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Climate Change Risk Perception Among Citizens Living in a Central Region of Italy

di Dario Sciulli[*], Edilio Valentini[†] e Pasquale Valentini[‡]

Abstract
Adequate knowledge of climate change and correct perception of the associated risks by the population are crucial factors for the effectiveness of climate policies.
We analyze this topic by collecting information on the degree of current risk perception and its evolution over the last ten years among citizens living in five municipalities in an area of Abruzzo, a central Italian region. In addition, we gather information on the willingness of citizens to stipulate public insurance against damages caused by extreme events.
The paper offers a descriptive analysis of the association between outcomes and individual/household characteristics. We find the degree of risk perception is relatively high, as around 2/3 of respondents believe the current risk of suffering damage from extreme events related to climate change is high or very high. More than 90% also believe that this risk has increased in the last ten years. The perception, however, is heterogeneous across population subgroups. Finally, citizens' inclination toward public insurance covering damage from extreme events is also high.
We also provide a quantitative analysis of the factors affecting the current risk perception by adopting a probit model. The related results essentially confirm evidence from the qualitative analysis and stress, in line with previous studies, the importance of previous damages as a predictor of risk perception.
JEL codes: Q54, Q58, C25
Keywords: Climate change, Extreme events, Risk perception, Municipal insurance, Italy

[*] Department of Economic Studies, University "G. d'Annunzio of Chieti-Pescara", Italy
[†] Department of Economic Studies, University "G. d'Annunzio of Chieti-Pescara", Italy. E-mail: edilio.valentini@unich.it
[‡] Department of Economic Studies, University "G. d'Annunzio of Chieti-Pescara", Italy

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Percezione del rischio associato al cambiamento climatico tra i cittadini residenti in una regione dell'Italia centrale

Sommario
Un adeguata conoscenza dei cambiamenti climatici e una corretta percezione dei rischi ad essi associati da parte della popolazione sono fattori cruciali per l'efficacia delle politiche sul clima. Qui analizziamo questo tema raccogliendo informazioni sul grado di percezione del rischio corrente e sulla sua evoluzione negli ultimi dieci anni tra i cittadini residenti in cinque comuni in una zona dell'Abruzzo, una regione dell'Italia centrale. Inoltre, raccogliamo informazioni sulla disponibilità della cittadinanza a stipulare un'assicurazione pubblica contro i danni causati da eventi estremi.
Il contributo offre un'analisi descrittiva della correlazione tra risultati e caratteristiche individuali e familiari. Troviamo che il grado di percezione del rischio è relativamente elevato, poiché circa 2/3 dei rispondenti ritiene che il rischio corrente di subire danni da eventi estremi connessi ai cambiamenti climatici sia alto o molto alto. Oltre il 90% ritiene anche che tale rischio sia aumentato negli ultimi 10 anni. La percezione, ad ogni modo, è eterogenea nei vari sottogruppi della popolazione. Infine, i cittadini valutano positivamente la possibilità di un'assicurazione pubblica che copra i danni da eventi estremi. L'analisi si conclude con un'analisi quantitativa, mediante l'adozione di un modello probit, dei fattori che influenzano la percezione del rischio corrente. I relativi risultati tendono a confermare le evidenze emerse dall'analisi qualitativa e sottolineano, in linea con gli studi precedenti, l'importanza di aver subito danni in precedenza quale elemento previsivo della percezione del rischio
Parole chiave: Cambiamento climatico, Eventi estremi, Percezione del rischio, Assicurazione comunale, Italia

1. Introduction

Events associated with climate change are increasingly affecting citizens' lives around the world. Also in Italy, extended periods of drought put a strain on families and businesses, with particularly serious effects in the agricultural sector. On the other hand, rains, snowfalls, and hailstorms of exceptional intensity, are not very helpful for meeting water needs, while they are dangerous and cause considerable damage to crops and infrastructures. Heat waves also represent a real risk to human health - especially for children, elderly people, and those suffering from certain chronic diseases - and animals. Coast erosion and the rise of sea level are already producing considerable damage to the tourism sector and, in the near future, could put at risk the survival of many coastal cities.

The common view among scientists is that all these atmospheric phenomena are due to the growing overheating of the planet caused by the increase in greenhouse gas emissions produced by human activities. Despite the scientific evidence and the increasing frequency of atmospheric extreme events that were once considered exceptional, the perception of the risk associated with such events and the awareness of their link with climate change is assumed to be still low among people. This underestimation of the real risk could have several causes and could represent a serious obstacle to the social acceptability of climate policies.

