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Research paper

Assessment of the exposure to coastal flood risk by inhabitants of French coasts: the effect of spatial optimism and temporal pessimism

Marie Coquet, Denis Mercier, Ghozlane Fleury-Bahi

Marie Coquet (corresponding author): Université de Nantes, Laboratoire LETG UMR 6554 CNRS, Campus du Tertre, BP 81227, 44312 Nantes Cedex 3, France, marie.coquet@univ-nantes.fr

Denis Mercier : Sorbonne-Universités, Laboratoire Espaces Nature et Culture ENeC UMR 8185 CNRS, 191 rue Saint Jacques 75005 Paris, France

Ghozlane Fleury-Bahi : Université de Nantes, Laboratoire de Psychologie des Pays de la Loire LPPL EA 4638

ABSTRACT

The increase in coastal population exposure to coastal flood risk can be explained by the concentration of stakes particularly induced by property development in areas exposed to coastal flooding. To this trend is added the sea level rise expected in 100 years, which leads to an increased coastal flood risk. This research analyzes how inhabitants perceive the exposure to coastal flood risk at different spatial and temporal levels. In this way, 318 individuals were surveyed in four coastal municipalities in France (Barneville-Carteret, Saintes-Maries-de-la-mer, Châtelaiillon-Plage and Sainte-Anne). Our research is based on two major assumptions that relate to the optimistic bias. First, we assumed that individuals are likely to perceive proximate areas more favorably than distant areas, in other words their assessment of exposure to coastal flood risk may increase as spatial level increases. Second, we assumed that individuals tend to believe that risk would be greater in the future than in the present, so their assessment of exposure may increase as temporal levels increase. We confirmed those assumptions and determined local and global level as significant levels of assessment. Respondents tend to assess their home exposure lower than the one of more distant spatial levels. However, it is precisely at the local level that prevention and risk reduction measures are the most carried out as they are relevant to community engagement.

KEY WORDS: risk perception; coastal flood risk ; spatial and temporal optimism ; Barneville-Carteret; Saintes-Maries-de-la-Mer; Châtelaiillon-Plage; Sainte-Anne

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1. INTRODUCTION

Coastal flooding is considered as a major risk in regards to the potential losses it can inflict in human, environmental and economic terms. Highly populated coastal areas are particularly exposed (Small and Nicholls, 2003; McGranahan et al., 2007). The sea level rise (Church and White, 2006; IPCC, 2014), the expected increase of coastal population (Nicholls, 2004; Lutz and Samir, 2010) and the concentration of stakes in coastal areas (Michael, 2007; Meur-Ferec et al., 2008) are all factors that contribute to the expected increase of coastal flood risk (Nicholls and Cazenave, 2010). Mc Granahan et al. (2007) determined that the low elevation coastal zones (up to ten meters elevation) represented two percent of the world's lands and contained ten percent of the global population that being 600 million people. Several recent disasters illustrated the growing exposure of low elevation coastal areas to coastal flooding. The Bay of Bengal represents the most exposed region to coastal flooding induced by tropical cyclones. Thus, in 2008, cyclone Nargis caused the death of 130 000 people in Myanmar (Wolf, 2009). The Gulf of Mexico appears also as one of the most exposed regions in the world to coastal floods. In 2005, hurricane Katrina caused more than 1500 deaths and 84 billion dollars damages (Blake et al., 2007).

In France, the last major flood event was associated to storm Xynthia during the night of February 27th and 28th, 2010. More than 50,000 ha of land were flooded, and 55 towns were affected by the flooding in the Atlantic coast. During this tragic event, 47 people died including 41 by drowning (Kolen et al., 2010; Vinet et al., 2012a; Breilh et al., 2014; Chadenas et al., 2014; Creach et al., 2015; Chaumillon et al., 2017). The storm also induced 2.5 billion euros of damages following the flooding (; Lumbroso et al., 2011; Creach et al., 2015). More recently, French Overseas territories in Antilles region were stroked by several cyclones and tropical depressions in 2017. Irma, one of the major cyclones of the 2017 cyclonic season induced coastal floods in Saint Barthelemy and Saint Martin on September 6th.

Following storm Xynthia, which highlighted the necessity to improve coastal risk management, the French government started the revision of the PPRI (Plan de Prevention des Risques littoraux or coastal risk prevention plan). The objective of the PPRI is to organize urbanization considering risks (Pottier et al. 2005; Chadenas et al. 2014) by combining hazard and stakes maps. However, these prevention plans which aim to limit or forbid constructions depending on the exposure to coastal flooding do not take into account inhabitants' perceptions. In this way, it seems necessary to study people's perceptions to understand their attitudes towards prevention measures and risk reduction policies (Lieske et al. 2014; Goeldner-Giannella et al. 2019).

1.1. Individuals' perceptions of coastal flood risk

According to Slovic (1987), "studies of risk perception examine the judgments people make when they are asked to characterize and evaluate hazardous activities and technologies". There are numerous studies about individuals' perceptions of coastal flood risk. Some of them focused on the adaptive

aspect of risk perception and explored what motivates coastal households to adapt to coastal flood risk (Koerth et al. 2013) or what are their preferences about adaptation strategies to coastal flood risk (Boyer-Villemaire et al. 2014). Other research investigated the willingness to cope among inhabitants exposed to coastal flooding (Lemée et al. 2019). The role of place attachment in the willingness to live in exposed areas was also explored (Costas et al. 2015). Studies focused on public's awareness and information seeking about coastal flood risk (Kellens et al. 2012; Lieske et al. 2014), others determined the role of sensitive and intellectual drivers in climate related coastal risks (Goeldner-Gianella et al. 2019). Researchers explored how location affects households' perceptions of coastal flood risk (Combest-Friedman, 2012). Studies were also interested in the place of coastal flood risk in people's representations of their living environment (Michel-Guillou and Meur-Ferec. 2017). At last, researchers explored individuals' perceptions as a component of coastal flood risk vulnerability assessment (Meur-Ferec et al. 2011; Hellequin et al. 2013).

Our research focuses on inhabitants' perception of the exposure to coastal flood risk in four coastal municipalities in France. People assess risk differently according to several individual factors (Slovic, 1987; Cadet et Kouabénan, 2005). This is particularly the case for non-expert individuals unlike expert individuals who tend to assess the risk according to objective data (Slovic and Peters 2006; Fleury-Bahi, 2010). However, although experts' assessments tend to objectivity, they remain incomplete and often divergent (Hellequin et al., 2013). Differences in individual perceptions can be explained by perception biases (Kouabénan et al. 2006), including among them optimistic bias.

1.2. Optimistic bias

Individuals assess risk differently depending on the assessment scale or target (Weinstein, 1980; Sjöberg, 2000; Hermand et al., 2003). This can be explained by an activation of optimistic bias (Weinstein, 1989) which leads individuals to assess the risk as greater for others than for themselves. This may be due to the belief that the probability of experiencing a positive event is higher for oneself than for others (Harris, 1996; Radcliffe and Klein, 2002). This tendency also applies to the assessment of environmental conditions and risks (Schmidt and Gifford, 1989; Uzzell, 2000; Hatfield and Soames Job, 2001; Pahl et al., 2005; Sherman-Morris and Del Valle-Martinez, 2017). Spatial and temporal optimism are two specific types of optimistic bias.

Spatial optimism bias refers to individuals' tendency to see proximate areas more favorably than similar but more distant areas: "things are better here than there" (Gifford et al., 2009; Milfont et al., 2011). Thus, an individual's assessment of risks increases as the spatial scale increases. In fact, individuals assess risks differently at local and global scales (Dunlap, 1993; Uzzell, 2000; García-Mira et al., 2005; Fleury-Bahi, 2008;; Gifford et al., 2009; Milfont et al., 2011).

Temporal pessimism bias refers to individuals' tendency to believe that environmental risks will be greater in the future than in the present: "things will get worse" (Gifford et al., 2009; Milfont et al., 2011). Thus, an individual's risk assessment increases as the temporal scale increases (Dunlap, 1993; García-Mira et al., 2005; Gifford et al., 2009; Milfont et al., 2011).

If spatial and temporal optimism biases are widely explored in social and environmental psychology, as theorized by this discipline, they are rarely studied by geographers interested in risk perception. Nevertheless, in the field of the perception of coastal flood risk, authors mentioned spatial and temporal biases but without determine their effect (Meur-Ferec et al. 2011, Rey-Valette et al. 2012; Hellequin et al. 2013).

