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RESEARCH ARTICLE

Contribution of perceptions to the acceptability of adaptation tools to sea level rise

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ABSTRACT

Using a perception survey of 782 residents of 227 French coastal communities, this study examines the underlying motives for the acceptability of property relocation policies in response to sea level rise. These policies are concerned with new land-use management methods that aim to reduce coastal vulnerability and are recommended for adaptation to climate change. The originality of the approach is to simultaneously analyze both the perception and acceptability of relocation policies and, through econometric models, compare the factors that facilitate or hinder their implementation. A wide variety of variables were tested to demonstrate the complexity of social and psychological determinants. The data show 52% of the sample have a negative perception of relocation. The results highlight social norms and perceived sense of control as the variables that could help increase acceptability of relocation. Therefore, efficiency and trust in the implementing institutions are important to increase acceptability of public policies.

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KEYWORDS
Relocation policies; perceptions; acceptability; sea level rise; theory of planned behaviour

KEY POLICY INSIGHTS

- Low acceptability of relocation policies depends on individual perception of policy feasibility (e.g. level of costs), status of the individual as owner or tenant, level of education and amenities that may benefit the individual (e.g. sea view).
- Citizens who believe their opinions are not shared by others are more likely to oppose relocation.
- Quality of governance influences the acceptability of relocation measures to citizens, notably through the inclusion of risk considerations in urbanization strategies, the existence of positive consent to a specific tax system, and by recognition of the courage of elected representatives to implement these policies.
- By adopting the theory of planned behaviour, we identify opposing or contradictory attitudes and behaviours. These demonstrate the existence of a NIMBY phenomenon and the importance of the degree of perceived control over relocation as key to acceptance (behaviour), which may be disconnected perceptions about relocation.

1. Introduction

Climate change makes shoreline areas particularly vulnerable to sea level rise because of high residential and tourist urbanization (IPCC, 2019). Rising sea levels have magnified storm surges and coastal flooding. In addition to the potential increase in the loss of human life and material damage, there will be a considerable structural economic impact on property markets and insurance mechanisms (Henderson, 2018; Treuer et al., 2018). Long-

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term coastline management policies must adapt to reduce coastline vulnerability by avoiding risk exposure through property relocation and the development of a risk culture that enables people to live with risk (Abel et al., 2011; Bongarts Lebbe et al., 2021; Hino et al., 2017; Lawrence et al., 2021; Magnan et al., 2020; McGinlay et al., 2021; Rocle et al., 2020). Despite the avoided costs and advantages for human safety, relocation policies still receive strong opposition from inhabitants who are attached to their places of residence and the amenities derived from proximity to the sea (Dachary-Bernard et al., 2019). Moreover, those most at risk are more often opposed to relocation. Potential resistance can thus lead to electoral issues. Consequently, elected representatives are often unwilling to implement such projects owing to their high costs, the legal constraints of coastline laws, and the political risk of low levels of public acceptability[1] (Gibbs, 2015).

Besides strengthening the awareness of risk, new risk management strategies rely on a profound change in land governance. This encompasses a shift that juxtaposes technical responses and expert knowledge, through recognition of the natural shifting of coastlines, on the one hand, and interest in more resilient natural infrastructures and relocation strategies on the other (Bongarts Lebbe et al., 2021). A considerable body of research and experimentation with relocation policies has highlighted the associated psychological, social, and political obstacles. The focus is often on risk perception, both cultural (Douglas, 1992) and psychometric (Lupton, 1999). These works underline the role of sociodemographic variables as well as that of previous risk experience and risk memory. For instance, Treuer et al. (2018) found a correlation between the level of worries about submersion risk and the decision to move. In general, this study considered the role of social interaction. Several surveys have shown the importance of social norms and positions adopted by families and friends (Adler et al., 2019; King et al., 2014; Kousky et al., 2018; Treuer et al., 2018). The study by Hino et al. (2017) provides 27 examples of relocation to show the importance of individual factors and of the perception of retreat zones; norms played a role among households initially opposed the idea of relocation, but households changed their opinion when they observed neighbours agreeing to be relocated. Moreover, the role of place attachment and, more globally, the sense of place, is considered in past research (Lewicka, 2011; Navarro et al., 2020).

In contrast, fewer institutional dimensions are included yet these are important to influence decisions. Institutional dimensions comprise elements such as the time period, characteristics of implementation (more or less debated, for instance), and the impact of trust placed by populations in institutions in charge of policies. Some studies have emphasized the importance of compensation procedures and governance, especially with respect to transparency of the relocation process (Kloos & Baumert, 2015; Lawrence et al., 2021). Trust in institutions, the level of information, and the existence of public debates have been shown to be influential (Hino et al., 2017; King et al., 2014; Piggott-McKellar et al., 2019). This literature supports the idea that to achieve a higher degree of acceptability of relocation policies, it is crucial to identify the degree to which people are aware of the risks, the factors determining resistance to relocation, and the types of bias or strategic behaviour that might explain their resistance.

These are acceptability constraints that suggest that anticipation strategies must be preventively implemented (Bongarts Lebbe et al., 2021; Gibbs, 2013; Haasnoot et al., 2021; Hino et al., 2017; Kloos & Baumert, 2015; Lawrence et al., 2021; Zavar et al., 2022). Adopting a strategy of anticipation means favouring voluntary and proactive measures that are disconnected from immediate risk. Therefore, these proactive measures suffer from the activation of psychological barriers identified in the literature (i.e; denial, low risk perception …). As underlined by Hino et al. (2017), most previous relocation measures have been applied after storms and severe damage. Conversely, when these measures are anticipating risk or implemented in a preventive manner, legal action may impede implementation. Thus, it is necessary to complement anticipation with information and communication campaigns.

