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Climate change and adaptation to coastal risks as perceived in two major coastal cities: An exploratory study in Marseilles and Nice (France)

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ABSTRACT

Adaptation to climate change and related coastal risks are key issues for communities living close to the Mediterranean Sea. The study explores how inhabitants of Marseilles and Nice, two major cities on the French Mediterranean coast, perceive recent climate change and how competent they find themselves in coping with changing climate and coastal risks. It also analyses the influence of socio-demographic and psycho-social variables on their perceived level of coping. The tool used is the French translated and adapted version of the Climate Change Perception Inventory (CCPI) by Rishi and Mudaliar (2014), filled in by a total of 475 participants in the study. Results show that in both cities, respondents are aware of climate change, but are not really worried about it. Marseilles and Nice differ in the role played by Coastal Subjective Well-Being. In both samples, the most important predictor of Coping and Adaptation is Climate related Stress and Emotional Concern. Finally, the study highlights the importance of considering psycho-social variables in the management of Climate Change Adaptation.

1. Introduction

According to the Intergovernmental Panel on Climate Change (IPCC), the Mediterranean region is one of the world's climate change hot spots (Loizidou et al., 2016). Subsequently, cities bordering the Mediterranean Sea are challenged to adapt to this ongoing process (Cramer et al., 2018) and its local consequences, e.g., coastal risks, such as sea level rise (SLR), more frequent storm surges, sea flooding and coastal erosion. This issue is particularly complex in large cities which combine high levels of economic, environmental, and social stakes.

In the North-Western Mediterranean, France has reacted to this necessity of adapting to climate change related coastal risks by issuing national strategies with the intention to improve adaptation to SLR by gradually reorganising coastal settlements – French National Climate Change Adaptation Strategy in 2007; French National Coastline Management Strategy in 2012; French National Strategy for the Sea and Coastal Areas in 2017 – and by promoting multi-level governance (Rocle et al., 2021). However, as a recent study showed, these national strategies have not yet been really translated locally by town managers into sustainable municipal developmental policies in the south-east part of

the French Mediterranean (Robert and Schleyer-Lindenmann, 2021). An institutional resistance considering the political, economic, demographic, and social stakes can possibly explain this delay. Yet, institutional actors must involve inhabitants into the planning of urban projects, especially in the environmental field (Van Lang, 2014). Indeed, the public opinion is of foremost importance in the question of climate change (Lorenzoni et al., 2005), not only under the aspect of adaptation to its consequences, but also of mitigation in order to slow down the process (Halady and Rao, 2010). In this context of public involvement, it is important to know if and how inhabitants of coastal cities perceive climate change (CC) and related coastal risks, and what socio-demographic or psycho-social variables influence their subjective adaptive capacity (Grothmann and Patt, 2005; Van der Linden, 2015). Moreover, even though CC is a global phenomenon, related events like storm surges or beach erosion arise and are managed locally. Inhabitants might have experienced these events themselves or have heard about them. It is therefore important to explore possible local variations of CC perception and to consider place related variables or local specificities in adaptation, as has been emphasized by scholars in relation to climate change (Adger et al., 2013; Mambet et al., 2020), flood risk (Dzialek

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et al., 2013), multi-risk localities (Ivčević et al., 2020) and the risk of coastal inundation (Bertoldo et al., 2020; Bertoldo et al., 2021). A localized approach also complies with the idea that risk perception is embedded in locally shared meaning or social representations of risk (Mambet et al., 2020; Meur-Ferec and Guillou, 2020; Moscovici, 2000). Indeed, people who have been living for some time in the same place are likely to observe and experience local climate phenomena and to integrate them through discursive exchange with their fellow citizens into a locally shared representation of the risk (Wagner, 2011; Wagner et al., 1999), inducing a shared attitude towards the phenomenon. This discursive interaction also integrates collective memories of past events which contribute to the present representation with the aim to maintain a coherent sense of place (Dias et al., 2021; Rosenberg and Hovland, 1960). These local variations can thus pertain to local urban identity (Belanche et al., 2017; Lalli, 1992; Lemée et al., 2019; Michel-Guillou and Meur-Ferec, 2017). According to Belanche et al. (2017), urban identity covers two dimensions: the identity of the city as ascribed collectively, and the self-identification of the individual with the city (his or her personal urban identity). In their study, Belanche et al. (2017) conceive this individual urban identity with three components: cognitive (the person identifies himself/herself as a member of the city), affective (the person has an emotional attachment to the city) and evaluative (the person judges the quality of the city). Their study proves that these three dimensions are influenced, in a differentiated way, by cultural, historical, and social representations people have of their city, in other words, by the urban identity people ascribe to their city.

In order to capture this urban socio-historical framework in which the risk representation is constructed, and the perception of CC is embedded, this study proposes an interdisciplinary approach shared between psychology and geography which proves heuristic in place related studies (Michel-Guillou and Meur-Ferec, 2017).

Also, this study focusses on large cities. Indeed, the question of perception and representation of a growing risk coming from the sea due to climate change (e.g. coastal flooding, erosion, SLR) has received attention in French coastal research, notably on the Atlantic Coast (Michel-Guillou and Meur-Ferec, 2017), and in the Mediterranean area: in the Occitanie Region (Meur-Ferec et al., 2011; Rey-Valette et al., 2012) and in the Provence Region (Bertoldo et al., 2021; Bertoldo et al., 2020; Rey-Valette et al., 2019). However, all these studies have been carried out in villages or small towns, and CC perception has not yet been explored in large coastal cities in France. To study the situation in such a context, we propose to compare climate change perception in Marseilles and Nice, both located on the Mediterranean coast (Fig. 1). Our study adopts a comparative approach in order to catch local specificities as well as shared dimensions which might inspire local authorities when designing their adaptation strategies.

In France, Marseilles and Nice are the two most populated coastal cities, respectively at the second and fifth ranks among all French cities. Marseilles, a large port city, is particularly exposed to flood risks due to climate change (Hallegatte et al., 2013) and in the past, several inundations have been observed, although this seems to be collectively forgotten by its inhabitants (Chalvet and Claeys, 2011). Nice, a major resort of the French Riviera, is regularly subject to severe storm surges which erode its well-known beach and has lived a dramatic inundation through heavy rainfall in October 2015 (Boschetti et al., 2017). The city is also threatened by tsunamis triggered by seisms in the Mediterranean Sea (Boschetti, 2020). Accordingly, both cities face particularly high stakes related to CC as their economy is largely linked to the sea. However, as we will see in the dedicated section, the relation to the sea in each city is based on particular socio-historical characteristics, outlining a specific urban identity.