1.3. Aims and objectives

The present paper aims to enrich the knowledge about coastal flood risk perception by non-experts and especially to help fill the lack of studies regarding the effect of spatial and temporal optimism biases. Thus, a survey was conducted among 318 participants among four coastal municipalities in mainland France (Barneville-Carteret, Saintes-Maries-de-la-Mer and Châtelailon-Plage) and in the French overseas department of Guadeloupe (Sainte-Anne) during which participants were asked to assess coastal flood risk exposure at different spatial (the home, the town, the country and the world) and temporal (current, in 25 years and in 100 years) levels.

After describing the study sites and the materials and methods used in this research, we analyze how participants assess the exposure to coastal flood risk depending on the spatial and temporal level. First, we assume that individuals are likely to perceive proximate areas more favorably than distant areas, in other words their assessment of exposure to coastal flood risk may increase as spatial level increases. Second, we assume that individuals tend to believe that risk would be greater in the future than in the present, so their assessment of exposure may increase as temporal level increases. To test the differences of assessment among spatial and temporal levels, we conduct repeated measures analysis of variance. Then, pairwise comparisons are performed in order to identify significant levels of assessment. At least, the paper discusses the implication of spatial and temporal biases in individuals' assessment of risk and the way it should be taken into account in prevention and risk reduction measures.

2. STUDY SITES

The coastal town of Barneville-Carteret is located in the department of Manche and faces the Channel Sea (Fig.1). Barneville-Carteret is exposed to coastal flooding by the sea front and also by the "Havre de Carteret" (Fig.2). This geomorphological shape is an inlet locally called a "havre" (Robin et al., 2007, 2009) dominated by a tide process. It is used as a natural harbor. Barneville-Carteret is also exposed to coastal flooding due to the poor condition of certain dykes located in the "havre". The 1990

storm was the latest biggest and most documented event on this coast (West Cotentin). The town also suffered a coastal flooding event in 1974, partly caused by the small size and poor condition of dykes in the “havre”. This earlier storm is still present in the memory of respondents.

Saintes-Maries-de-la-mer is a coastal town located in the regional park of Camargue. The town is surrounded by marshes and the Mediterranean Sea (Fig.1). As can be seen on the map (Fig.3), most of the surveyed people were concentrated in the largest urbanized area corresponding to the center of the municipality, locally called “the village”. The remainder of the municipality that we studied consists of lowland areas (marshes and ponds). The elevation of the village is between 0 meters and 2 meters above the sea level, which induces a high vulnerability to coastal flood risk. High energy waves and strong winds from the SE and SSE are associated with coastal flooding (Sabatier et al., 2009). They can also generate overflow from marshes and flooding from “Le Petit Rhône”, a tributary of the Rhone, by disrupting the normal flow. The village of Saintes-Marie-de-la-mer suffered from the 1982 storm during which the city center was flooded.

The third study site is the town of Châtelailon-Plage, which stretches along the Atlantic Ocean (Fig.1; Fig.4). This area is mainly composed of lowlands and appears to be the most vulnerable area to coastal flooding on the French Atlantic coasts (Breilh et al., 2014). The town suffered from storm Xynthia during the night of February 27th and 28th in 2010, which produced the last major coastal flood event in France (Breilh et al., 2014; Chaumillon et al., 2017).

Sainte-Anne is a vast municipality located in the French overseas department of Guadeloupe. It faces the Caribbean Sea on the Atlantic Ocean side (Fig.1; Fig.5). Sainte-Anne is exposed to coastal flooding especially by hurricane-induced storm surges. The most recent coastal flood event was induced by hurricane Hugo in 1989, which impacted the low-lying areas of Sainte-Anne (Krien et al., 2015).

3. MATERIALS AND METHODS

3.1. Data collection

3.1.1. Survey procedure and participants

Convenience sampling was used for the data collection. Individuals were interviewed at their home. We intended to obtain spatial homogeneity of the individuals' location. We also aimed to survey both individuals living in areas exposed to coastal flooding and those who didn't. According to prevention plans, the proportion of areas exposed to coastal flooding differs depending on the study site. This is why the percentage of respondents who lived in those areas varies. Following this methodology of data collection, 318 individuals were surveyed.

In April 2015, we surveyed 92 individuals living in Barneville-Carteret (Fig. 2), 58 of them were women with an average age of 63 and 34 were men with an average age of 59 (Fig. 6A). Thirty two individuals lived in areas exposed to coastal flooding, that being 35% of that sample. Eighty one inhabitants of Saintes-Maries-de-la-mer (Fig.3) were surveyed in May and October 2015, due to the very large surface area of the municipality, we decided to survey in a delimited area that stretches 8 km along the seashore and 4.5 km into the hinterland. 43 of the participants were women with a mean age of 54 and 38 were men with a mean age of 52 (Fig. 6B). Since a very large area of the municipality is considered as exposed to coastal flooding, all the respondents lived in exposed areas. During June 2015, 77 individuals were surveyed in Châtelaiillon-Plage (Fig. 4), 44 of them were women with a mean age of 61 and 33 were men with a mean age of 69 (Fig. 6C). Forty four respondents lived in areas exposed to coastal flooding, that corresponds to 57% of the sample. We surveyed 68 inhabitants in Sainte-Anne in August 2015 (Fig. 5). The sample was composed of 44 women with an average age of 43 years and 24 men with an average age of 45 years (Fig. 6D). Six respondents lived in areas exposed to coastal flooding, accounting to 9% of the sample.

Data was mostly collected by face to face interviews and some surveys were returned from randomly selected postal addresses. Those returned surveys represented 5.4% of the surveys in Barneville-Carteret, 16% in Saintes-Maries-de-la-mer and 13% in Châtelaiillon-Plage. We didn't distribute surveys in mail boxes in Sainte-Anne. The survey consisted of 49 questions divided into the following sections: coastal flood risk exposure scale, residence choices, protection structures, coastal flooding experience, knowledge about coastal flood risk, socio-demographic characteristics. Coordinates of each respondent's home were also collected. In this present research, we focused on data from the coastal flood risk exposure scale and from the coordinates of respondents' home.

3.1.2. Individuals' assessments of the exposure to coastal flood risk

Individuals were asked to assess the exposure to coastal flood risk at different spatial and temporal levels using a scale composed of three subscales. First, respondents rated the current coastal flood risk exposure for their home, their town, their country and the world using a 4-point scale (1: non-existent, 2: rather low, 3: rather high, 4: very high). Then, they compared their assessment of the current exposure with that of the expected exposure in 25 and 100 years for the same spatial level using a 5-point scale (1: much lower, 2: lower, 3: similar, 4: worse, 5: much worse).

3.2. Statistical analysis

First, we tested the reliability of the scale used to assess the assessment of the exposure to coastal flood risk using Cronbach's α (alpha) (Cronbach, 1951). This indicator measures the internal consistency of a scale. It is expressed as a number between 0 and 1 and it is generally considered as acceptable from 0.7 (Devellis, 2003).

3.2.1. Individuals' assessments of the current exposure to coastal flood risk

To study variations in individuals' assessments of the current exposure to coastal flood risk across spatial levels (the home, the town, the country and the world) between study sites, a repeated measures analysis of variance was performed. In order to test the effects of spatial levels and study sites on these variations, spatial level was used as the within-factor subject and study sites as the between-factor subject. Then, post hoc tests were conducted in order to understand where the differences occurred.

3.2.2. Individuals' assessments of the expected exposure to coastal flood risk in 25 and 100 years

Repeated measures analysis of variance was also performed to analyze variations in individuals' assessments of the expected exposure to coastal flood risk across spatial and temporal levels between study sites. This time, spatial and temporal levels were used as the within-factors subject and study sites as the between-factor subject. Post hoc tests were again conducted.

For both repeated measures analysis of variance, Mauchly's sphericity test of spatial and temporal levels indicated a violation of the sphericity assumption. So, the corrected Greenhouse-Geisser values were used. Partial eta squared was used to determine an effect size index for ANOVA, with values of 0.01, 0.06 and 0.14 corresponding to small, medium and large (Cohen, 1988).

4. RESULTS

4.1. Reliability of the measures of coastal flood risk exposure

Cronbach's α s for the 3 subscales of the coastal flood risk exposure scale were as follows: current coastal flooding exposure ($\alpha=0.596$), expected coastal flood risk exposure in 25 years ($\alpha=0.853$) and expected coastal flood risk exposure in 100 years ($\alpha=0.876$). Although the alpha of the current coastal flood risk exposure subscale was questionable, the reliability of the whole scale was high ($\alpha=0.874$). Table I presents the ranges, means and standard deviations for the 3 subscales.