In summary, both individual and collective factors drive decision-making in any adaptation or relocation policy context. A conjunction of resistance factors are, on the one hand, individual (the way in which one perceives: the risk, place attachment, relevance of the policy, for example). On the other hand, there are collective factors that are linked to the social dynamics and interactions in decisions and actions within a population

[1]In our study, the term relocation is used in the sense of relocation measures or relocation policies, whether in terms of perceptions or acceptability.

(what neighbours do, in particular). However, there is also a temporal and social link between these individual and collective factors, because these current and individual perceptions are ultimately part of a collective dynamic. Perceptions are fleeting and feed a stable and transmissible image of things (to the rest of the population and to future generations) through social representation. Therefore, perceptions can, individually and at present, hinder the implementation of an adaptation policy. However, they can also have a lasting long-term impact by underpinning collective scale responses through constructed social representations of risks or of politics of adaptation.

This study goes beyond the specificities of local stakeholder systems by using a national-scale survey in France to test the explanatory power of the theory of planned behaviour (Ajzen, 1985; Ajzen & Fishbein, 1980). The focus of this research is on relocation policies, and specifically on how individual perceptions of relocation may vary from acceptance behaviour towards relocation. We hypothesize that there would be discrepancies between perceptions and actual behaviours, and our objective is to explain the importance and determining factors of such discrepancies. This hypothesis explains our choice to refer to Ajzen's theory, which allows us to study these divergences. We therefore design two econometric models to assess and compare the determinants of (i) the perceptions of relocation policies and (ii) the level of agreement or acceptability of relocation policies.

The rest of this article is organized as follows. In Section 2, we identify the factors that may determine relocation acceptability based on the theory of planned behaviour. Section 3 explains the methodological protocol of our survey and econometric modelling (perceptions and acceptability). The main results are presented in Section 4 and discussed in Section 5.

2. Explaining resistance to relocation by associating individual and collective factors

We used the theory of planned behaviour (Ajzen, 1985; Ajzen & Fishbein, 1980) which offers an ordered synthesis of individual and collective impacts on human decision-making. This can guide studies on perceptions and their differentiated impacts on behaviour. The theory describes a linear sequence in which four categories of determinants explain a position and then make a final decision (behaviour). In this study, we test each of these dimensions. The first category deals with individual characteristics, which are mainly studied using socio-demographic variables. The second category addresses personal motivations and individual norms. These are the psychological elements and rules that we have made on our own and that condition our attitudes. We integrated these elements by testing perceptions and potential biases (ex., optimism or overconfidence, denial, attachment, and strategic bias). The third category aims to identify the role of subjective norms in influencing personal attitudes. Elster (1989) defined social norms as rules, explicit or implicit, that apply to a group. In the literature, these norms, state (normative norm) or show (descriptive norms) which actions are socially acceptable or unacceptable. In the survey, we tested the perception that participants had of the opinions of others. The fourth category of factors relates to the degree of perceived control, that is, the belief of a person regarding the usefulness of their behaviour, individually and collectively. Finally, Ajzen's sequence explains that attitudes, under social constraints, condition intention. This makes it possible to predict the behaviour of individuals except when there is a low perceived degree of control. Although the intention is clear and behavioural consistency is expected, external elements sometimes block or discourage action or decision. This is a deviation that Ajzen attributes to various factors, in particular, the lack of the necessary resources to take costly action to have the desired impact (i.e. financial, material, time resources, and even human resources in terms of the cooperation necessary for the result to be reached when the issue is collective; also trust – or lack of it – in the institutions or beliefs that an efficient policy will be implemented by skilled institutions).

Based on the sequence proposed by Ajzen, we construct an analytical framework that identifies six themes, with two themes each corresponding to perceptions, acceptability, and results (Figure 1). These themes made it possible to construct the questionnaire used to gather data on these factors (see Appendix A in Supplementary Material). The last two themes refer to the results according to whether there is concordance between the variables determining perceptions (perception modelling, (i) and those determining behaviours (acceptability modelling, (ii). For example, a positive perception implies proactive behaviour in favour of relocation; conversely, a negative perception explains resistance to relocation.

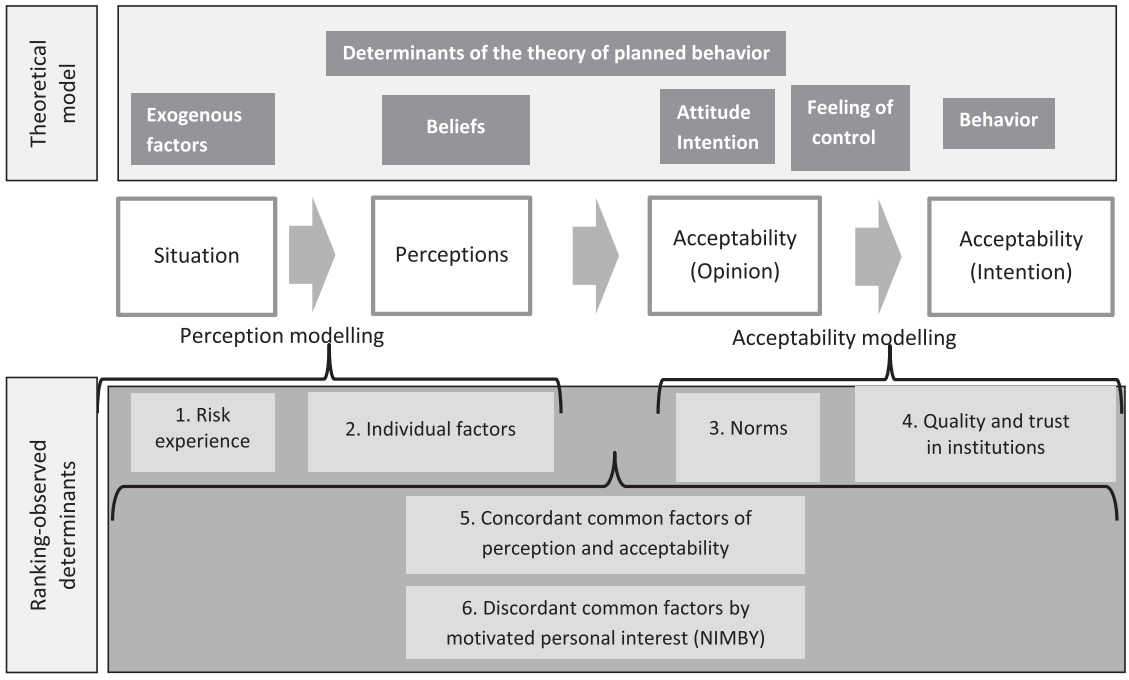

Figure 1. Confronting the categories of significant determinants with the categories of the theory of planned behaviour.

