding to impact you?
	cfld_exp	Have you or your family ever experienced the impacts of coastal flooding?
	cfld_prepactions_a-cfld_prepactions_n	What have you done to prepare for coastal flooding in the last year?
	cfld_stepshelp	How much would taking steps to prepare help you get through coastal flooding?
	cfld_confidence	How confident are you that you can take steps to prepare for coastal flooding?
	cfld_soc	Thinking about preparing yourself for coastal flooding, which of the following best represents your degree of preparedness?
	cfld_floodzone	Do you live in a designated flood zone?
	cfld_driving	If you come across a flooded road while driving, what is the BEST thing to do?

	cfld_safetyafter_a-cfld_safetyafter_f	Which of the following are health/safety issues you would be concerned about after a flood?
	cfld_atleast1_prepaction	CALCULATED FIELD Selecting at least one preparedness action for coastal flooding
	cfld_atleast3_prepaction	CALCULATED FIELD Selecting at least three prepardness actions for coastal flooding
	cfld_iawareness	CALCULATED FIELD Having awareness of preparedness information for coastal flooding
	cfld_iexp	CALCULATED FIELD Having disaster experience from coastal flooding
	cfld_iprepefficacy	CALCULATED FIELD Having preparedness efficacy for coastal flooding
	cfld_iperception	CALCULATED FIELD Having risk perception for coastal flooding
	cfld_atleast1_influencer	CALCULATED FIELD Having at least one of four factors that influence preparedness actions (awareness of preparedness information, disaster experience, preparedness efficacy, risk perception) for coastal flooding
	cfld_atleast2_influencers	CALCULATED FIELD Having at least two of four factors that influence preparedness actions (awareness of preparedness information, disaster experience, preparedness efficacy, risk perception) for coastal flooding
	cfld_atleast3_influencers	CALCULATED FIELD Having at least three of four factors that influence preparedness actions (awareness of preparedness information, disaster experience, preparedness efficacy, risk perception) for coastal flooding
	cfld_4_influencers	CALCULATED FIELD Having all four factors that influence preparedness actions (awareness of preparedness information, disaster

		experience, preparedness efficacy, risk perception) for coastal flooding
	cfld_3_prepstages	CALCULATED FIELD Perceived preparedness for coastal flooding collapsed into three categories
	cfld_2_prepstages	CALCULATED FIELD Perceived preparedness for coastal flooding collapsed into two categories
Socio-economic & socio-demographic covariates	**age**	What is your age?
	sex	What is your sex? (includes imputed values and calculated values)
	sex_open	Open ended answer for sex (other)
	education	What is your highest completed level of education? (includes imputed values)
	vocational	Did you attend a technical trade, or vocational school?
	ethnicity	Are you of Hispanic, Latino, or Spanish origin? (includes imputed values)
	race_selfid	Which of the following describes your race? (includes imputed values and calculated values)
	disability	Do you have a disability or a health condition that might affect your capacity to respond to an emergency situation (a mobility, hearing, vision, cognitive, or intellectual disability or physical, mental, or health condition)? (includes imputed values)
	care	Do you currently live with or have primary responsibility for assisting an elderly person or someone with a disability who requires assistance (a mobility, hearing, vision, cognitive, or intellectual disability or physical, mental, or health condition)?
	homeownership_open	Open ended answer for homeownership (other)
	income	Which of the following describes your total household ANNUAL income before taxes? Please include income from wages and salaries, remittances from family members living elsewhere, farming, and all other sources. (includes imputed values)

	rentmortgage	How much do you spend each month on rent or mortgage?
	numadult	Including yourself, how many adults live in your household?
	numchild	How many household members are children under the age of 18?
	numchild_school	#Display if a number greater than 0 is entered in numchild# Does at least one of the children currently attend a school outside of your home, including day-care or part-time kindergarten?
	numchild_school_emerplan	#Display if "Yes" is selected in numchild_school# Are you aware of the school's Emergency Plan(s), including evacuation locations and how to get information about the child if a disaster occurs?
	primarylanguage	What is the primary or main language spoken among those living in your household?
	primarylanguage_open	Open ended answer for primary language (other)
	homeownership	Do you rent or own your home? (includes imputed values)
	employment	Are you currently employed? If not, how long have you been unemployed?
	sixtyplus	CALCULATED FIELD Age collapsed into two groups
	socioeconomically_disadvantaged	CALCULATED FIELD Socioeconomic status based on state, household size, and income
	englishlang	CALCULATED FIELD English is the primary or main language spoken among those living in the household
	rentmortgage_agg	CALCULATED FIELD How much do you spend each month on rent or mortgage? collapsed into four categories
	income_agg	CALCULATED FIELD Which of the following describes your total household ANNUAL income before taxes? collapsed into three categories (includes imputed values)
	sex_original	What is your sex?