4.2. Individuals' assessments of the current coastal flood risk exposure

Mean ratings for the current exposure to coastal flood risk were above "rather low" and increased for increasingly distant spatial levels (Table I). In general, the same trend was observed for all sites: mean ratings increased from the least distant spatial level (home) to the most distant spatial level (the world) (Fig.7). At the home level, respondents from Saintes-Maries-de-la-mer were the most pessimistic; the mean rating was about 2.2 (above 'rather low'). Respondents from Sainte-Anne were the least pessimistic with a mean rating of 1.7 (below 'rather low'). There was no shared trend at the town and country levels between the sites. At the world level, respondents from Sainte-Anne were the most

pessimistic, with a mean rating of 3.1 (above ‘rather high’) while respondents from Barneville-Carteret were the most optimistic with a mean rating of 2.7 (below ‘rather high’).

4.2.1. Spatial optimism

The results showed significant differences between spatial levels with a main effect on the assessment of the current exposure to coastal flood risk ($F(2.3;711.6)=105.93$, $p<0.001$). The effect size was 0.252 (partial η^2), which means that more than 25% of the assessment rating variations could be explained by spatial level.

In order to identify where differences occurred, Bonferroni post hoc tests were carried out. Pairwise comparisons (Fig. 8) indicated a significant difference between assessments at the home and town levels (difference of 0.514 between the two mean ratings; $p<0.001$). They also showed a significant difference between assessments at the country and world levels (difference of 0.354; $p<0.001$) but not between assessments at the town and country levels. These comparisons confirmed the main effect of spatial level, indicating that respondents across the study sites assessed the exposure to coastal flood risk as lower at a short distance spatial level.

According to the pairwise comparisons, there was no significant difference between assessments in study sites. This means that the places where respondents lived did not explain independently the differences between their assessments of the current exposure to coastal flood risk. However, when we analyzed the interaction between spatial level and study sites, we observed a significant effect ($p<0.001$) of 0.070 (partial η^2) on the variation of assessments. This means that more than 7% of the assessment variation could be explained by the interaction between these factors.

4.3. Individuals’ assessments of the expected coastal flood risk exposure in 25 and 100 years

Mean ratings for the expected exposure to coastal flood risk in 25 years were above “similar” and became more pessimistic for increasingly distant spatial levels, reaching 3.85 (close to “worse”) at the world level. Mean ratings for the expected exposure to coastal flood risk in 100 years were around “worse” and became more pessimistic as spatial level expanded. Mean ratings for the country and world levels were more than “worse” (Table I). We observed a general trend among study sites: mean ratings became more pessimistic as spatial level and time level expanded (Fig. 9).

4.3.1. Temporal pessimism

The results showed a significant difference between temporal levels with a main effect on the assessment of the expected coastal flood risk exposure ($F(1;314) =317.512$, $p<0.001$). The effect size was 0.503 (partial η^2), which means that more than 50% of the assessment variations between assessments of the expected exposure to coastal flood risk in 25 years and in 100 years could be explained by the temporal level. Pairwise comparisons (Bonferroni post hoc test) showed a significant

mean difference (0.532, $p < 0.001$) between expected assessments in 25 and in 100 years. Respondents' assessments were more pessimistic as temporal level increased.

4.3.2. Spatial optimism

The effect of spatial level on the assessment of the expected coastal flood risk exposure was significant ($F(2.3;738.3) = 44.521$, $p < 0.001$) but smaller than the temporal level effect (partial $\eta^2 = 0.124$). In fact, more than 12% of the assessment variation could be explained by the spatial level.

Pairwise comparisons (Fig. 10) indicated a significant difference between assessments at the home and town levels (difference of 0.168 between the two mean ratings; $p < 0.001$). They also showed a significant difference between assessments at the country and world levels (difference of 0.219; $p < 0.001$) but not between those at the town and country levels. These comparisons confirmed the main effect of spatial level, indicating that respondents across the study sites were more optimistic at a short distance spatial level.

When we analyzed the interaction between spatial and temporal factors, we found no significant effect on assessments of the expected exposure to coastal flood risk, even if these factors had a main effect independently.

Unlike the assessments of the current exposure to coastal flood risk, pairwise comparisons (Bonferroni post hoc test) showed significant differences between the study sites in the assessments of the expected exposure to coastal flood risk (Fig. 11). In fact, there was a significant mean difference between Barneville-Carteret and Saintes-Maries-de-la-mer (difference of 0.311 between the two mean ratings; $p < 0.05$) and also between Barneville-Carteret and Sainte-Anne (difference of 0.406; $p < 0.01$).

When we studied the interaction between spatial level and study sites, we observed a significant effect ($p < 0.001$) of 0.065 (partial η^2) on the variation of the assessments of expected exposure to coastal flood risk. This means that 6.5% of the variation in assessments could be explained by the interaction between these factors. Concerning the interaction between temporal level and study sites, we also observed a significant ($p < 0.01$) but smaller effect of 0.042. So, more than 4% of the variation in assessments could be explained by the interaction between these factors.

5. DISCUSSION

5.1. Spatial and temporal biases

We demonstrate in this paper the activation of comparative optimism biases in individuals' assessments of exposure to coastal flood risk at different spatial and temporal levels. In this study, comparative optimism takes the shape of spatial optimism and temporal pessimism. Thus, we show that assessments of exposure to coastal flood risk increase significantly as spatial and temporal

distances increase. To our knowledge, there has been no research that demonstrated the effect of spatial optimism and temporal pessimism in individuals' assessments of coastal risks.

5.1.1. Spatial effect on individuals' assessments of exposure to coastal flood risk

The effect of spatial level on the assessment of the current environmental conditions and risks is supported by other studies. Uzzell (2000) examined the perception of environmental problems. He showed that environmental problems are perceived as more serious as the distance from the perceiver increased. Those problems included risks induced by human activities such as pollution but not natural hazards. Fleury-Bahi (2008) determined the effect of spatial level in individuals' assessments of environmental risks. In her research, environmental risks were gathered in 3 categories: technological and chemical hazards, climate change and loss of biodiversity. The author determined that perceived environmental risks increased as spatial level of assessment increased. In their research about individuals' assessments of environmental conditions among 18 nations, Gifford et al. (2009) developed a scale of 20 items including natural hazards. They demonstrated the effect of spatial level on assessments of current environmental conditions. As a result, environmental conditions were rated more positively at local level than at national and global level. Milfont et al. (2011) exploited that same scale in their research about individuals' assessments of environmental conditions in New-Zealand. They obtained results similar to Gifford et al.'s findings. García-Mira et al. (2005) investigated the perception of environmental problems and exposed how individuals made distinctions between the local level and the global level in their assessments. This way, they demonstrated the effect of the environmental hyperopia that Uzzell (2000) developed before. Our results are congruent with the literature and contribute to the field by specifically identifying this effect for coastal flood risks.

5.1.2. Temporal effect on individuals' assessments of the expected exposure to coastal flood risk

In order to test the hypothesis of temporal biases in assessments of the expected exposure to coastal flood risk, assessment ratings in 25 years were compared with those in 100 years. A part of the studies mentioned above compared assessments of present and future environmental conditions or problems for each spatial level and showed a significant difference between them. Gifford et al. (2009) demonstrated that respondents were more pessimistic by assessing environmental future conditions than present conditions at all spatial levels. Milfont et al. (2011) determined that respondents assess environmental conditions to be better in the present than in the future at all spatial levels.

5.1.3. Which are the significant spatial levels of assessment?

Spatial and temporal optimism bias can be explained by the difference in assessing risk depending on the target. In fact, according to Catton Jr and Dunlap (1978), individuals see the environment in terms of immediacy and local. The local level might be the only one where individuals exist and function in

a more significant way (Zube, 1991). According to individuals' assessments of the current exposure to coastal flood risk, we show that the nearest level (home) is significantly different from other spatial levels. This result is supported by other studies, such as Fleury-Bahi's (2008) research about individuals' perception of climate change and Gifford et al.'s (2009) research about individuals' environmental assessments in 18 nations. However, we show in this study that not only the home level but also the world level is significant in individuals' assessments. In fact, individuals may over-evaluate the exposure to coastal flood risk at the global level but this is significantly different from the other levels. This is how Uzzell argued that individuals are "able to conceptualize problems at global level" (2000) in his study about individual perception of environmental conditions. This tendency is confirmed by the findings of Fleury-Bahi (2008) who showed a significant difference between the country and world levels. This was also confirmed by Milfont et al. (2011) who demonstrated the significance of the global level in their study about the assessment of environmental conditions in New Zealand and also by Gifford et al. (2009). We found the same trend in individuals' assessments of the expected exposure to coastal flood risk. In fact, local and global levels both appeared as significant levels of assessment.