3. Survey protocol methodology and modelling

3.1. Questionnaire design

We designed a questionnaire to assess the respondent's acceptability of relocation policies. Based on our literature review, we included sections to identify the factors that could determine these perceptions, in particular, the perception of flood risks, attachment to place and proximity to the sea, trust in institutions, and environmental concerns (Table 1).

The aim was to conduct a national-scale approach, the first of its kind in France, on this topic, and the questionnaire was designed for online use. However, it was pretested using an exploratory survey of 198 residents in four coastal communities (Grau du Roi, Grande Motte, Carnon-Mauguio, and Palavas les Flots) located near Montpellier in the South of France. This study enabled us to standardize some questions based on free responses to the open-ended questions. During the initial survey, the average length of the questionnaire was 15 min. For the national online survey, the questions concerning coastline management were preceded by the photographs reproduced below on a smaller scale (Figure 2) and text that aimed to provide basic and consistent information: 'Until now, management policies for coastline erosion and flooding consisted of building groynes or breakwaters and replenishing beaches with sand. In the medium term (after 2050), sea level rise will cause flooding of low-lying areas and an increase in the strength of storm surges due to higher water levels. Therefore, the intention is to implement the relocation of the seafront roads and dwellings

Table 1. Questionnaire structure.

Themes	Number of questions
Location and attachment to the sea	5
Perception of the risk of coastal flooding	6
Perception of relocation policies	17
Perception of the quality of institutions of coastal governance	12
Environmental concern	11
Respondents' socio-demographic profile	19

Figure 2. Visual presentation showing coastline management methods.

Table 2. Assessment scale.

Strongly agree		Agree		Somewhat agree		Somewhat disagree		Disagree		Strongly disagree
10	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	

that are most at risk. The aim of these measures is to reduce property loss, physical danger, and environmental damage.'

Finally, to facilitate assessment, a large number of questions were formulated in association with a Likert scale ranging from 1 to 10 (Table 2).

Moreover, in accordance with Ajzen's theory, our questionnaire included the importance of the feelings individuals have about the fact that their opinions (about the relevance and feasibility of relocation) are shared within the community and by public decision makers. These factors account for Ajzen's perceived degree of control, which depends on the perception that individuals have of the quality of the implemented policies.

3.2. Conducting the survey

Our survey was conducted online using a list of resident addresses in French coastal communities provided by a specialist survey organization.[2] Coastal communities are those that fall under the Coastal Areas Act of 1986, which introduced special features to the town-planning code to control land use, avoid property speculation, and allow free public access to the sea. The exclusion of questionnaires that were incomplete or completed too quickly reduced the sample size from 1,177–782 respondents. In total, 227 coastal communities were surveyed. They were distributed according to their relative length of coastline in France and considering the differences in urbanization according to zones with, for example, a very high population density in the Mediterranean. This resulted in the following shares: 40% Mediterranean (30% of the coastline), 17% English Channel (30% of the coastline), and 43% Brittany and Atlantic (40% of the coastline).

3.3. Objective data on hazards and respondent distribution according to town profile

Since research on the psychology of risk has highlighted the vital role of risk experience, particularly in reducing optimism bias (Richert et al., 2017), we assessed communities' levels of exposure to flooding on the Prim Net commune website[3], run by the French Ministry of Ecology, Sustainable Development and

[2]www.dynata.com
[3]http://macommune.prim.net/

Energy (MEEDDAT). This website lists all the natural disasters that have occurred in French towns. It is important to note that within a given town, flooding may not necessarily have affected the respondents. Since the latter are not geolocated to their residential communities, it is impossible to infer level of flooding exposure. After analyzing the town characteristics, we built two variables for each community based on (i) the total number of floods (on three levels: no floods, one or two, three and more) and (ii) the date of the last flood. It emerged that 29% of the communities had never experienced a flood, 50% had experienced one or two floods, and 21% had experienced at least three floods (with a maximum of seven floods). By comparing the date of the last flood and the respondents' length of residence, we calculated that 58% of the respondents had never experienced a flood since arriving in their location, and the remaining respondents were equally distributed among those who had experienced a flood more than five years ago and those who had witnessed a flood less than five years ago.

The demographic data for each community included the number of inhabitants, residences, and the distribution of primary or secondary homes. Using maps of the coastal areas, we characterized each community's location using three ascending levels of distance from the sea: immediate proximity for communities along the shoreline, close proximity for those along estuaries or deltas, and extended proximity for those slightly farther from the sea. Our sample (Table 3) showed an even distribution among the different community categories.

3.4. Socio-demographic characteristics of the sample population[4]

The average age of respondents in our coastal inhabitant sample was 50 years, with 20.5% over 65 years of age (compared to 21% in the total inhabitants in coastal zones of metropolitan France[5]). Just over a quarter (28%) of respondents had retired (compared to 31% overall in coastal zones nationally). The gender distribution was even with 59% women (compared to 53%), and 65% of respondents lived as couples with an average monthly household income of €2,453. Respondents tended to be homeowners (57% compared to 55%) with an average length of residency in their homes of 12 years (15 years for homeowners and 8 years for tenants) and 47% had lived there for more than ten years. There was a large proportion of educated people, 48% of whom were graduates with higher education. Socio-professional categories were relatively well-balanced: 39% for intermediate-level jobs, employees, and manual workers (compared to 40%), and 10% for executives, skilled self-employed people, shopkeepers, and company owners (compared to 6.4%). Overall, the characteristics of the survey respondents were quite similar to those of the coastal areas of metropolitan France. Thus, we can consider our sample to be representative of the target population.