1.1. Perceiving climate change and related coastal risks – the role of psycho-social variables

As all risk perception, the perception of CC related coastal risks is



Fig. 1. Geographical location of Marseilles and Nice, Southern France.

also the result of a combination of multiple factors and a complex phenomenon to study (Slovic, 1999; Van der Linden, 2015), being socially constructed (Joffe, 2003) and eventually socially amplified (Pidegon et al., 2003). Van der Linden (2015) has proposed a comprehensive model of social-psychological determinants of climate change risk perceptions demonstrating the important role played by experiential and socio-cultural dimensions as compared to the influence of either cognitive or socio-demographic variables. Concerning (river) inundations and the behavioural adaptation to this risk, a general model has been proposed by Grothmann and Patt (2005), taking as well into account socio-economic (e.g., resources like time or money) and psycho-social factors, such as climate change appraisal and adaptation appraisal in adaptive choices. The authors show the major role played by psycho-social variables in the decision to adopt individual adaptive behaviours such as buying flood protection devices as compared to the influence of socio-economic characteristics. Psycho-social variables are therefore a major factor to consider when studying CC perception and behavioural adaptation. Several of these variables have been combined in a recent tool, the Climate Change Perception Inventory (CCPI) which aims to apprehend cognitive, affective, and motivational aspects of climate change perception and adaptive as well as mitigative behaviours in relation to CC related coastal risks (Rishi and Mudaliar, 2014). We propose to use this tool to study CC perception and adaptation in Marseilles and Nice and review in the following section the relevant variables it proposes to measure.

1.1.1. Climate change awareness

In order to perceive CC related coastal risks, some CC knowledge, or awareness (Ivčević et al., 2020), i.e., a cognitive dimension, is paramount. However, De Paula Baer et al. (2019) show that although CC knowledge is a necessary element to trigger risk perception, it is not sufficient (Van der Linden, 2017). As to the link between awareness and behaviour, studies show that it is not necessarily robust (Van der Linden, 2017). Recently, Ivčević et al. (2020) show that risk awareness is positively correlated with protective behaviour in a multi-risk context in Morocco. In the CCPI (Rishi and Mudaliar, 2014) the awareness dimension is apprehended by general and experiential knowledge about climate change and its consequences on the coast.

1.1.2. Climate Stress and Emotional Concern

Recently, the emotional or stress component has also gained attention in the study of coastal risk perception (Lemée et al., 2019; Navarro et al., 2020). Indeed, risk perception is not only related to cognitions, but also to feelings (Loewenstein et al., 2001; Slovic and Peters, 2006; Slovic et al., 2004), and its effects are expected to be more extensively studied (Bazart et al., 2020; Terpstra, 2011; Van der Linden, 2015). Navarro et al. (2020) show in their study on coping strategies with regard to coastal inundations, that difficulties to regulate emotions predict avoidance coping, i.e. people distance themselves from the problem. The emotional dimension as it is operationalized in the CCPI (Rishi and Mudaliar, 2014) pertains to personal feelings of concern or fear related to coastal risks.

1.1.3. Coastal subjective well-being

The Coastal Subjective Well-Being dimension proposed by Rishi and Mudaliar (2014) specifically measures the satisfaction of the inhabitants with the quality of life in the coastal city. It can be, therefore, compared to the evaluative dimension of urban identity (Belanche et al., 2017), i.e., how people judge the quality of their city. This dimension has not been studied frequently regarding natural risks. The affective component of urban identity, i.e., place attachment (Lewicka, 2011; Low and Altman, 1992) has been studied more often, and plays, with regard to the question of coastal risk perception and readiness to adopt collective strategies such as relocation, a major role (Meur-Ferec and Guillou, 2020). Indeed, humans and human society specifically seek for and appreciate proximity and particular relations to places located next to the sea (Kelly, 2018; Corbin, 1988). However, with regard to coastal risks, studies also show that such a particular coastal attachment interacts with risk perception (Michel-Guillou and Meur-Ferec, 2017; Michel-Guillou et al., 2016; Bertoldo et al., 2021), can counteract intentions of coping behaviour (Dias et al., 2021; Bertoldo et al., 2020) or lessen the acceptability of relocation strategies (Meur-Ferec and Guillou, 2020; Rey-Valette et al., 2019).

1.1.4. Institutional accountability

Finally, the role of trust in institutions or managers has been emphasized in the context of climate-change related risks and their perception (Mees and Driessen, 2019). Indeed, institutional accountability, i.e., trust in authorities concerning CC phenomena, has not been integrated often into studies about coastal flooding (Bamberg et al., 2017; Kellens et al., 2013). Moreover, this variable has shown inconsistent influence on adaptive behaviour in the field of flood risk (Diakakis et al., 2018; Lin et al., 2008). Trust in authorities can strengthen or weaken the link between climate change perception and coping and adaptation behaviour, and different types of trust (instrumental vs social trust: Earle, 2010) can be linked to the presence or absence of adaptive behaviour (Dias et al., 2021).

1.1.5. Coping and adaptation

This last dimension in the CCPI covers a dimension which is in general (and will be in a second step also in this study) taken as a dependent variable in studies about risk perception. Indeed, the question of adopting appropriate mitigative or adaptive behaviours regarding climate change or associated risks as a consequence of awareness, emotions, attachment and trust, is of high interest (Navarro et al., 2020). However, studies show that this link which could be expected is not very robust (Van der Linden, 2017), possibly because the level of conceptualisation between the predictor and the predicted variable is too different (Van der Linden, 2017). In the CCPI, Coping and Adaptation covers personal behaviours, as well as opinions in the field of adaptation and mitigation of CC in general or on a personal level.

Rishi and Mudaliar (2014), using the CCPI, studied the perception of and adaptation to CC and CC related coastal risks in two Indian coastal cities: Mumbai and Chennai. The authors found a rather high level of CC awareness and coastal well-being among Indian participants, although

they were experiencing a moderate amount of climate stress and had the feeling that they were unable to fully cope with it.