The significant difference between assessments at the home level and assessments at the world level might be explained by public awareness regarding the impacts of climate change on environmental risks including natural risks. Those impacts are widely covered by the media and especially at a global level (Gifford et al., 2009; Milfont et al., 2011) such as the rise of sea level which leads to an increase of human exposure to coastal flood risk. The respondents assess global exposure to that risk as more important compared to the exposure of the other levels of assessment. This general trend could be explained by global media coverage. However, public awareness about the environmental risks including natural risks doesn't seem to be transposed to the local level (Uzzell, 2000). In fact, respondents tend to assess the exposure of their home to coastal flood risk as less important compared to the exposure of the other levels of assessment. Moreover, respondents tend to assess the future exposure to coastal flood risk of the world as much worse than its current exposure. In contrast, they perceive future exposure of their homes as similar or worse than the current exposure.

5.3. CONCLUSION

To conclude, this study contributes to enrich the knowledge about individuals' perceptions of coastal flood risk by analyzing spatial and temporal optimism biases. Previous studies have focused on the effect of spatial and temporal biases in the perception of environmental conditions sometimes including natural risks but to our knowledge, none has determined the effect of these biases on the perception of coastal flood risk. Thus, in this present paper, we demonstrated the activation of spatial optimism and temporal pessimism in individuals' assessments of the exposure to coastal flood risk

among four coastal municipalities in mainland France (Barneville-Carteret, Saintes-Maries-de-la-Mer and Châtelailon-Plage) and in the French overseas department of Guadeloupe (Sainte-Anne). We determined that participants are likely to perceive proximate areas more favorably than distant areas and that they tend to believe risk would be greater in the future than in the present. Thus, participants tend to assess the exposure of their home exposure lower than the one of more distant spatial levels. However, it is precisely at the local level that prevention and risk reduction measures are the most carried out as they are relevant to community engagement.

REFERENCES

Blake, E.S., Rappaport, E.N., Jarrell, J.D., Landsea, C., Center, T.P., 2007. The deadliest, costliest, and most intense United States tropical cyclones from 1851 to 2006 (and other frequently requested hurricane facts). NOAA/National Weather Service, National Centers for Environmental Prediction, National Hurricane Center Miami.

Boyer-Villemaire, U., Bernatchez, P., Benavente, J., Cooper, J.A.G., 2014. Quantifying community's functional awareness of coastal changes and hazards from citizen perception analysis in Canada, UK and Spain. *Ocean & Coastal Management* 93, 106–120. <http://doi.org/10.1016/j.ocecoaman.2014.03.016>

Breilh, J.-F., Bertin, X., Chaumillon, É., Giloy, N., Sauzeau, T., 2014. How frequent is storm-induced flooding in the central part of the Bay of Biscay? *Global and Planetary Change* 122, 161–175. <http://doi.org/10.1016/j.gloplacha.2014.08.013>

Cadet, B., Kouabénan, D. R., 2005. Evaluer et modéliser les risques: apports et limites de différents paradigmes dans le diagnostic de sécurité. *Le Travail Humain* 68(1), 7-35. <http://doi.org/10.3917/th.681.0007>

Chadenas, C., Creach, A., Mercier, D., 2014. The impact of storm Xynthia in 2010 on coastal flood prevention policy in France. *Journal of Coastal Conservation* 18(5), 529–538. <http://doi.org/10.1007/s11852-013-0299-3>

Chaumillon, E., Bertin, X., Fortunato, A.B., Bajo, M., Schneider, J.-L., Dezileau, L., Walsh, J.P., Michelot, A., Chauveau, E., Créach, A., Hénaff, A., Sauzeau, T., Waeles, B., Gervais, B., Jan, G., Baumann, J., Breilh, J.-F., Pedreros, R., 2017. Storm-induced marine flooding: Lessons from a

multidisciplinary approach. *Earth-Science Reviews* 165, 151–184.
<http://doi.org/10.1016/j.earscirev.2016.12.005>

Church, J.A., White, N.J., 2006. A 20th century acceleration in global sea-level rise: an acceleration in global sea level rise. *Geophysical Research Letters* 33(1). <http://doi.org/10.1029/2005GL024826>

Cohen, J., 1988. *Statistical power analysis for the behavioral sciences*. Lawrence Earlbaum Associates.

Combest-Friedman, C., Christie, P., Miles, E., 2012. Household perceptions of coastal hazards and climate change in the Central Philippines. *Journal of Environmental Management* 112, 137–148.
<http://doi.org/10.1016/j.jenvman.2012.06.018>

Costas, S., Ferreira, O., Martinez, G., 2015. Why do we decide to live with risk at the coast? *Ocean & Coastal Management* 118, 1-11. <http://doi.org/10.1016/j.ocecoaman.2015.05.015>

Creach, A., Pardo, S., Guillotreau, P., Mercier, D., 2015. The use of a micro-scale index to identify potential death risk areas due to coastal flood surges: lessons from Storm Xynthia on the French Atlantic coast. *Natural Hazards* 77 (3), 1679–1710. <http://doi.org/10.1007/s11069-015-1669-y>

Cronbach, L. J., 1951. Coefficient alpha and the internal structure of tests. *Psychometrika* 16(3), 297-334.

Devellis, R. F., 2016. *Scale Development: Theory and Applications*, fourth ed. Sage publications.

Dunlap, R., 1993. Of Global Concern: Results of the Health of the Planet Survey. *Environment: Science and Policy Development* 35 (9), 7-39.

Dunlap, R.E., Catton Jr, W.R., 1978. Environmental sociology: A new paradigm. *The American Sociologist* 13(1), 41–49.

Fleury-Bahi, G., 2008. Environmental risk: perception and target with local versus global evaluation. *Psychological Reports* 102(1), 185–193. <http://doi.org/10.2466/pr0.102.1.185-193>

Fleury-Bahi, G., 2010. *Psychologie et environnement: des concepts aux applications*. De Boeck Supérieur, Louvain-la-Neuve, Belgique.

García-Mira, R., Real, J.E., Romay, J., 2005. Temporal and spatial dimensions in the perception of environmental problems: An investigation of the concept of environmental hyperopia. *International Journal of Psychology* 40(1), 5–10. <http://doi.org/10.1080/00207590444000078>

Gifford, R., Scannell, L., Kormos, C., Smolova, L., Biel, A., Boncu, S., Corral, V., Güntherf, H., Hanyu, K., Hine, D., others, 2009. Temporal pessimism and spatial optimism in environmental assessments: An 18-nation study. *Journal of Environmental Psychology* 29(1), 1–12. <https://doi.org/10.1016/j.jenvp.2008.06.001>

Goeldner-Gianella, L., Grancher, D., Magnan, A. K., de Belizal, E., Duvat, V. K., 2019. The perception of climate-related coastal risks. *Ocean & Coastal Management* 172, 14-29. <https://doi.org/10.1016/j.ocecoaman.2019.01.018>

Harris, P., 1996. Sufficient Grounds for Optimism?: The Relationship Between Perceived Controllability and Optimistic Bias. *Journal of Social and Clinical Psychology* 15(1), 9–52. <https://doi.org/10.1521/jscp.1996.15.1.9>

Hatfield, J., Soames Job, R.F., 2001. Optimis bias about environmental degradation: the role of the range. *Journal of Environmental Psychology* 21(1), 17–30. <https://doi.org/10.1006/jevp.2000.0190>

Hellequin, A. P., Flanquart, H., Meur-Ferec, C., Rulleau, B., 2013. Perceptions du risque de submersion marine par la population du littoral languedocien: contribution à l'analyse de la vulnérabilité côtière. *Natures Sciences Sociétés* 21(4), 385-399. <https://doi.org/10.1051/nss/2014002>

Herland, D., Karsenty, S., Py, Y., Guillet, L., Chauvin, B., Simeone, A., Teresa, M., Sastre, M., Mullet, E., 2003. Risk Target: An Interactive Context Factor in Risk Perception. *Risk Analysis* 23(4), 821–828. <https://doi.org/10.1111/1539-6924.00359>

IPCC, 2014. *Climate change 2014: mitigation of climate change ; Working Group III contribution to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge Univ. Press, New York, NY.

Kellens, W., Zaalberg, R., De Maeyer, P., 2012. The informed society: an analysis of the public's information seeking behavior regarding coastal flood risks. *Risk Analysis* 32(8), 1369-1381. <https://doi.org/10.1111/j.1539-6924.2011.01743.x>

Koerth, J., Jones, N., Vafeidis, A.T., Dimitrakopoulos, P.G., Melliou, A., Chatzidimitriou, E., Koukoulas, S., 2013. Household adaptation and intention to adapt to coastal flooding in the Axios – Loudias – Aliakmonas National Park, Greece. *Ocean & Coastal Management* 82, 43–50. <https://doi.org/10.1016/j.ocecoaman.2013.05.008>

Kolen, B., Slomp, R., Balen, W.V., Bottema, M., Nieuwenhuis, S., Terpstra, T., 2010. Learning from French experiences with storm Xynthia. Rijksoverheid NL.