3.5. Model variables and results

The originality of our approach lies in its aim to study and compare the determinants of (i) the perceptions of relocation and (ii) the level of agreement or acceptability of relocation policies. The key explanatory variables are outlined in Table 4.

A total of 48% of respondents had a positive perception of relocation (hope or opportunity) (Table 5), and the acceptability of relocation for high-risk property (Figure 3) was, on average, 7.4, with 18% totally agreeing (value of 10) and 51% in favour (value from 7 to 9) of relocation. These are the endogenous variables in our econometric model. However, for practical reasons, we did not use raw data from the survey and chose to cluster items for each of the two variables. Thus, for the perception of the relocation variable, we built two levels according to whether individuals had a positive or negative view (we considered the utopian view to be negative). Again, for the acceptability variable, we chose to keep only two levels: acceptable (values between 6 and 10) and unacceptable (less than or equal to 5).

Cross-tabulation analysis revealed a strong correlation between these two variables – positive or negative perception of relocation policies versus relocation acceptability – ($p < 0.01$). It should be noted that a

[4]Comparative data of French metropolitan coastal zones was taken from the National Sea and Coast Observatory (http://www.onml.fr/uploads/media/texte-mediterranee.pdf).

[5]These data cover all municipalities located by the sea and affected by the Coastal Areas Act which imposes specific environmental constraints. In mainland France, the total number of such municipalities is 885.

Table 3. Sample distribution according to community profile.

Number of floods experienced		Date of the most recent flood		Distance from the sea		% of secondary homes		Number of inhabitants	
None	29%	None	29%	Extended	13%	< 10%	49%	> 50,000	33%
1	28%	Av. 2010	30%	Close	52%	10–30%	25%	15–50,000	18%
2	22%	2010–2013	28%	Immediate proximity	35%	> 30%	26%	5–15,000	26%
> 2	21%	2014	13%					< 5,000	23%

quarter of the respondents had self-contradictory perceptions, since they viewed relocation as a threat or harm but were somewhat in favour of it (so finding it acceptable), which leads one to believe that they consider it inevitable.

The clustering of some labels for the endogenous variables of the model shows that they may be considered dichotomous, both for perception and acceptability; thus, we use a binary logit model. Therefore, the endogenous variables in the two models are expressed as follows:

$$y_i = \begin{cases} 1 \textit{ if individual has a positive perception of relocation} \\ (\textit{resp.if he or she considers relocation policies acceptable}) \\ 0 \textit{ if not} \end{cases}$$

A latent variable y_i^* is thus defined for the individual *i*:

$$\begin{cases} y_i^* = 1 & si \quad Z_i \geq c \\ y_i^* = 0 & si \quad Z_i < c \end{cases} \text{with } Z_i = X_i\beta + u_i$$

in which X_i is a vector of explanatory, quantitative, or qualitative variables (see Table 4), β a vector of coefficients to be estimated, and u_i a random term. If we posit that this random term is distributed according to the Gumbel distribution, with a zero mean and variance equal to $\pi^2/3$, then the expression of the probability that a given individual has a positive perception of relocation (that they consider relocation policies acceptable) is expressed simply as:

$$Prob(y_i = 1) = \frac{\exp(Z_i)}{1 + \exp(Z_i)}$$

It is this type of model that we estimate in the next section.

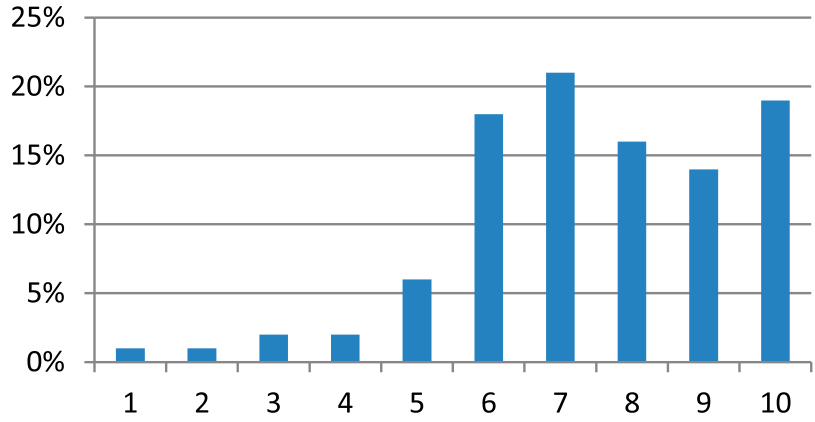

Figure 3. Assessment of relocation acceptability.

Table 4. Explanatory variables of the models of i) perception and ii) acceptability of relocation.