	education_original	What is your highest completed level of education?
	ethnicity_original	Are you of Hispanic, Latino, or Spanish origin?
	race_selfid_original_aian	Which of the following describes your race? (selections of American Indian or Alaska Native)
	race_selfid_original_asian	Which of the following describes your race? (selections of Asian)
	race_selfid_original_blackaa	Which of the following describes your race? (selections of Black or African American)
	race_selfid_original_nhopi	Which of the following describes your race? (selections of Native Hawaiian or Other Pacific Islander)
	race_selfid_original_white	Which of the following describes your race? (selections of White)
	race_selfid_original_other	Which of the following describes your race? (selections of Other)
	race_selfid_original_dk	Which of the following describes your race? (selections of Don't know)
	race_selfid_open	Open ended answer for race (other)
	race_selfid_original	Which of the following describes your race? (includes calculated values)
	disability_original	Do you have a disability or a health condition that might affect your capacity to respond to an emergency situation (a mobility, hearing, vision, cognitive, or intellectual disability or physical, mental, or health condition)?
	homeownership_original	Do you rent or own your home?
	income_original	Which of the following describes your total ANNUAL household income before taxes? Please include income from wages and salaries, remittances from family members living elsewhere, farming, and all other sources.
Other covariates	**hometype**	What best describes the type of home you live in?
	hometype_open	Open ended answer for home type (other)
	lgb_selfid	Do you, personally, self-identify as LGBTQIA+?
	lgb_orientation	#Display if “Yes” is selected in lgb_selfid#

		How do you identify your sexual orientation?
	lgb_orientation_open	Open ended answer for LGBTQ+ orientation (other)
	lgb_gender	#Display if "Yes" is selected in lgb_selfid# What is your gender identity?
	lgb_gender_open	Open ended answer for LGBTQ+ gender (other)
	lgb_obstacles	#Display if "Yes" is selected in lgb_selfid# Have you ever experienced obstacles in accessing preparedness resources or services because of your LGBTQIA+ identity?
	lgb_influence	#Display if "Yes" is selected in lgb_selfid# Please select the degree to which your identity as LGBTQIA+ has influenced you to prepare more or less for an emergency or a disaster.
	rel_selfid	Do you consider yourself affiliated with or a member of an organized religion or spiritual practice?
	rel_affiliation_a-rel_affiliation_f	#Display if "Yes" is selected in rel_selfid# What religion or spirituality are you a member of or affiliated with?
	rel_affiliation_open	Open ended answer for religious affiliation (other)
	rel_minority	#Display if "Yes" is selected in rel_selfid# Do you consider yourself to be a religious minority?
	rel_degree	#Display if "Yes" is selected in rel_selfid# To what degree do you consider yourself to be religious?
	rel_attendance	#Display if "Yes" is selected in rel_selfid# How often do you attend religious services?
	rel_pray	#Display if "Yes" is selected in rel_selfid# How often do you pray outside of religious services?

	rel_meditate	#Display if “Yes” is selected in rel_selfid# How often do you meditate outside of religious services?
	rel_scripture	#Display if “Yes” is selected in rel_selfid# How often do you read scripture outside of religious services?
	rel_source	#Display if “Yes” is selected in rel_selfid# Do you receive preparedness information from an organization connected to your religion or spirituality (e.g., sermons, teachings, messages from leaders or teachers, etc.)?
	rel_obstacles	#Display if “Yes” is selected in rel_selfid# Have you ever experienced obstacles in accessing preparedness resources or services because of your religious identity?
	rel_influence	#Display if “Yes” is selected in rel_selfid# Please select the degree to which your religious or spiritual identity has influenced you to prepare more or less for an emergency or a disaster.
	rurality	CALCULATED FIELD Rurality designation based on ZIP code, county, and state
Support variables	**age_imputed**	CALCULATED FIELD Indicator for whether the value in 'age' is imputed
	sex_imputed	CALCULATED FIELD Indicator for whether the value in 'sex' is imputed
	education_imputed	CALCULATED FIELD Indicator for whether the value in 'education' is imputed
	race_imputed	CALCULATED FIELD Indicator for whether the value in 'race_selfid' is imputed
	disability_imputed	CALCULATED FIELD Indicator for whether the value in 'disability' is imputed

	homeownership_imputed	CALCULATED FIELD Indicator for whether the value in 'homeownership' is imputed
	income_imputed	CALCULATED FIELD Indicator for whether the value in 'income' is imputed
	ethnicity_imputed	CALCULATED FIELD Indicator for whether the value in 'ethnicity' is imputed
	date	Date of survey completion
	time	Time of survey completion
	sample	Respondent sample designation
	hazard_weights	CALCULATED FIELD Weight for analysis

Table 4: Selected Variables in "disaster preparedness dataset"