We propose to use this tool to compare the climate change perception of inhabitants of Marseilles and Nice, the two largest coastal cities on the French Mediterranean shore. Indeed, the importance of taking into account local historical frames in order to capture variations about risk perception has been demonstrated by Dzialek et al. (2013) in their work on the perception of flood risk in southern Poland, as well as recently by Ivčević et al. (2020) in a multi-risk context in Morocco.

1.2. The importance of local variations: the study sites

Marseilles and Nice are two interesting cities as their urban identity (Belanche et al., 2017) is strongly linked to the sea, but for different reasons. As will be detailed hereafter, Marseilles has a strong link to the sea as a commercial pathway, whereas Nice has a strong link to the sea, especially to the beach, as a touristic amenity.

Today, Marseilles has a little less than 900,000 inhabitants (municipal population). Known as the oldest town in France, it has been founded by ancient Greeks as a trading post in the 6th century BC (Roncayolo, 2014). Throughout history, it developed thanks to overseas trade, and became the major port of the country in the 19th century, with the expansion of the former French colonial empire. In that period, Marseilles also developed as an industrial center, because many entrepreneurs took advantage of the port and the possibility to import goods of all kinds to develop factories (cement, tiles, fertilizers, ship building and repair, soap, oil, food, etc.). Accordingly, the city worked as a melting-pot, where workers from the hinterland and overseas countries used to meet in relation to port activities. After the collapse of the French colonies (early 1960's), the city entered a long phase of economic decline, but it remained largely rooted to its port with a multicultural population. Today, port related activities still represent an important share of the economic activity in the whole metropolitan area and the harbor ranks first in France for all traffics (Fig. 2).

More recently, particularly during the last two decades, Marseilles also developed as a cultural and tourist spot, to enlarge the panel of its activities. In 2012, the southern part of its territory and the adjacent marine space was included into the Calanques National Park, an area recognized for its outstanding biodiversity and beautiful landscapes. In 2013, the city was elected European capital of culture, which had a booster effect on the whole territory. Before the Covid-19 pandemic, its port ranked 1st in France and 5th in the Mediterranean for Cruise passengers. Undoubtedly, Marseilles is very much related to the sea. This very old relation is under renewal, but it remains highly based on



Fig. 2. The harbour of Marseilles as seen from the North (June 2021)
Source: SR.

productive activities, marine shipping, and innovation. To sum up, its urban maritime identity covers especially commercial and navigational aspects. Although the city has 57 km of linear coastline ([Direction de la Mer de la Ville de Marseille, 2021](#)), the public beaches where residents can practice the sea, cover only 91 000 m² as measured with GIS on aerial photographs.

In Nice, whose population is a little less than 350,000 inhabitants, the sea is also a strong component of the city, but its contribution to the identity of the place is different. Nice never developed as a harbor, though there is a small one. Indeed, the city remained rather small until the beginning of the 19th century when it became a winter resort for travelers coming from northern Europe ([Boyer, 2002](#)). At that time, many aristocrats and wealthy people used to spend several months on the French Riviera to enjoy the weather during the winter season. The sea shore was a hotspot of this society. People used to walk and meet along the shore, on the “Promenade des Anglais”, where jetties, casinos and promenades were developed ([Fig. 3](#)).

Hotels and villas were also built to offer sea views, as enjoying the visible landscape was a must of the stay. This trend grew substantially after the arrival of the railway line in the 1860's. The city, like other resorts of the Riviera (Monaco, Cannes, Antibes), experienced a fast urban development. Very frequently, it also hosted famous political leaders, aristocrats, and artists, who all contributed to its celebrity. During the 20th century, Nice continued to develop as a resort, but it turned into a summer one instead of winter resort. After World War 1st, tourism evolved, and summer became the most frequented period of the year. After World War 2nd, the city sprawled a lot because of the ongoing economic boom and the dissemination of personal cars. Today, like many other cities, Nice intends to diversify its activities, but it remains mainly a spot for tourism and secondary homes. These two activities are at the roots of the whole urban system, and they strongly rely on the sea and the beach as a place for entertainment and recreation, and as a major component of the highly promoted landscape of the Riviera. The central shoreline is highly valued as a major amenity with its beach and promenade, making this an essential part of the city's urban maritime identity. Indeed, Nice has, with a linear shoreline of 17 km, 126,000 m² of public beach, as measured with GIS on aerial photographs.

As the beach with its amenities has a much more central place in Nice than in Marseilles both topographically, and in the uses of urban space, we can expect that inhabitants of Nice are more aware of CC related coastal risks than inhabitants of Marseilles and that their evaluation of the coastal urban identity in terms of coastal quality of life and coastal subjective well-being is more positive.

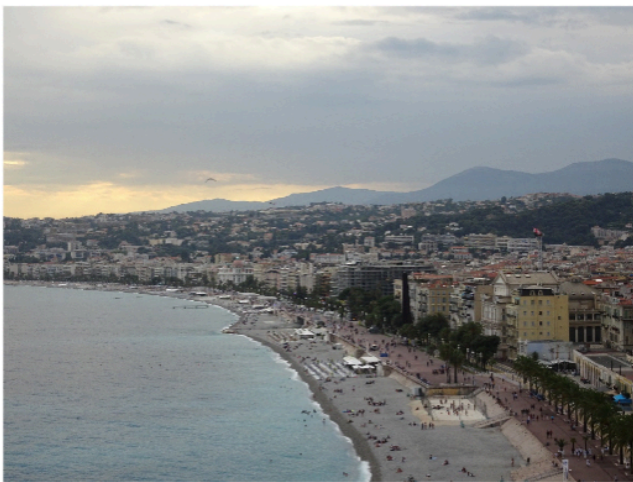


Fig. 3. The bay of Nice, the beach and the Promenade des Anglais (July 2020)
Source: MLT.

1.3. Objectives of the study

To sum up, this study proposes to explore the perceptions of climate change in the two largest French Mediterranean cities, Marseilles and Nice, with the following questions: are inhabitants aware of climate change and associated coastal risks? Do they worry about it, and have they adopted adaptive or mitigative behaviours? Are the two cities similar in their perception of climate change and CC related risks or are there local specificities? How do socio-demographic and psycho-social variables influence adaptive behaviours in each city? In order to verify these questions, we administered CCPI, which is the first use of this inventory, to our best knowledge, with a French sample.