Variables (code)	Aims and categories	Descriptive statistics
Perception of coastal flooding		
Opinion on the impossibility of combatting sea level rise (SLR_opinion)	This variable captures perceptions of the impossibility of combatting sea level rise (scale 1–10).	Mean: 6.8; Standard dev.: 2.5
Perception of the most feared consequences of flooding (flood_fears)	The reference category or label is fear for one's life and that of one's family. Respondents could also have no fear by not believing themselves to be at risk (cat2) or they could fear an increase in insurance premiums (cat3), taxes (cat4), property damage (cat5), a decrease in property value (cat6), or psychological impact through stress or depression (cat7).	The most feared consequence is an impact on life or health (28%) followed by impacts on housing (damage or loss of property value (20%) and an increase in taxation (15%)). The remainder corresponds to respondents who are not affected.
Perception of relocation policies		
Perception of coastal management policies (management_option)	Respondents had to choose between relocation, the reference, and the construction of breakwaters to dampen wave strength (cat2), building dikes (cat3), and building housing on stilts (cat4).	Relocation is the most cited (38%), followed by breakwaters (33%), dikes (25%), and housing on stilts (4%).
Financial feasibility of relocation	The degree to which the high costs of relocation are prejudicial to its implementation (scale 1–10).	Mean: 6.1; Standard dev.: 1.9
Loss of proximity to friends	Assessment of consequences of relocation in sensitivity to loss of social bonds and sea view (scale 1–10).	Mean: 4.7; Standard dev.: 2.6
Loss of sea view		Mean: 5.3; Standard dev.: 2.7
Role of norms, values, and networks		
Unshared opinion about relevance of fighting against the sea (inhabitants_common_opinion)	Respondents assessed whether they thought it was vain to support relocation when opinions were not shared by others (scale 1–10)	Mean: 5.7; Standard dev.: 1.5
Courage of elected representatives	Perception of the courage required to implement relocation policies	Mean: 7.6; Standard dev.: 1.8
Fairness of public funding (fair_funding)	Public funding of adaptation to coastal flooding is fair because solidarity is required in the face of risk (scale 1–10)	Mean: 6.3; Standard dev.: 1.8
Location and proximity to sea attachment		
Sea view (sea_view)	The reference category concerns respondents who have a sea view compared to those with none (cat1) or only from afar (cat2). It is an indicator of proximity to the sea since having a sea view from a distance does not necessarily indicate proximity to the shoreline.	70% respondents had no sea view, 22% only from afar, and 8% had a sea view
Childhood memories linked to the coast (coast_childhood)	A binary variable (yes/no) indicating the importance of place attachment.	Roughly half of respondents (52%) had childhood memories linked to the sea.
Housing status	Housing attachment differs between owners and tenants	57% of respondents own their homes
Perception of the quality of institutions and coastal management		
Inclusion of risk in urban planning regulations	Assessing respondent awareness of the role of inadequate risk planning and anticipation in land-use management (scale 1–10)	Mean: 5.3; Standard dev.: 1.9
Level of feedback information from institutions on the effectiveness of measures	Variable assessing how well-informed respondents feel about the effectiveness of coastal management measures and the action against flooding (scale 1–10)	Mean: 5.5; Standard dev.: 2.0
Taking collective interest into account	Respondents' opinion on how far coastal management is implemented in the collective interest (scale 1–10)	Mean: 6.3; Standard dev.: 1.7
Concern and commitment		
Concern by relocation (Relocation_concern)	Variable designed to assess whether individuals feel concerned by relocation (concerned, unconcerned, or do not know)	Only 6% of respondents felt directly concerned by relocation

(*Continued*)

Table 4. Continued.

Variables (code)	Aims and categories	Descriptive statistics
Consent to pay more taxes for relocation	Assessing commitment according to willingness to contribute to fund this policy (scale 1–10)	Mean: 4.6; Standard dev.: 2.3
Consent to pay more taxes for coastal zones	Commitment is assessed at a wider level through the use and management of the coast in general (scale 1–10)	Mean: 5.0; Standard dev.: 2.2
Experience of flooding	Number of years since the last flood in the community	Mean: 5.9; Standard dev.: 6.9
Environmental concern		
Environmental concern (variable taken from the NEP scale)	Respondents indicated their level of agreement with statements about humans having the right to rule over nature (Likert scale from 1 (strongly disagree) to 5 (strongly agree))	Mean: 1.7; Standard dev.: 1.0 (90% strongly disagree or disagree with the statement)
Socio-demographic profile		
Educational level	Number of years' study beyond secondary school in five levels	26% of respondents had no secondary school diploma, 26% had a secondary school diploma, 24% had a diploma corresponding to two years of study beyond secondary school, 15% had done three or four years, and 10% had done five or more years (Number of years of further education: Mean: 1.6; Standard dev.: 1.4)
Number of months residing in the community (Months_part_r_ vs annual)	This variable aims to distinguish between primary and secondary residents.	Mean: 11.5; Standard dev.: 1.6 Only 5% of the sample did not reside in the community all year-round.

Table 5. Global perception of relocation policies.

Opportunity	19%	Hope	29%	Utopia	23%	Threat	12%	Harm	17%
Positive view 48%				Negative view 52%					

4. Econometric estimation of the perception of relocation policies and their acceptability

4.1. Perception of relocation policies

Results of the binary logit model for the 'Global perception of relocation policies' variable are presented in column (i) of Table 6 which shows the coefficient estimates and their significance. The modelled probability is that of having a positive perception of relocation. The goodness of fit is presented in the Appendix B (see Supplementary Material). The model is globally valid with a pseudo-R^2 of 0.1482, which is satisfactory for this type of model. It correctly predicted 67% of the global individual observations and 71% of the negative perceptions of relocation. All explanatory variables or labels are statistically significant (5% Type I error for quantitative variables and Type 3 effects lower than or equal to the 5% threshold for qualitative variables, Table 6).

From an economic or psychological perspective, it is interesting to analyze the signs associated with the explanatory variables or labels at a 10% threshold. For the 'coastal flood management option,' the choice of traditional management methods ('build dikes' or 'breakwaters dampening waves') negatively affects the probability of a positive perception of relocation (reference category). Logically, individual concern for proximity to the sea lowers the probability of positive perception, whereas concern for the loss of friendships, which may be rebuilt in retreat zones, increases the probability of positive perception. The opinion that relocation is unfeasible due to high costs lowers positive perceptions, which is also linked to the courage of representatives trying to implement relocation. The same is true for being a tenant in one's residence, as well as for residing there year-round. A positive perception is also influenced favourably by the belief that policies are implemented for the collective good, as is the case when individuals are in favour of taxation

Table 6. Econometric estimation of binary logit models.