Kouabenan, D. R., Cadet, B., Hermand, D., Munoz Sastre, M. T. 2006. *Psychologie du risque: identifier, évaluer, prévenir*. De Boeck Supérieur, Louvain-La-Nouvelle, Belgique.

Krien, Y., Dudon, B., Roger, J., Zahibo, N., 2015. Probabilistic hurricane-induced storm surge hazard assessment in Guadeloupe, Lesser Antilles. *Natural Hazards and Earth System Sciences* 15(8), 1711–1720. <https://doi.org/10.5194/nhess-15-1711-2015>

Lemée, C., Fleury-Bahi, G., Navarro, O., 2019. Impact of place identity, self-efficacy and anxiety state on the relationship between coastal flood risk perception and the willingness to cope. *Frontiers in Psychology* 10. <http://doi:10.3389/fpsyg.2019.00499>

Lieske, D.J., Wade, T., Roness, L.A., 2014. Climate change awareness and strategies for communicating the risk of coastal flooding: A Canadian Maritime case example. *Estuarine, Coastal and Shelf Science* 140, 83–94. <https://doi.org/10.1016/j.ecss.2013.04.017>

Lumbroso, D., Stone, K., Vinet, F., 2011. An assessment of flood emergency plans in England and Wales, France and the Netherlands. *Natural Hazards* 58(1), 341–363. <https://doi.org/10.1007/s11069-010-9671-x>

Lutz, W., Samir, K., 2010. Dimensions of global population projections: what do we know about future population trends and structures? *Philosophical Transactions of the Royal Society B: Biological Sciences* 365(1554), 2779–2791. <https://doi.org/10.1098/rstb.2010.0133>

McGranahan, G., Balk, D., Anderson, B., 2007. The rising tide: assessing the risks of climate change and human settlements in low elevation coastal zones. *Environment and Urbanization* 19(1), 17–37. <https://doi.org/10.1177/0956247807076960>

Meur-Ferec, C., Deboudt, P., Morel, V., 2008. Coastal risks in France: an integrated method for evaluating vulnerability. *Journal of Coastal Research* 24(sp2), 178–189. <https://doi.org/10.2112/05-0609.1>

Meur-Ferec, C., Flanquart, H., Hellequin, A.-P., Rulleau, B., 2011. Risk perception, a key component of systemic vulnerability of the coastal zones to erosion-submersion. A Case study on the French Mediterranean coast. *Littoral 2010–Adapting to Global Change at the Coast: Leadership, Innovation, and Investment*. <https://doi.org/10.1051/litt/201110003>

Michael, J.A., 2007. Episodic flooding and the cost of sea-level rise. *Ecological Economics* 63(1), 149–159. <https://doi.org/10.1016/j.ecolecon.2006.10.009>

Michel-Guillou, E., Meur-Ferec, C., 2017. Representations of coastal risk (erosion and marine flooding) among inhabitants of at-risk municipalities. *Journal of Risk Research* 20(6), 776-799. <https://doi.org/10.1080/13669877.2015.1119181>

Milfont, T.L., Abrahamse, W., McCarthy, N., 2011. Spatial and temporal biases in assessments of environmental conditions in New Zealand. *New Zealand Journal of Psychology* 40(2) 56–67.

Nicholls, R.J., 2004. Coastal flooding and wetland loss in the 21st century: changes under the SRESclimate and socio-economic scenarios. *Global Environmental Change* 14(1), 69–86. <https://doi.org/10.1016/j.gloenvcha.2003.10.007>

Nicholls, R.J., Cazenave, A., 2010. Sea-level rise and its impact on coastal zones. *Science* 328(5985), 1517–1520. <https://doi:10.1126/science.1185782>

Pahl, S., Harris, P.R., Todd, H.A., Rutter, D.R., 2005. Comparative optimism for environmental risks. *Journal of Environmental Psychology* 25(1), 1–11. <https://doi.org/10.1016/j.jenvp.2004.12.004>

Pottier, N., Penning-Rowsell, E., Tunstall, S., Hubert, G., 2005. Land use and flood protection: contrasting approaches and outcomes in France and in England and Wales. *Applied Geography* 25(1), 1-27. <https://doi.org/10.1016/j.apgeog.2004.11.003>

Radcliffe, N.M., Klein, W.M., 2002. Dispositional, unrealistic, and comparative optimism: Differential relations with the knowledge and processing of risk information and beliefs about personal risk.

Personality and Social Psychology Bulletin 28(6), 836–846.
<https://doi.org/10.1177/0146167202289012>

Rey-Valette, H., Rulleau, B., Meur-Ferec, C., Flanquart, H., Hellequin, A. P., Sourriseau, E., 2012. Les plages du littoral languedocien face au risque de submersion: définir des politiques de gestion tenant compte de la perception des usagers. *Géographie, économie, société* 14(4), 369-392. <https://www.cairn.info/revue-geographie-economie-societe-2012-4-page-369.htm>.

Robin, N., Levoy, F., Monfort, O., 2009. Short term morphodynamics of an intertidal bar on megatidal ebb delta. *Marine Geology* 260(1-4), 102–120. <https://doi.org/10.1016/j.margeo.2009.02.006>

Robin, N., Levoy, F., Monfort, O., 2007. Bar Morphodynamic Behaviour on the Ebb Delta of a Macrotidal Inlet (Normandy, France). *Journal of Coastal Research* 23(6), 1370–1378.

Sabatier, F., Samat, O., Ullmann, A., Suanez, S., 2009. Connecting large-scale coastal behaviour with coastal management of the Rhône delta. *Geomorphology* 107(1-2), 79–89. <https://doi.org/10.1016/j.geomorph.2006.09.026>

Schmidt, F.N., Gifford, R., 1989. A dispositional approach to hazard perception: Preliminary development of the environmental appraisal inventory. *Journal of Environmental Psychology* 9(1), 57–67. [https://doi.org/10.1016/S0272-4944\(89\)80026-X](https://doi.org/10.1016/S0272-4944(89)80026-X)

Sherman-Morris, K., Del Valle-Martinez, I., 2017. Optimistic bias and the consistency of hurricane track forecasts. *Natural Hazards* 88(3), 1523–1543. <https://doi.org/10.1007/s11069-017-2931-2>

Sjöberg, L., 2000. Factors in risk perception. *Risk Analysis* 20(1), 1–12. <https://doi.org/10.1111/0272-4332.00001>

Slovic, P., 1987. Perception of risk. *Science* 236 (4799), 280-285. <https://doi.org/10.1126/science.3563507>

Slovic, P., Peters, E., 2006. Risk perception and affect. *Current directions in psychological science* 15(6), 322-325. <https://doi.org/10.1111/j.1467-8721.2006.00461.x>

Small, C., Nicholls, R.J., 2003. A global analysis of human settlement in coastal zones. *Journal of Coastal Research* 19(3), 584–599. <https://www.jstor.org/stable/4299200>

Uzzell, D.L., 2000. The psycho-spatial dimension of global environmental problems. *Journal of Environmental Psychology* 20(4), 307–318. <https://doi.org/10.1006/jevp.2000.0175>

Vinet, F., Defossez, S., Rey, T., Boissier, L., 2012a. The production process of flooding risk in coastal area: the example of " Xynthia" areas. *Norois* 222, 10-26. <http://norois.revues.org/3834?lang=en>

Weinstein, N.D., 1989. Optimistic biases about personal risks. *Science* 246(4935), 1232–1234.