2. Materials and methods

2.1. Questionnaire tool

The Climate Change Perception Inventory (CCPI) is a questionnaire based on a Likert-type scale with 39 items (affirmative sentences expressing opinions or beliefs respondents can agree with or not) distributed into five subscales which are presented hereafter with examples. The detailed CCPI with the items used in this study is shown in [Appendix A](#).

2.1.1. Subscale 1: Climate change awareness

This dimension measures how coastal inhabitants perceive risks and coastal hazards associated with CC in addition to their beliefs or awareness about CC itself. E.g.- *The temperature of seas and oceans has gone high and global average sea level has risen over the past 50 years.*

2.1.2. Subscale 2: Climate Stress and Emotional Concern (CSEC)

This dimension aims to assess the level of perceived and experienced stress and emotions associated with CC related events/changes in their environments. E.g.- *I am frightened about imagining my future stay near the coast due to the talks of sea level rise in coming years.*

2.1.3. Subscale 3: Coastal subjective well-being (CSWB)

This dimension offers to measure the feeling of well-being the individual retrieves from living in a coastal city. The items of this CSWB scale were taken from the Subjective Well-Being Scale by ([Diener, 2009](#)) and adapted to evaluate this well-being in a coastal location. E.g.- *The quality of my surrounding coastal environment is close to my ideal.*

2.1.4. Subscale 4: Institutional accountability (IA)

This dimension measures the trust people have in local institutional bodies (both governmental and non-governmental) for being capable in their dealing with CC and associated impacts in the coastal area they live in. E.g.- *Whenever there is coastal upheaval, the disaster management system of my city is able to meet it well.*

2.1.5. Subscale 5: Coping and adaptation (CA)

This dimension aims to measure how the coastal inhabitants are coping behaviourally by measuring the occurrence of mitigative and adaptive behaviours. E.g.- *As I live near the coast, I always keep considerably more stock of food items and other necessary things to meet coastal disaster.*

The initial English tool was translated by a French native English teacher into French and checked by back-translation into English by a group of experts in social environmental sciences, which is an acceptable methodology for tool translation ([Vallieres and Vallerand, 1990](#)). Originally proposed response categories were: “do not agree at all”, “do not agree”, “agree”, “totally agree” and “I don't know”. This last category was interpreted as a category of uncertainty or neutrality (“neither agree or disagree”) and was therefore recoded as mid-point (“3”) in a numerical recategorization of the data, reaching from 1 (“do not agree at all”) to 5 (“totally agree”), in order to allow the use of parametric

statistics (Norman, 2010).

This inventory was integrated into a larger questionnaire about climate change perception which will not be presented exhaustively in this paper.

To capture if there were locally perceived or shared consequences of CC, the following question about personal knowledge of hazards in the city was asked: "According to you, which events have been observed in this city over the past five years?", followed by a list of 12 CC-related phenomena, ranging from heatwaves to sea-level rise. The question was termed with the range of five years in order to give some possibility of in-depth observation, rather than remember only the most recent and thus rather salient event (Van der Linden, 2017). The answer modus was "yes", "no" or "I don't know" for this question.

2.2. Sample and procedure

The questionnaire was administered in Marseilles and Nice during summer 2015, through judgmental sampling technique. The principle was to question people who were living or working close to the sea, as this might heighten their CC perception. As our study was exploratory, we did not focus on a representative sample of the cities' population, but on participants reflecting a diversity of age and gender, who were, by their work or residence, in daily proximity of the sea. Sample design was decided on a geographical basis, looking for respondents from educational institutions, banks, hotels, restaurants, shops, hospitals, retirement homes, and organizations falling within 2 km' distance from the sea. First, the institutions were contacted by letter or mail to allow the survey to take place on their premises. When the institutions had agreed, one of the authors, assisted by a trainee, went to the institution, and proposed to the people working or living there to participate in the survey and answer the questionnaire face-to-face. The advantage of this technique was that people could fill out the questionnaire in a comfortable condition, as responding to all the questions took 15–20 min.

We collected the responses of 475 adults, respectively 283 in Marseilles and 192 in Nice. Sample profiles are presented in Appendix B. They were comparable concerning gender (about 52% female) and length of residence (over 70% lived in their respective city for more than 5 years). Three age groups (18–24 yrs; 25–45 yrs; >45yrs) were constituted. There was no significant difference in age, except for the group aged 25–45 which was more numerous in Marseilles than in Nice. Participants were also asked to evaluate the distance between the coast and their place of residence in three groups (less than 2 km; between 2 and 5 km; more than 5 km); on this criterion, Nice participants lived significantly more often closer to the coast. Globally, the samples are thus comparable while also reflecting known differences (younger population in Marseilles than in Nice for instance; INSEE, 2021). However, as stressed before, these two samples are not representative of the population of each city. They are based on a judgemental technique and their objective is to provide an overview of the people diversity living or frequenting the areas closest to the seashore.

2.3. Data processing and analysis

In a first step, and for all CCPI dimensions, descriptive statistics were produced. The means were calculated and served as indices, and correlational analyses were performed on these continuous data series. The comparisons were made through t-tests (comparison between two independent samples). The internal consistency of the dimensions was assessed with Cronbach's alpha (Table 1). This index is a criterion of the quality of the measurement and can vary between 0 and 1. It is considered as good when higher than 0.80, satisfactory when higher than 0.70 and unsatisfactory when lower than 0.50. Values of 0.60 can be considered acceptable (Schmitt, 1996).

In a second step and in order to perform logistic regression integrating binary variables such as city (Nice = 0; Marseilles = 1), gender

Table 1
Alpha coefficients of the CCPI dimensions.

Dimension	N° items	Cronbach's α
Climate Change Awareness CCA	5	.63
Climate Stress and Environmental Concern CSEC	14	.84
Coastal Subjective Well-Being CSWB	4	.87
Coping and Adaptation CA	7	.53
Institutional Accountability IA	3	.35

Note: for dimensions CCA, CSEC and CA: number of items retained after reliability check.

(female = 0; male = 1), age (<45=0; >45 = 1), length of residence (<10years = 0; >10years = 1) and study level (up to including sophomore = 0; >sophomore = 1), all CCPI indices were transformed into binary variables with 0 equals "less of the dimension" and 1 equals "more of the dimension".