Variables	Categories	Relocation perception (i) Coefficient (*p*-value)	Relocation acceptability (ii) Coefficient (*p*-value)
Intercept		−1.3215** (0.0381)	0.000960 (0.9994)
Perception of coastal flooding risk			
Opinion on impossibility of fighting sea level rise		/	0.1116* (0.0666)
Fears of flooding	Loss of life and family risk	/	−0.2102 (0.5837)
	None because unconcerned	/	Ref.
	Higher insurance premiums	/	−0.5895 (0.2307)
	Higher taxation	/	−0.6245 (0.3675)
	Severe damage	/	−0.2256 (0.6244)
	Decrease in property values	/	−2.0203*** (0.0002)
	Stress or depression risk	/	0.9097 (0.7264)
Perception of relocation policies			
Management option	Relocation	Ref.	Ref.
	Breakwaters dampening waves	−0.8736*** (<.0001)	−1.5067*** (0.0027)
	Building dikes	−0.9526*** (<.0001)	−1.3079** (0.0125)
	Building housing on stilts	−0.6226 (0.1456)	−1.9933*** (0.0059)
Concern about loss of friendship		0.0793** (0.0166)	/
Concern about loss of sea view		−0.1150*** (0.0003)	/
Financial feasibility of relocation		−0.0982** (0.0213)	−0.2318*** (0.0062)
Role of norms, values, and networks			
Feeling of unshared opinions		/	−0.2677*** (0.0051)
Courage of elected representatives		0.2037*** (<.0001)	0.8328*** (<.0001)
Fairness of public funding		/	0.1654* (0.0733)
Location and proximity to sea attachment			
Sea view	Yes, direct	/	−1.0754** (0.0247)
	No	/	Ref.
	Yes, from a distance	/	−0.6845** (0.0418)
Childhood memories linked to the coast	Yes	/	Ref.
	No	/	−0.5985** (0.0442)
Ownership status	Yes	Ref.	/
	No	0.3248** (0.0500)	/
Perception of the quality of institutions and coastal management			
Inclusion of risk/urban planning		/	−0.2315** (0.0233)
Feedback information/measure effectiveness		/	0.1891** (0.0464)
Collective interest		0.1170** (0.0229)	/
Concern and commitment			
Concern by relocation	Yes	1.1520** (0.0023)	/
	Do not know	0.1474 (0.5005)	/
	No	Ref.	/
In favour of higher relocation taxes		0.2152*** (0.0012)	0.3274*** (0.0020)
In favour of higher coastal zone taxes		−0.1525** (0.0230)	−0.2521** (0.0155)
Length of time since last flood		−0.0427** (0.0167)	/
Environmental concern			
Environmental concern (NEP scale)		0.2258*** (0.0050)	/
Socio-demographic profile			
Educational level		−0.1504*** (0.0080)	/
Number of months residing in the community	All year	Ref.	/
	Part of the year	−0.8061** (0.0434)	/

*** significant at 1%, ** significant at 5%, * significant at 10%.

specifically dedicated to relocation. Being unconcerned and having longer time intervals since the last flood negatively impacted positive perceptions. The same is true when people favour taxation for coastal development (which implies maintaining current policies) and, in a more self-contradictory way, higher educational levels (number of years beyond secondary school).

In conclusion, in our sample, the model-predicted probability of having a positive perception of relocation is 0.4790 (Table 7), which fits with the descriptive statistics of our sample (see Table 5). The elasticity of the probability of a positive perception of relocation and acceptability of relocation related to various explanatory items is presented in Table 7.

Table 7. Elasticities of the two probabilities.

Variables	Categories	Perception of relocation (i)	Acceptability of relocation (ii)
Probability at midpoint		0.4790	0.9753
Perception of coastal flooding risk			
Opinion on impossibility of combatting sea level rise		/	+0.00%
	None because unconcerned	/	Ref.
	Decrease in property value	/	−3.30%
Perception of relocation policies			
Management option	Relocation	Ref.	Ref.
	Breakwaters dampening waves	−37.55%	−1.80%
	Building dikes	−40.70%	−1.39%
	Building housing on stilts	/	−3.20%
Concern about loss of friendship		+0.16%	
Concern about loss of sea view		−0.26%	
Financial feasibility of relocation		−0.26%	−0.0%
Role of norms, values and networks			
Feeling of unshared opinion		/	−0.01%
Courage of elected representatives		+0.67%	+0.03%
Fairness of public funding		/	+0.01%
Location and proximity to sea attachment			
Sea view	Yes, direct	/	Ref.
	No	/	−1.00%
	Yes, from a distance	/	−0.51%
Childhood memories linked to the coast	Yes	/	Ref.
	No	/	−0.43%
Ownership status	Yes	Ref.	Ref.
	No	+13.07%	/
Perception of the quality of institutions and coastal management			
Inclusion of risk/urban planning		/	−0.01%
Feedback information/measure effectiveness		/	+0.01%
Collective interest		+0.32%	/
Concern and commitment			
Concern by relocation	Yes	+40.81%	/
	Do not know	Ref.	/
	No	+0.43%	/
In favour of higher relocation taxes		−0.33%	+0.01%
In favour of higher coastal zone taxes		−0.09%	−0.01%
Environmental concern			
Environmental concern (NEP scale)		+0.17%	/
Socio-demographic profile			
Educational level		−0.11%	/
Number of months residing in the town	All year	−34.81%	/
	Part of the year	Ref.	/

The calculation of elasticities at the sample mean is provided in the formula below ($\overline{Prob(y_i = 1)}$; $\bar{X}$) and is presented in Table 7 (only significant variables):

$$E_{Prob(y_i=1)/X_i} = \frac{\partial Prob(y_i = 1)}{\partial X_i} \times \frac{\bar{X}}{\overline{Prob(y_i = 1)}}$$

For illustrative purposes, at the sample mean, and other things being equal, not being a homeowner increased the probability of having a positive perception of relocation (+13.07%). Similarly, the probability of having a positive perception increased (+40.81%) when the respondents are directly concerned by relocation policies.