Weinstein, N.D., 1980. Unrealistic optimism about future life events. *Journal of Personality and Social Psychology* 39(5), 806. <http://dx.doi.org/10.1037/0022-3514.39.5.806>

Wolf, J., 2009. Coastal flooding: impacts of coupled wave–surge–tide models. *Natural Hazards* 49(2), 241–260. <https://doi.org/10.1007/s11069-008-9316-5>

Zube, E.H., 1991. Environmental psychology, global issues, and local landscape research. *Journal of Environmental Psychology* 11(4), 321–334. [https://doi.org/10.1016/S0272-4944\(05\)80105-7](https://doi.org/10.1016/S0272-4944(05)80105-7)

TABLES

Assessment of	N	Mean	SD	α	Mean	SD
Current exposure to coastal flood risk ¹						
At home level	318	2.02	0.82	0.596	2.45	0.71
At town level	318	2.50	0.66			
At country level	318	2.47	0.61			
At world level	318	2.82	0.73			
Expected exposure to coastal flood risk in 25 years ²						
At home level	318	3.47	0.74	0.853	3.64	0.73
At town level	318	3.61	0.76			
At country level	318	3.64	0.73			
At world level	318	3.85	0.68			
Expected exposure to coastal flood risk in 100 years ²						
At home level	318	3.96	1.02	0.876	4.17	0.96
At town level	318	4.12	1.03			
At country level	318	4.18	0.95			
At world level	318	4.40	0.85			
¹ Current exposure to coastal flood risk is assessed on a 4-point scale (non-existent to very strong)						
² Expected exposure to coastal flood risk is assessed on a 5-point scale (much weaker to much worst)						

Table I Descriptive statistics for the coastal flood risk exposure subscales

FIGURE CAPTIONS

Fig. 1 Location of study sites

Fig.2 Location of respondents' homes in the town of Barneville-Carteret.

(color should be used in print)

Fig.3 Location of respondents' homes in the town of Saintes-Maries-de-la-mer

(color should be used in print)

Fig.4 Location of respondents' homes in the town of Châtelailon-Plage

(color should be used in print)

Fig.5 Location of respondents' homes in the town of Sainte-Anne

(color should be used in print)

Fig. 6 Age pyramid of respondents in the town of A) Barneville-Carteret; B) Châtelailon-Plage; C) Saintes-Maries-de-la-Mer and D) Sainte-Anne

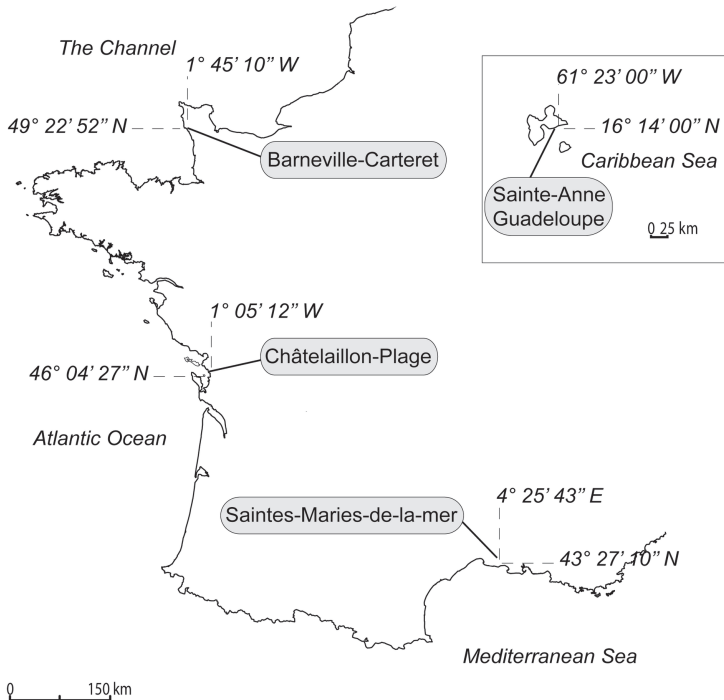
Fig.7 Subscales means of assessments of current exposure to coastal flood risk between study sites

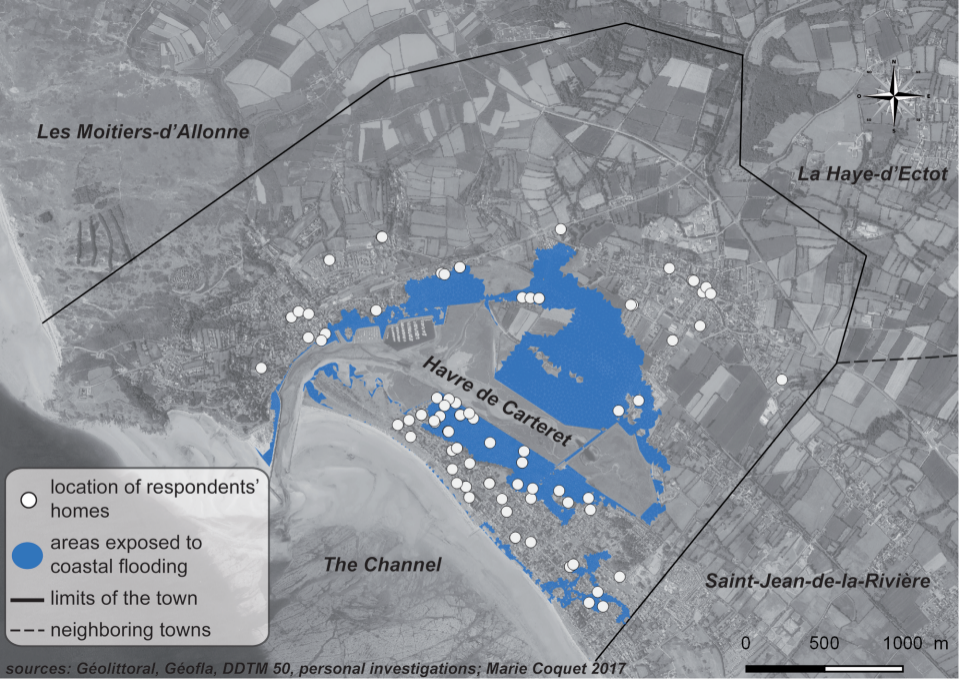
Fig.8 Differences between subscales means of assessments of current exposure to coastal flood risk between spatial levels. Caption: Bar charts showing variation in the subscales means of assessments of current exposure to coastal flood risk between spatial levels (values represent mean and standard deviation). Differences between means are significant at 0.001 level***

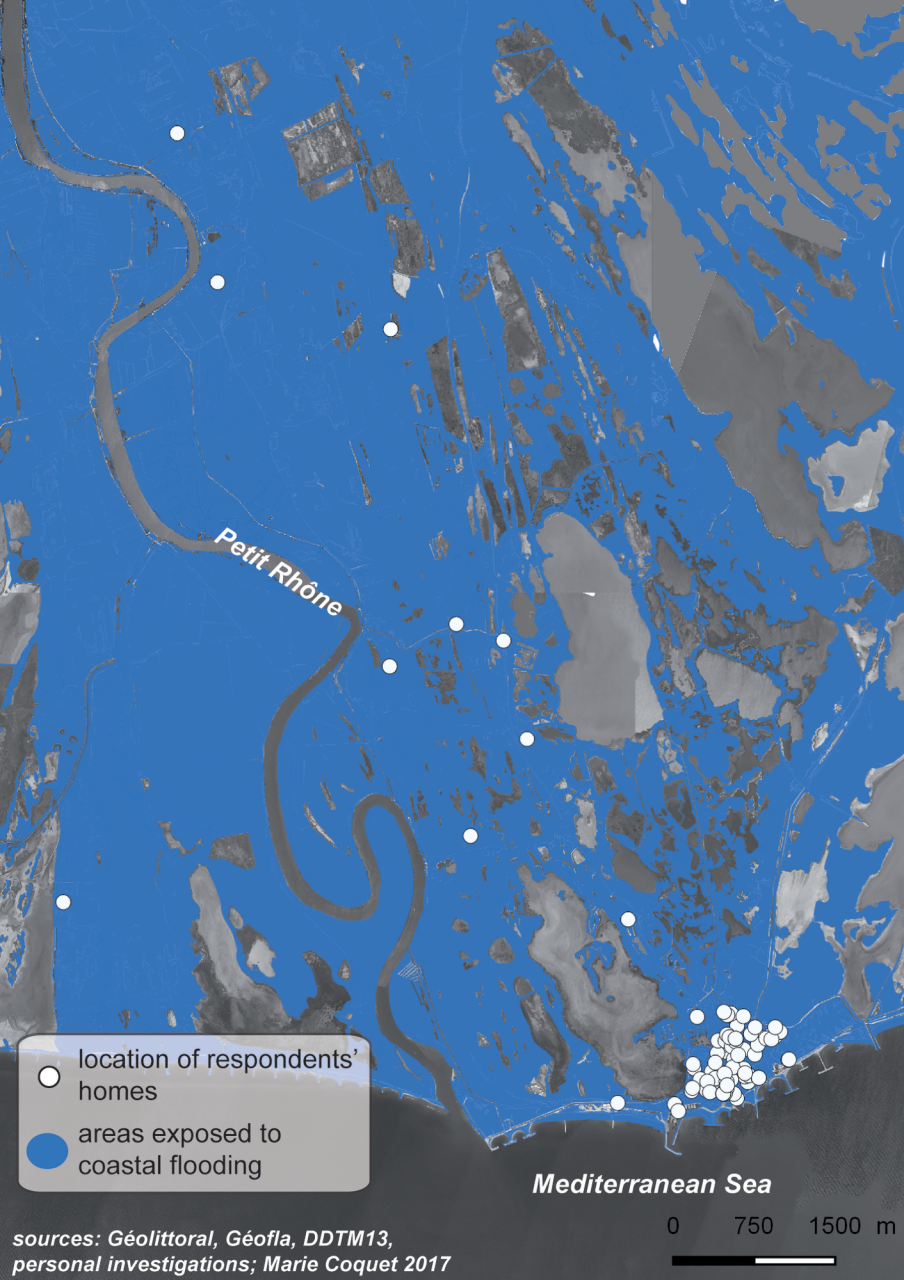
Fig.9 Subscales means of assessments of expected exposure to coastal flood risk between study sites