As shown in Table 1, Cronbach's alpha is about acceptable to good for three of the five dimensions. Two dimensions, Coping and Adaptation (CA scale) and Institutional Accountability show weak alphas and should be improved for further studies. Indeed, the CA scale reunites items concerned with mitigation of climate change, as well as items concerned with adaptation to climate change and is somewhat intrinsically heterogeneous. The IA scale measures trust in three different types of institutions through only three items, which might contribute to the low alpha. This scale could have been longer to measure the dimension more precisely and obtain a better reliability coefficient.

3. Results

3.1. Perception of climate change related phenomena

In order to give a first account about the perceptive and representational context in the two cities, Fig. 4 shows the distribution of affirmative answers about perceived climate change related phenomena over the last five years.

We observe that for many CC related phenomena the percentage of agreement is under 50%, indicating that less than half of the participants have perceived these phenomena over the last five years. In both cities, heat waves are the most perceived CC related phenomenon (by more than 50% of respondents), followed by droughts and proliferation of pests. Furthermore, in Nice more than 50% of participants report sea-related phenomena. Existential issues like natural resource scarcity, food or drinking shortages are commonly not reported in either city. There is a significant association between the city and the type of hazard experienced $\chi^2(2) = 6,97$, $p < .03$. In detail, heatwaves are reported significantly more often in Marseilles than in Nice ($p < .05$), whereas all hazards related to the sea, such as floods, storms, degradation of beaches or coastal roads (all $p < .001$) and sea level rise ($p < .05$) are significantly more often reported in Nice than in Marseilles. Globally, it is observed that dangers coming from the sea are more agreed to and thus more present in the answers of respondents from Nice than from Marseilles.

3.2. Similarities and differences between Marseilles and Nice in the CCPI dimensions

The CCPI measures climate change perception with a multi-dimensional scale. A comparison between the obtained means in each city by independent t-tests yields the following results (Table 2).

The results show that in both cities respondents are very much aware of climate change, with mean scores well over the theoretical midpoint of the scale (3.73 and 3.71). They also share a relative unconcern with scores of Climate Stress and Emotional concern around the mean, though somewhat a little higher in Marseilles (3.14 as compared to 3.06). Both samples also express a low level of trust into institutional

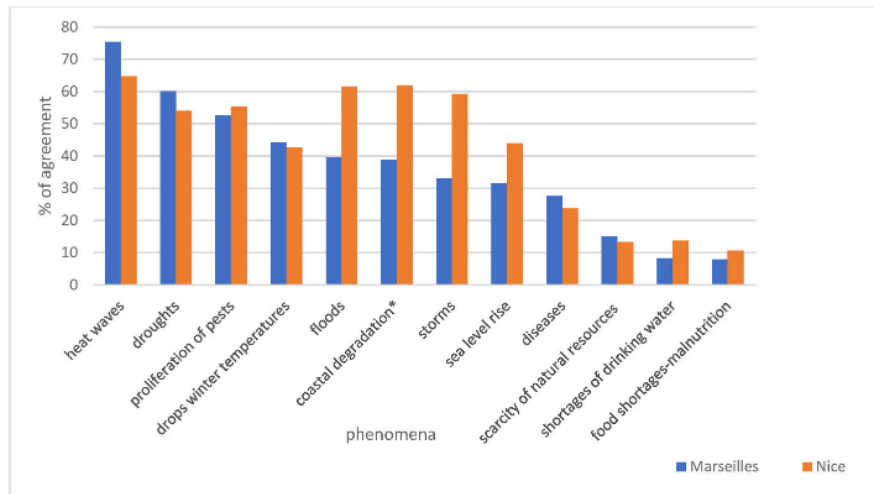


Fig. 4. Perceived climate change related phenomena over the last five years in Marseilles and Nice
* of beaches, roads, infrastructures.

Table 2

Differences between means over the 5 dimensions of the CCPI in Marseilles and Nice.

CCPI Dimension	Marseilles mean (sd)	Nice mean (sd)	t-test	p-value
CCA climate change awareness	3.71 (0.64)	3.73 (0.70)	-.32	ns
CSEC Climate Stress and Emotional Concern	3.14 (0.61)	3.06 (0.70)	1.35	ns
CSWB Coastal Subjective Well-Being	2.76 (0.97)	3.32 (0.93)	-6.17	.000
CA Coping Adaptation	3.00 (0.56)	2.89 (0.64)	2.01	.05
IA Institutional Accountability	2.73 (0.66)	2.83 (0.74)	-1.61	ns

accountability (scores between 2.73 and 2.83). There are no significant differences between the cities on these three dimensions. Conversely, the cities differ significantly in the two other dimensions, notably in Coastal Subjective Well-Being, which is much higher in Nice than in Marseilles (3.32 in Nice as compared to 2.76 in Marseilles). There is also a slight but significant difference in Coping and Adaptation, respondents in Nice feeling a little less able to cope (3.00 in Marseilles as compared to 2.89 in Nice). To sum up, in both cities, participants are aware of CC and rather do not trust institutions to manage CC-related events well. They are however not very much stressed about CC-related coastal events. Respondents from Marseilles feel clearly less coastal well-being than their Nice counterparts, whereas Nice participants feel more coastal well-being but feel less prepared to cope than Marseilles respondents.

3.3. Correlations between the dimensions

The correlations (Table 3) indicate interesting and logical links between dimensions in both cities: CCA and CSEC, CCA and CA, as well as CA and CSEC correlate positively. In other words, the higher the Climate Change Awareness, the higher Climate Stress and Emotional Concern (and conversely); the higher Climate Change Awareness, the higher Coping and Adaptation (CA); and finally, the higher Climate Stress, the higher Coping and Adaptation (and conversely). Both cities also display a significantly positive relationship between Coastal Subjective Well-Being (CSWB) and institutional accountability (IA), which means that the more the respondents evaluate positively the quality of life in their city, the more they trust local institutions (and conversely). In sum, both

Table 3

Correlations between dimensions in Marseilles (lower left corner of the table, numbers in bold) and Nice (upper right corner, numbers not in bold).

Dimensions	CCA	CSEC	CA	IA	CSWB
Climate Change Awareness CCA		.45**	.37**	-.19**	-.02
Climate Stress and Emotional Concern CSEC	.54**		.62**	-.13	-.04
Coping and Adaptation CA	.35**	.47**		.11	-.08
Institutional Accountability IA	-.09	-.14*	.08		.18*
Coastal Subjective Well-Being CSWB	-.19**	-.22**	-.18**	.18*	

Note: (*) expresses that coefficients are significant at the following levels: ** < 0.01 * < 0.05.

cities show coherent and consistent relations between awareness, stress, and coping on the one hand, and coastal well-being and trust (institutional accountability) on the other hand.