4.2. Acceptability of relocation policies

Column (ii) of Table 6 presents the estimation results of the binary logit model for the acceptability of the relocation variable. The modelled probability is that of having a positive acceptability of relocation policies.

The assumed model is globally valid with a pseudo-R^2 of 0.4209, which attests to the goodness of fit (see Appendix B in Supplementary Material). It correctly predicts 90% of the global individual observations and 98% of the acceptability of relocation policies. Analysis of Type 3 effects showed that all variables (or categories) were significant at a threshold of 10%.

Concerning the signs of significant variables or categories (10% threshold), the probability of being in favour of relocation is positively linked to the opinion that it is impossible to combat sea level rise (SLR_opinion). Fear of a decrease in property values following coastal flooding lowers the probability of being in favour of relocation compared to the reference category 'None because unconcerned.' Logically, respondents who think that building housing on stilts is a solution are less in favour than those who think that relocation is the main tool for combating coastal flooding. The more people who believe relocation policies are costly, the less they favour relocation. Location and proximity to the sea also have an impact. Not having a sea view strongly increases the probability of being in favour of relocation, as do memories linked to the coast, which shows attachment to beach maintenance. Finally, we observe that those in favour of relocation are more willing to pay higher taxes but less inclined to support other coastal planning policies that they deem less effective. There is also a link between the acceptability of relocation and respondents' opinions that these risks are not sufficiently taken into account in urban planning documents.

At the sample mean, the probability of being in favour of relocation is 0.9753. To study the sensitivity of this probability to different explanatory variables, we calculated the elasticity of the sample mean (see Column (ii), Table 7).

5. Discussion

Beyond the observation of a link between perceptions and acceptability of relocation policies (see 3.5.), it is interesting to compare the modelling of determinants to find out whether there are common explanatory factors for the two models and the relative weight of each variable in both models. We guided our discussion of the results by using the synthetic framework provided by the theory of planned behaviour to highlight the relationship between perception, intention, and decision (Figure 1). A comparison of the determinants of perceptions and acceptability confirmed the link between factors derived from individual, social, and institutional motivations.

5.1. Concordance between perceptions and behaviours

First, we observed (point 5, Figure 1) the existence of four explanatory factors for both perception and acceptability. The variables emphasized rationality in opinions as follows: it is rational for individuals to be in favour of a policy in which they have a positive perception; that people who support relocation have a negative perception of other measures, and vice versa, those who support alternative policies are less in favour of relocation. When respondents doubt the financial feasibility of relocation, they have a negative perception and are not in favour of it. Those who have a positive perception and are in favour of relocation are also of the opinion that the elected representatives are courageous. They support relocation but are aware that it is difficult to implement, as research has shown (Bongarts Lebbe et al., 2021; Gibbs, 2013; Lawrence et al., 2021; Piggott-McKellar et al., 2019; Rocle et al., 2021). Finally, there is an obvious similarity between perceptions and opinions of relocation when the question of agreeing to taxation arises.

5.2. Confirmation of psychological determinants

Among the determinants of perceptions alone (point 1, Figure 1), the experience and memory of risk are often highlighted in the literature. Effectively, people who believe it is impossible to combat sea level rise are mostly in favour of relocation, while those who are particularly concerned about a decrease in real estate values (more than damage to property or human safety) are not in favour of relocation. This may be explained by the fact that, at the moment, these risks have had no real impact on the property market. While the influence of risk perception is widely shared, depending on the approach, the emphasis is either on the existence of cognitive

bias (optimistic, status quo, or even the selection of information reinforcing perceptions), attachment processes (Navarro et al., 2020), or trade-offs between the expected effects of risks and the current benefits of amenities linked to proximity to the sea (Michel-Guillou & Meur-Ferec, 2016). At the individual level, subjective or intangible variables also intervene (point 2, Figure 1), especially environmental concerns and education. Perceptions differ greatly depending on the respondents' sensitivity to various consequences: people who fear the loss of social bonds after moving house have a more positive perception than those who favour a sea view. Of course, relocation means losing these privileges. The model's explanatory variables on individual opinions, which may have multiple origins, ranging from personality to previous experience or knowledge, in accordance with theories from the field of risk perception.

5.3. Confirmation of the role of social norms and institutional characteristics

The importance of social norms and institutional characteristics that are in favour of or against the acceptability of relocation is akin to an additional facet of perception: one may hold an opinion but also not agree with it because the conditions for its implementation are not met. The first thing to note of is the importance of social norms (point 3, Figure 1), which is revealed in the fact that respondents who believe their opinions are not shared are more likely to oppose relocation. Collective support is necessary to ensure effectiveness. It is unsurprising that norms affect individual acceptability by fostering the idea that a locally-shared opinion increases the degree of perceived control, and thus reinforces intention, which is in line with many studies on the role of social representations and norms. Treuer et al. (2018) and Hino et al. (2017) showed that decisions to move depend, in many cases, on the behaviour of neighbours and friends. More generally, other surveys in France attest to the role of social representation (Chadenas et al., 2023; Michel-Guillou & Meur-Ferec, 2016).

Werners et al. (2021) highlighted the role of governance (point 4, Figure 1) and the involvement of local communities. Based on a review of 19 relocation experiences, the authors demonstrated the need for long-term action plans, role of experience sharing, and establishment of social learning mechanisms. Similarly, the latest report from the Impacts, Adaptation, and Vulnerability Working Group of the IPCC (IPCC, 2022) highlights several conditions related to governance capacity (strengthened community capacity and facilitated tailor-made participation processes) to promote shared understanding.