Fig.10 Differences between subscales means of assessments of expected exposure to coastal flood risk between spatial levels. Caption: Bar charts showing variation in the subscales means of assessments of expected exposure to coastal flood risk between spatial levels (values represent mean and standard deviation). Differences between means are significant at 0.001 level***

Fig.11 Differences between subscales means of assessments of expected exposure to coastal flood risk between study sites. Caption: Bar charts showing variation in the subscales means of assessments of expected exposure to coastal flood risk between study sites (values represent mean and standard deviation). Differences between means are significant at 0.05 level* and 0.01 level**.







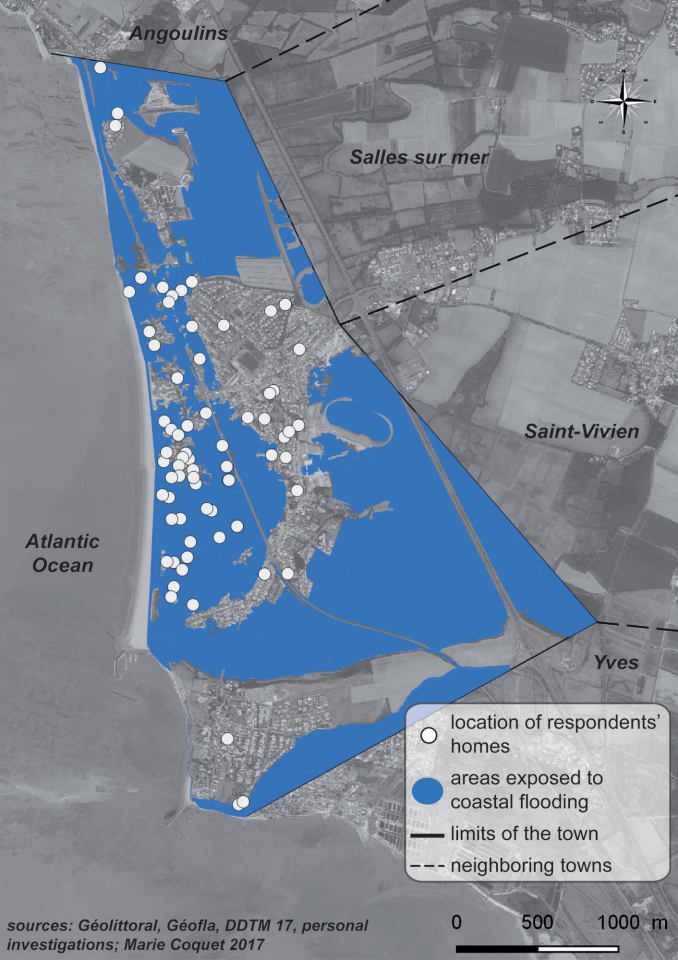
Petit Rhône

Mediterranean Sea

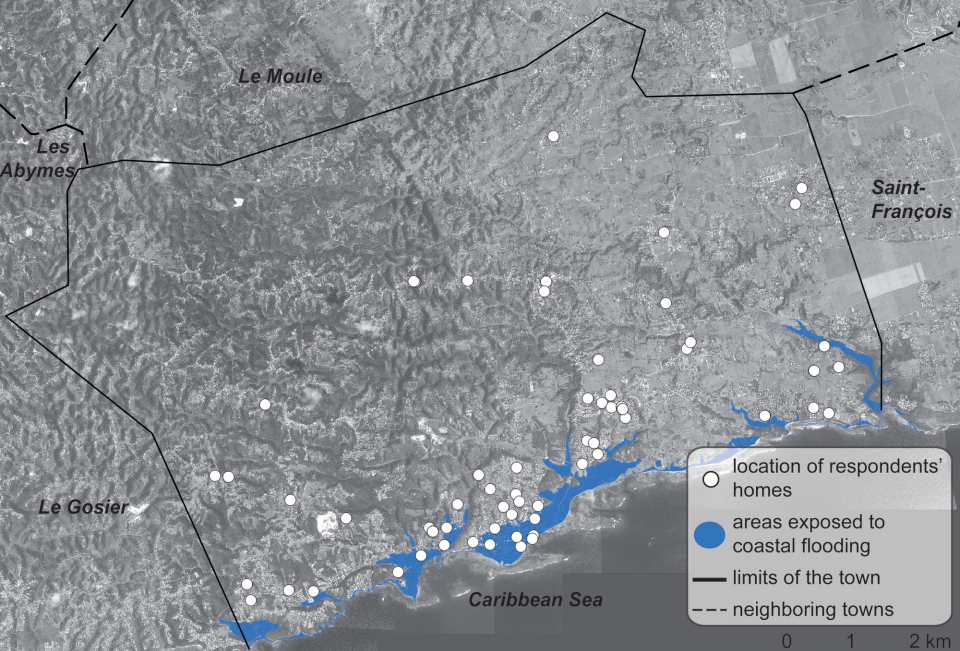
- location of respondents' homes
- areas exposed to coastal flooding

0 750 1500 m

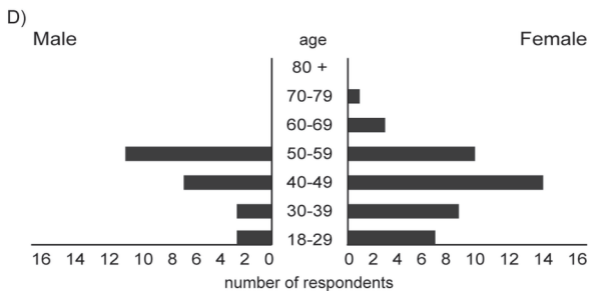
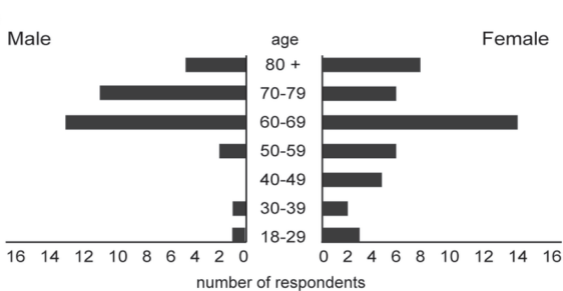
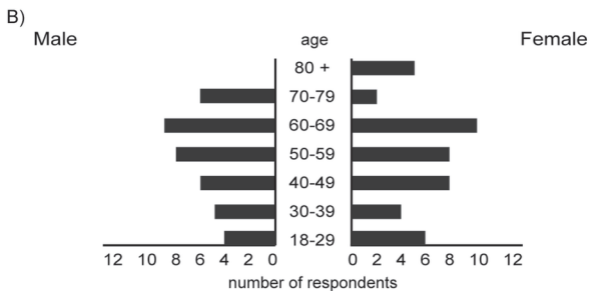
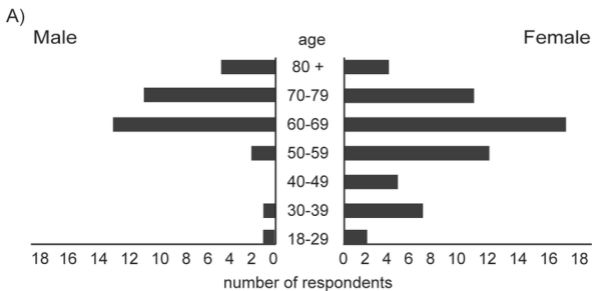
sources: Géolittoral, Géofla, DDTM13, personal investigations; Marie Coquet 2017