In terms of differences between cities in the correlations, they are relatively few. In Marseilles, Climate Stress is significantly negatively related to Institutional Accountability (the higher CSEC, the lower IA, and conversely), this correlation falls short of significance in Nice. In Nice, IA and Climate Change Awareness correlate negatively (the higher Institutional Accountability, the lower Climate Change Awareness and conversely).

The major difference is that in Marseilles, Coastal Subjective Well-Being is significantly negatively related to CCA, CSEC and CA, i.e., the higher Climate Change Awareness, Climate Stress, or the feeling of Coping and Adaptation, the lower Coastal Subjective Well-Being (and conversely). In other words, Marseilles participants who are the most aware of CC, are also those who appreciate the least their urban coastal quality of life (and conversely). This correlation, which is very interesting, does not mean that CC awareness explains well-being on the coast, but it encourages to study this relationship more in detail. Moreover, in Nice this correlation is not observed: Coastal Subjective Well-Being is not significantly correlated to these dimensions. In other words, participants from Nice could display any combination between high or low Climate Change Awareness, Climate Stress or Coping and Adaptation with high or low Coastal Subjective Well-Being.

3.4. What predicts coping and adaptation?

A binary regression was performed on the total sample to test the possibility to predict Coping and Adaptation (CA) in function of socio-

demographic and contextual variables such as city, length of residence, study level, age, and gender (Table 4).

Only two socio-demographic variables significantly predict Coping and Adaptation (CA), the outcome variable of the model. Indeed, gender ($-0.51, p < .01$) and city ($0.49, p < .01$) have a strong influence: women have a higher score than men, i.e., women are more ready to cope and adapt to CC than men. Furthermore, respondents in Marseilles have a higher score than respondents in Nice, i.e., they have higher scores in Coping and Adaptation. The difference between the cities is significant enough to justify running the binary regression separately in both cities (Table 5). Age, study level and length of residence do not have a significant influence on Coping and Adaptation.

The role played by psycho-social variables is uneven between the cities (Table 5). Whereas in Marseilles three of the five predictor variables have a significant influence on the outcome variable, in Nice only one dimension qualifies for this.

In Marseilles in particular, Climate Stress and Emotional Concern ($0.91, p < .000$) as well as Institutional Accountability ($0.56, p < .05$) predict Coping and Adaptation positively: the higher CC related stress, the higher the level of Coping and Adaptation; the higher trust in local institutions, the higher Coping and Adaptation; on the other side, Coastal Well-Being predicts Coping and Adaptation negatively ($-0.32, p < .05$), i.e. the higher participants score on Coastal Well-Being, the lower they score on Coping and Adaptation.

In Nice, the only significant predictor is Climate Stress and Emotional Concern ($1.46, p < .000$) which predicts positively Coping and Adaptation. Only people who are greatly worried adopt mitigative or adaptive behaviours.

Also, it is important to highlight that in both cities CC awareness does not predict Coping and Adaptation, i.e., some people who are aware of CC and its consequences adopt adaptive behaviours, whereas others, who are also conscious about CC, may not.

4. Discussion and conclusion

4.1. CC risk perception and its dimensions

CC risk perception is a multi-dimensional concept (Van der Linden, 2015). Accordingly, different dimensions have been studied here in order to comprehensively measure the risk perception construct: Climate Change Awareness, Climate Stress, Coastal Well-Being, Institutional Accountability, and finally, Coping and Adaptation. Results show that all these dimensions are important.

Climate Change Awareness (CCA) is a dimension of major importance. In both cities, it has the highest mean, significantly higher than the midpoint of the scale. Respondents in Marseilles and in Nice are strongly aware of climate change. Concomitantly, CC related events were reported, as perceived by participants, with a higher incidence of heat waves in Marseilles, and higher incidence of floods, storms, coastal degradation and SLR in Nice. In both cities, CC Awareness correlates positively with Coping and Adaptation, corroborating results by Marshall et al. (2013) who also found a higher CC Awareness associated to a higher adaptive capacity to climate change. However, as we will see below, this high correlation does not translate into a predictive

relationship.

In both cities, CC Awareness also correlates positively with Climate Stress and Emotional Concern. This correlation underlines the important role played by emotions (Van der Linden, 2017) in the field of CC perception. Indeed, studies show that emotions might be a primary element for risk perception, playing a heuristic role (Slovic et al., 2004). In other words, risk perception does not only trigger emotions, but a given phenomenon/object might trigger emotions which then heighten risk perception (Loewenstein et al., 2001; Slovic and Peters, 2006).

Institutional Accountability (IA) is, in a general way, particularly low in both cities. This might be linked to the fact, that in large cities, the distance between inhabitants and local institutions is more important than in small towns, where residents often personally know local decision-makers. However, Institutional Accountability is positively correlated to CSWB, which confirms results by Diener and Tov (2007) who find that people with high Subjective Well-Being tend to be more credulous, collaborative, and peaceful with a higher level of confidence in the institutional systems.

Additionally, respondents from Nice (who also have a higher CSWB) have a lower CC awareness associated to a higher level of trust in local authorities: the higher the trust in local institutions, the lower CC Awareness (and conversely); this confirms the importance of the role played by trust regarding risk perception and risk management (Earle, 2010). In a review, this author highlights two forms of trust: relational trust and calculative trust. In relational trust the person attributes good intentions to the authorities, trusting them to manage well, and therefore possibly does not need to cultivate CC awareness. In the case of a high CC awareness however, inhabitants might rather use calculative trust ("the authorities are competent to manage CC"), comparing their own level of knowledge to the institutional level of knowledge, and displaying distrust if they think that authorities are less competent than themselves (Dias et al., 2021). This could also be the case of Nice participants who report more often CC related coastal events (and thus are more aware and possibly more knowledgeable) than their Marseilles counterparts.

Climate Stress and Emotional Concern (CSEC) is a dimension at the midpoint of the scale in both cities. People are aware of CC and CC related events in their town, but they are not particularly worried. Indeed, possible existential consequences of CC related events are not reported, either in Marseilles or in Nice. This finding confirms results by Meur-Ferec and Guillou (2020), an observation the authors have termed "a paradox": people are aware of coastal risks but are not worried. This is also the case in large cities such as Marseilles and Nice. In both cities, emotions are however linked with the highest correlations (between 0.45 and 0.62) to Climate Change Awareness, and Coping and Adaptation, which suggests that people are, at least conceptually, in a state of concern.