It also appears that trust in institutions influences perceptions, since people who believe policies are implemented in the public interest often have a positive perception of relocation. This institutional dimension is also found in the variables of funding, public information, and the (positive) assessment of public action (Hurlimann et al., 2014; Rocle et al., 2021). Acceptability of relocation is positively linked to the opinion that (i) it is fair that these measures receive public funding, (ii) citizens are well informed of the effectiveness of the measures, and (iii) risks are included in the process of land-use planning. More generally, a review of 51 articles conducted by Bergquist et al. (2022) shows the importance of factors related to the perceived equity and effectiveness of policies, confirming the role of institutional factors and, therefore, extending the study from perceptions to behaviours for adaptation policies.

5.4. Counter-intuitive observations that refer to the NIMBY

Finally, in connection with our hypothesis that, paradoxically, it is more often the people who are directly concerned who are most against relocation (Michel-Guillou & Meur-Ferec, 2016), we focus on the results on perceptions and acceptability (point 6, Figure 1). Our aim was to understand why those people prefer short-term amenities rather than the public good of managing coastal areas, and their own mid-term financial benefits when faced with loss of property values. The reasoning behind a positive perception but a low level of acceptability is not based on a lack of trust in institutions, but on the priority that individuals allocate to their short-term interests, or more precisely, to the amenities that accompany proximity to the sea; this fits a NIMBY behaviour pattern (Doberstein et al., 2016). The elasticity in our models (see Table 7) highlights the role of perceptions of relocation policies and situational factors that confirm our hypothesis; that is, being directly concerned by

relocation or not, being a homeowner or a secondary resident in the case of perceptions, and having a sea view or not in the case of acceptability.

5.5. Implication for the decision process in the short and long term

Public support for adaptation policy is beginning to emerge thanks to shifts towards flexible and proactive planning processes (McGuire, 2020). As noted by Hinkel et al. (2019), it is a question of distinguishing between support for decisions that are more 'technical' in the short term and those that are more strategic in the long term. Most studies, particularly those focusing on psychometric determinants, emphasize the dissemination of information. However, when the acceptability of relocation involves changes in value, and when there is a wide variety of determinants of perceptions and behaviours, it is necessary to question the type and form of information to display to drive change, according to the type constraints. The segmentation of policy design, presentation, and implementation is crucial. Moreover, proactive and voluntary action (Bongarts Lebbe et al., 2021; Lawrence et al., 2021; Magnan et al., 2020) are important and should be encouraged besides traditional policies.

We have tried to offer a better understanding of the factors that public bodies need to consider when conducting specific information campaigns and revising governance measures. We have shown that factors influencing the feeling of control that individuals have are important, and thereby influence their willingness to accept relocation. A comparison of the two notions – control and acceptance – shows that they are more complementary than their substitutes. Therefore, it is important to consider such factors in the development of information campaigns and accompanying measures, i.e. those that boost public engagement and control in relocation decisions. Recent work on NIMBY behaviour shows that arguments for public interest and benefits are likely to influence acceptability (Doberstein et al., 2016). In our case, another issue is for people who are directly concerned by relocation will want to avoid the loss of property capital when flooding recurs; with the risk of greater damage each time a flood event occurs, they will find it increasingly difficult to insure and sell their property (Adler et al., 2019; Kousky et al., 2018). These people should not be considered selfish or irrational, but as caught in a trade-off between several variables, which makes any interpretation of their situation more complex (Michel-Guillou & Meur-Ferec, 2016; Petrova, 2016). In France, the new law (climate and resilience) of 2021 offers new planning tools to buy back only bare ownership and authorize housing occupation for a few years. This new measure makes it possible to both reduce acquisition costs for city managers and to offer residents time to accept the idea of relocation. Arbitration between dikes and relocation evolves over time and should benefit relocation decisions (Rulleau & Rey-Valette, 2017). Similarly, the law proposes a partnership mechanism between the state and municipalities to promote the implementation of experimental operations. These new measures are decisive for the acceptability of relocation for both residents and city public decision makers (Rocle et al., 2020, 2021).

6. Conclusion

The aim of this work was to test all potential constraints on the acceptability of relocation policies designed to respond to sea level rise. The interest and novelty of our approach lies in jointly modelling the perception of relocation versus the acceptability of relocation policies, and by referring to the theory of planned behaviour. We have attempted to compare the explanatory factors of perception compared to behaviour (to accept or not relocation); we examine the way individual, social, and institutional determinants are involved, and the respective influence of feelings and knowledge of targeted individuals. Cross-tabulation of the two econometric models of perceptions and acceptability shows that, in some cases, particularly for owners concerned by relocation, low acceptability is paradoxically accompanied by a positive perception of relocation. This behaviour can be associated with the NIMBY phenomenon and with the absence of a feeling of control over the policies being implemented.

This approach to understanding perception and acceptability of relocation policy options can be widely generalized to other climate change adaptation measures that involve transition processes concerning value changes. The econometric modelling of the diverse determinants of perceptions and behaviours makes it

possible to better identify the types of measures and incentives that promote proactive behaviour to adhere to the transition. These results show that change in behaviour and practices towards climate change action will result not only from knowledge, but also from a broader approach building off of interaction across individual, social, institutional, cognitive, emotional, and behavioural factors. This approach to tailoring adaptation to sea level rise can be generalized to all transformational change issues related to climate change. For example, we can cite the management of water resources in the face of increasing droughts or the transformation of urban development models to respond to extreme temperatures in the face of the more frequent and severe heat waves.

Effectively, the joint study of the determinants of perceptions and behaviours makes it possible to broaden the range of factors to be considered in policy design and to develop more tailored policy measures with high levels of feasibility and acceptability. On the one hand, such results can help city and regional public decision-makers to design and implement a wider range of policy measures according to the diversity of homeowner profiles identified. On the other hand, the importance of institutional factors points to the need to sensitize decision makers to the role of different methods of implementation a priori (engage those who will be affected by relocation, and to offer flexibility when possible in the timeline for relocation). Of course, national legal frameworks and the multilevel governance of adaptation policies also need to be considered.

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