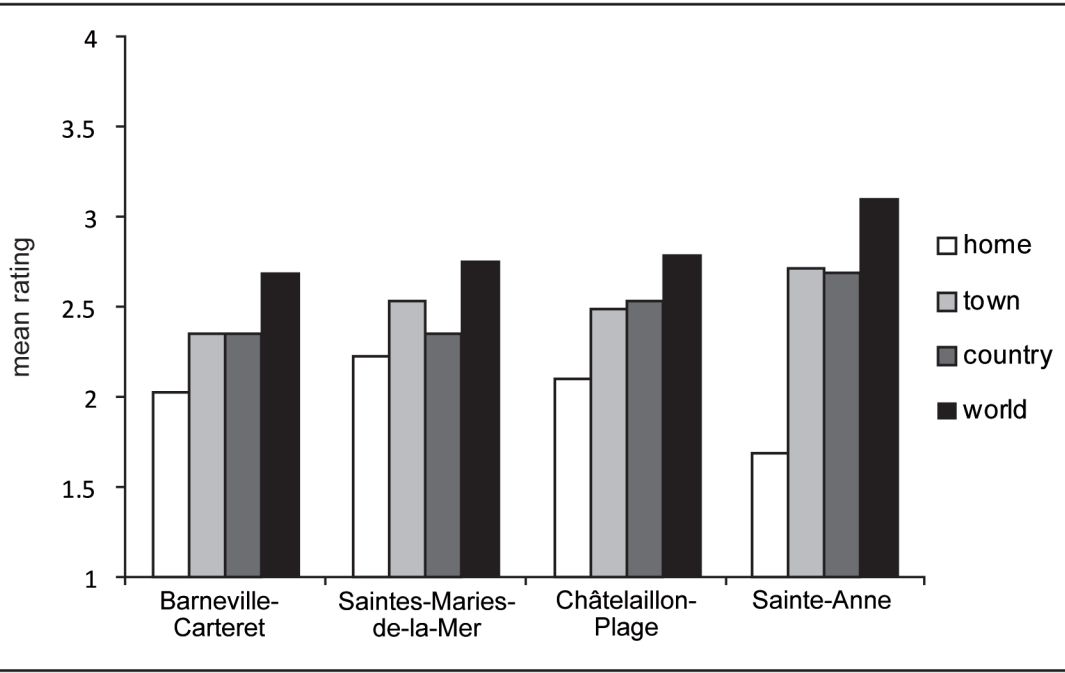


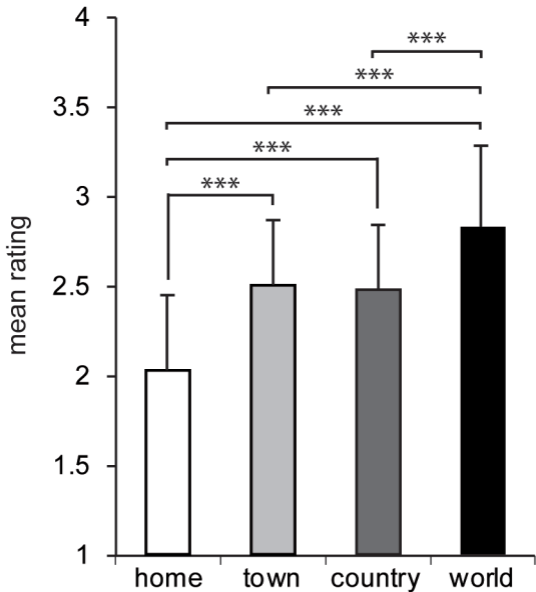
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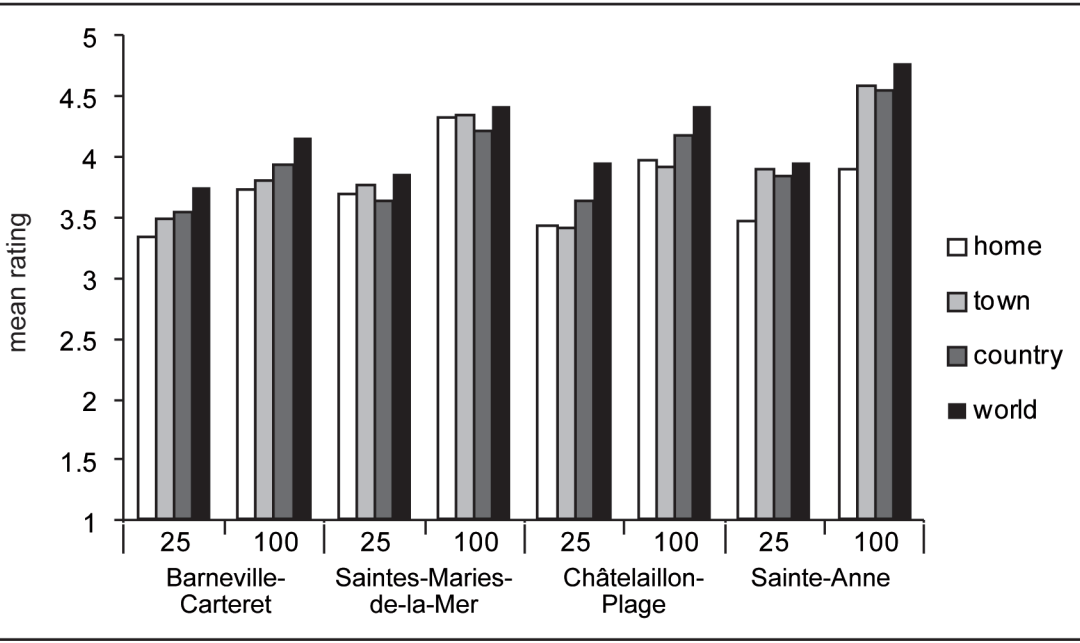
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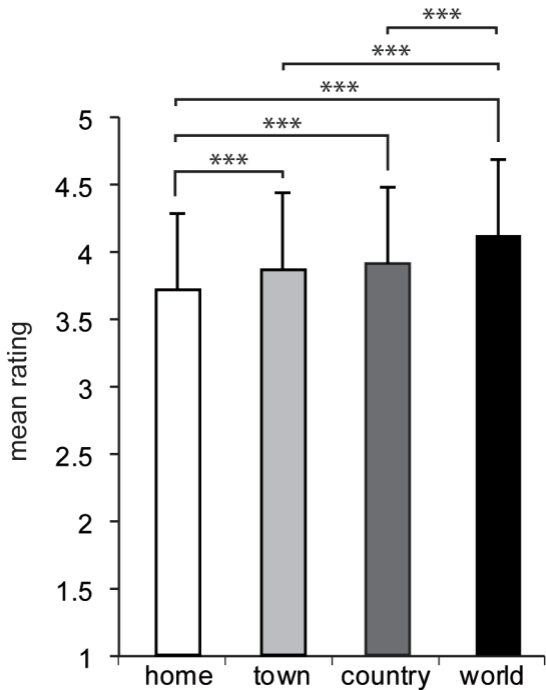




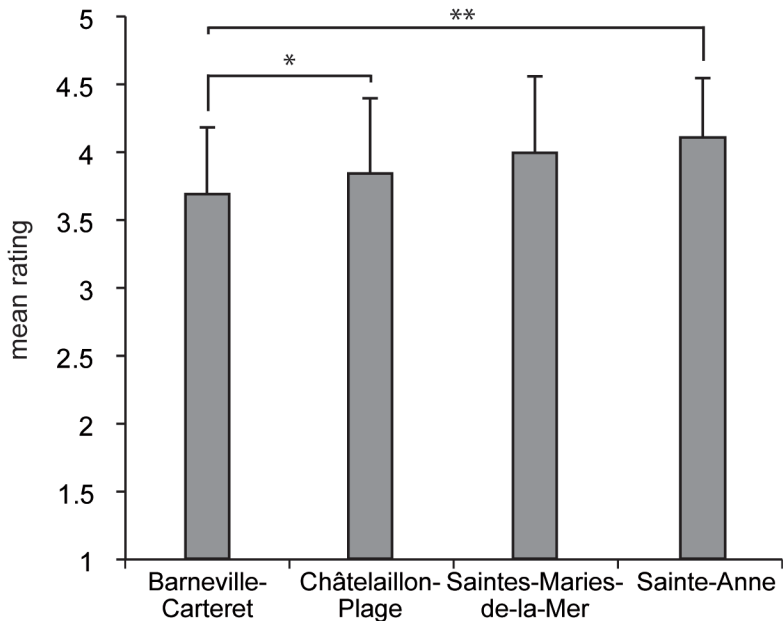


***Mean difference is significant at the 0.001 level





***Mean difference is significant at the 0.001 level



*Mean difference is significant at the 0.05 level

**Mean difference is significant at the 0.01 level