Coastal Subjective Well-Being (CSWB). The significant difference between the two cities on this dimension might be explained through the importance the coast has for Nice's urban identity (Belanche et al., 2017): the "promenade des Anglais" with its exposure to the sea is a central feature of the city. It is one of its attractions and "raisons d'être". In Marseilles, there is no such coastal symbolic place which allows bathing and having a direct experience of the sea. Of course, there is the

Table 4
Influence of socio-demographic variables on Coping and Adaptation.

Predictor	-2log-likelihood	Nagelkerke R2	Khi2	df	Sig.	B	SE	Exp(B)
	608.77	.048	16.7	5	.005			
Gender						-.51**	.19	.60
Age						.17	.22	1.19
Study level						-.31	.20	.74
Length of residence						-.26	.21	.77
City						.49**	.19	1.64
Constant						.47**	.27	1.60

Note: (*) expresses that coefficients are significant at the following levels: ** < 0.01 * < 0.5.

Table 5
Influence of psycho-social variables on Coping and Adaptation in Marseilles and Nice.

City	Predictor	-2log-likelihood	Nagelkerke R2	Khi2	df	Sig.	B	SE	Exp(B)
Marseilles		332.24	.17	36.89	4	.000			
	CC awareness						.46	.28	1.59
	Climate Stress						.91***	.26	2.49
	Coastal Well-Being						-.32*	.14	.73
	Institutional accountability						.56*	.27	1.75
Nice	Constant	213.78	.27	40.95	4	.000	-1.99*	.91	.14
	CC awareness						.39	.34	1.47
	Climate Stress						1.46***	.29	4.29
	Coastal Well-Being						-.24	.18	.79
	Institutional accountability						.52	.35	1.69
	Constant						-4.23***	1.10	.02

Note: (*) expresses that coefficients are significant at the following levels: *** <0.000 ** <0.01 * < 0.5.

harbour, and since 2013 also prestigious buildings with recreative public spaces close to the shore. But it is not allowed to swim there and the beaches, although in town, are not in the very heart of the city. In terms of Well-Being, this coastal dimension might therefore be under-invested by the participants of Marseilles, whereas it is highly valued in Nice.

However, the correlational approach shows a more complex image: whereas in Nice CSWB is only positively correlated (rather logically) to IA (as it is in Marseilles), in Marseilles CSWB is significantly negatively correlated to all other three dimensions. Participants from Marseilles who evaluate the coastal quality of life negatively display high CC awareness, high climate stress, and high coping and adaption (and conversely). The positive evaluation of the proximity to the sea and coastal surroundings does not work as an “identity protection” (Breakwell, 2001) regarding risk perception, as is the case in other coastal places where, taking into account the emotional bond to the coast, studies found that high risk perception can be associated with high place attachment (Meur-Ferec and Guillou, 2020). This might possibly be because the sea is not resented as a perfect amenity included in self-definition in Marseilles. Indeed, the fact to live close to the sea does not necessarily mean that it is an important aspect of the personal urban identity, as Krien et al. (2019) observed on the Guadeloupe Island in the Caribbean Sea. In their study, these authors found that only respondents who had integrated the coastal surroundings as part of their living area, for example through sea-related activities, perceived coastal-related risks. The other respondents, with their “back to the sea” (Krien et al., 2019, p. 10), did not consider the sea as a part of their living environment, and therefore perceived less associated dangers.

Coping and Adaptation (CA) The mean of this dimension is on the midpoint in Marseilles, a little lower in Nice. In other words, people feel neither particularly well, nor insufficiently prepared. They are not worried (mean about the same as stress), so why should they prepare? In their perception of risks over the last five years, essential dangers (e.g., lack of basic resources such as water or food) are very little reported. However, participants in Marseilles felt significantly more prepared for CC risks than people in Nice. This might be linked to the fact that most of the coastline in Marseilles is rocky and a large part of the shore is protected by harbour infrastructures. People might think that they are thus rather less exposed. Also, respondents from Nice, who remember significantly more climate related phenomena which feature the sea, might feel less adapted, as they see their central beach annually diminished by erosion during winter storms.

4.2. Prediction of adaptive behaviour

In this regard, dimensions prove to play a very varied role. Contrary to what could have been expected given its high mean in both cities, CC awareness proved not to be a predictor of adaptive behaviour, in either city. Indeed, whether climate change awareness can make a difference in the way people behave or lead to behavioural change is a question which

could not be affirmatively confirmed in a study by Halady and Rao (2010).

In both cities, **Climate Stress and Emotional Concern** qualifies as the most important predictor for Coping and Adaptation behaviours. In Nice, it is even the sole and highly significant predictor of the outcome variable. This result highlights again the major role of emotions in risk perception and motivation to act – or not (Navarro et al., 2020; Lemée et al., 2019).

In Marseilles only, **Institutional Accountability** predicted Coping and Adaptation positively. This result follows other studies which found a positive association between trust in authorities and readiness to prepare (Lin et al., 2008).

Again in Marseilles only, **Coastal Well-Being** predicts Coping and Adaptation negatively, i.e. the higher participants score on Coastal Well-Being, the lower they score on Coping and Adaptation. This result is in line, for the evaluative dimension of individual urban identity (Belanche et al., 2017), with research by Bertoldo et al. (2021), Meur-Ferec and Guillou (2020), and Michel-Guillou et al. (2016) on the role of place attachment hampering adaptive choices.

What does this tell us about psycho-social dimensions intervening in climate change perception and possible action of local policies in Marseilles and Nice? As research has shown for the major part of the regional coastline (Robert and Schleyer-Lindenmann, 2021), both cities are at the beginning of the implementation of adaptive strategies with regard to CC risks. However, since Emotional Concern and Stress are a major predictor of Coping and Adaptation, they could be used as a leverage: local adaptive strategies should be conceived to connect with inhabitants' concerns. As has shown a recent workshop organized by CEREMA (a governmental service in charge of supporting the authorities in the design and implementation of their policies) and the ANEL (National Association of elected coastal representatives) (CEREMA, 2021), local authorities' representatives are often conscious of the emotional and stressful dimension of this adaptation for the inhabitants, and ask for support to better explain each local context, empower the population to feel more confident and pave the way for local adaptive policies. Therefore, more research and especially more multi-level interaction is needed between local actors and researchers, as well as with inhabitants, associations, artists ..., to fuel reflection in the context of public policy support initiatives, as demonstrated by Rocle et al. (2021). In their review and analysis of governance of coastal managed retreat in France, these authors highlight the importance of co-construction of adaptation options, through a synergy between various categories of actors and scales, which favours ultimately the relocation policy's legitimacy, credibility, applicability, and acceptability.

4.3. Limitations of the study

Our comparative approach is interesting and provides relevant data to approach adaptive capacities in each city. Indeed, between Marseilles and Nice, macro-level (Bronfenbrenner, 1979) differences are clearly

observable, and we have interpreted them in terms of urban identity (Belanche et al., 2017; Lalli, 1992). However, as we have not measured participants' individual representations of their city, we cannot, with total certainty, link our macro-setting observations to the obtained individual results. Nevertheless, the attention to local variations is necessary to implement adapted management and participative processes, and a recent proposal of measurement by Belanche et al. (2017) could be very useful to apprehend urban identity on the individual level. A second limitation is the fact that due to our exploratory approach through seeking out participants living or working close to the sea, our samples are not representative of the population of each city. A more comprehensive study in both cities is needed to know for example if people of all parts of town would perceive CC as did participants in this study. It is interesting to observe however, that the distance between coast and home did not influence results in these samples.

4.4. Conclusion and perspectives

The interest of this study is to capture local variations as well as shared aspects of climate change perception of people living in two large cities, Marseilles and Nice. We could show that although respondents of both cities are aware of climate change, they do not really worry about it. Participants from Marseilles feel a little more prepared than respondents in Nice. Coastal Subjective Well-Being distinguishes clearly the two samples. However, in terms of Adaptation and Coping, the most predictive variable in both cities was Climate Stress and Emotional Concern which should encourage more studies on this specific dimension. For example, Bazart et al. (2020) recently studied the impact of

including emotional aspects in the communication about climate change related management and found that humour-based communication elicited more interest and thought in the participants.

As a tool, the CCPI proved to be easily employable and useful. Indeed, there is a need for multi-dimensional scales, as risks are multi-dimensional constructs, like the "Coastal Flooding Risk Evaluation Scale" by Lemée et al. (2018), which is specific to coastal inundations. However, the CCPI should be reviewed to strengthen the scales measuring Institutional Accountability and Coping and Adaptation.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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7. Appendices

Appendix A: CCPI subscales and items used in this study (French version can be asked of the authors)

Subscale 1 "Climate Change Awareness" (CCA) (n = 5)

1. Climate change has started creating environmental crises such as earthquake, cyclones and tsunami in our country.
2. The livelihoods of coastal population would be greatly affected because of climate change.
3. I have personally noticed the impact of climate change in my coastal area during my lifetime.
4. The temperature of seas and oceans has gone high and global average sea level has risen over the past 50 years.
5. Melting of glaciers is the biggest cause of Sea level rise.

Subscale 2 "Climate Stress and Emotional Concern" (CSEC) (n = 14)

1. I feel anxious and stressful that the sea might get furious anytime and ruin our lives.
2. I am afraid of more high tides, cyclones, Tsunami occurrences/reoccurrences in my city because of climate change.
3. I am frustrated that not enough is being done to reduce the impact/mitigate the climate change in my coastal area.
4. Shortage of water makes me worried though I have sufficient water supply at home.
5. It frightens me to think that we are heading towards ice age.
6. When I think of the ways big, developed nations are using electricity and energy, I get frustrated and angry.
7. There is a need for more stringent environmental laws to control global warming.
8. I feel disturbed regarding degradation of coastal resources because of storms and floods.
9. I am frightened about imagining my future stay near the coast due to the talks of sea level rise in coming years.
10. I feel annoyed of increasing humidity and increasing temperature day by day.
11. I feel risky regarding land salinity and quality of drinking water because of the possibility of sea water intrusion into groundwater.
12. I wish I could live in some low-risk and safe area away from the coast.
13. I get irritated because of industrial and domestic based pollution aspects along the coastline.
14. Improper management of coastal zones is a major reason for my anger.

Subscale 3 "Coastal Subjective Well-Being" (CSWB) (n = 4)

1. The quality of my surrounding coastal environment is close to my ideal.
2. The condition of coastal life in my city is very excellent for my life.
3. So far in this coastal city, I have got the optimal environmental conditions I want in life.

4. If I could live my life over, I would change almost nothing in this coastal city.

Subscale 4 "Institutional Accountability" (IA) ($n = 3$)

1. Whenever there is coastal upheaval, the disaster management system of my city is able to meet it well.
2. There are Govt./non govt. institutions in my city to create awareness in public about environmentally healthy lifestyle.
3. Visual and print Media is giving enough importance to news items creating awareness about climate change and its possible effects on people.

Subscale "Coping and Adaptation" (CA) ($n = 7$)

1. Policy for public transport should be compulsory for all to control traffic and pollution.
2. I would like to initiate a campaign for car-pooling and walking/bicycle use for shorter distances or use of public transport.
3. Energy efficiency of an electric item is one of the factors to make a choice before buying them.
4. As I live near the coast, I always keep considerably more stock of food items and other necessary things to meet coastal disaster.
5. I have faced coastal upheavals in the past and was able to fight/overcome the situation well.
6. Migration is the only option left for me in the event of any coastal disaster taking place.
7. Awareness campaigns about coastal threats from climate change are needed to educate the coastal population.

(Appendix B)

Table B1

Descriptive details of samples and comparison between Marseilles and Nice

Variable	Categories	Total sample %	Marseilles %	Nice %	Significant difference
Age	18–24 years	27.22	26.1	28.9	ns
	25–45 years	39.87	44.9	32.6	.05
	>45 years	32.91	29.0	38.4	ns
Gender	Male	47.67	47.0	48.4	ns
	female	52.33	53.0	51.6	ns
Length of residence	0–2 years	12.29	12.8	11.6	ns
	>2 < 5 years	15.25	17.7	11.1	ns
	>5 years	72.45	69.5	77.2	ns
Distance between coast and home	<2 km	50.53	43.9	60.9	.03
	2–5 km	31.08	32.5	29.1	ns
	>5 km	18.39	23.7	10.1	ns

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