Such policies, in fact, pay little from an electoral point of view mainly because of the temporal misalignment between the costs that governments, firms, and individuals are called to bear immediately, and the benefits that tend to fall mainly on future generations. A better knowledge of climate change and a correct perception of the risk associated with it are therefore important for supporting climate policies and, at the same time, it is important for policymakers to know the level of awareness of the population.

This paper contributes to this issue by investigating the awareness and perception of the risk associated with climate change among people living in five municipalities in an area of Abruzzo, a central region of Italy[1]. We acquire information by a sample survey and the collected data allows us to identify the role of some socio-demographic and economic variables on the degree of risk perception in the analyzed territory.

A descriptive analysis of our data allows us to evaluate the perception of current risks, its evolution in the last 10 years and the willingness of citizens

[1] The selection of the five municipalities under scrutiny depended on their participation, together with CDCA-Abruzzo and the Department of Economic Studies of the University of Chieti-Pescara in a local joint research project.

to stipulate public insurance against damages caused by extreme events. We also provide an econometric exercise that supports some evidence suggested by the analysis on how citizens currently perceive the climate risks. The analysis of the data suggests that the degree of risk perception is relatively high. About 2/3 of respondents believe, in fact, that the current risk of suffering damage from extreme events related to climate change is quite or very high. More than 90% also believe that this risk has increased in the last 10 years. The analysis identifies some factors related to a greater or lesser perception of risk. In particular, the perceived risk is greater among young people, among those who live in small municipalities and rural areas, and lower among individuals with low educational qualifications. In addition, the perceived risk is greater among individuals who report that they have suffered damage from extreme weather events in the last 10 years. Citizens' predisposition towards public insurance covering damage from extreme events is also high (over 87%). Such predisposition is higher among young people, unemployed, and those who have already incurred expenses due to events referable to climate change rather than among those who have never suffered damage.

Our econometric analysis employs a probit model to determine whether and how socio-demographic and residential factors affect the risk of suffering damage from extreme weather. Related evidence essentially confirms the main findings that emerged from the descriptive analysis, including the crucial role played by having been affected by previous damages in the last ten years.

This result is consistent with the main findings of former studies (e.g. Dai et al., 2015; Frondel et al., 2017) and suggests that direct experience with adverse events is an important factor in changing one's perception of the risk associated with extreme events related to climate change.

The paper proceeds as follows. Section 2 reviews the most related literature; Section 3 presents the characteristics of data and sample; Section 4 offers a descriptive analysis; Section 5 shows the quantitative analysis and the related results, while Section 6 provides some concluding remarks.

2. Literature review

The literature on how people perceive climate changes is vast and still growing (comprehensive surveys are in Howe et al., 2019; Sambrook et al., 2021; and Baiardi, 2023). Indeed, understanding the determinants of climate change beliefs is important for policy makers at the international, national and local level as citizens' support for climate policies is a necessary

condition for their successful implementation (e.g. Dai et al., 2015; Frondel et al. 2017). Under this respect, it is well known from previous researches (e.g. Spence et al., 2011) that there exists a positive relationship between having personally experienced extreme weather events and the awareness (and concern) about climate change. However, awareness and risk perception about climate change-related issues can change over time, between countries and also between people in the same country (e.g. Tranter, 2013; Lee et al., 2015; Reser et al., 2015; Xie et al., 2019; Leiserowitz et al., 2021). In fact, albeit the general perception of climate change has been increasing around the world (Capstick et al., 2015), such awareness is mostly higher in advanced economies such as Australia, Japan, Europe, and USA, that are also among countries showing the highest levels of CO2 emissions (Baiardi, 2023). Therefore, it is important to collect further evidence on how perceived extreme weather events affect climate change beliefs at the country level and what other variables may play a role in explaining the heterogeneity of such beliefs.

This paper contributes to this issue by adding some empirical evidence to the very scant literature dealing with risk perception about climate change in Italy. In fact, the relationship between climate change awareness and perceived extreme events experiences has been widely investigated in the U.S. (e.g. Joireman et al., 2010; McCright and Dunlap, 2011; Hamilton, 2011; Akerlof et al., 2013), UK (e.g. Whitmarsh, 2008; Spence et al., 2011; Demski et al., 2017; Lohmann and Kontoleon, 2023), Australia (e.g. Li et al., 2011), Germany (e.g. Frondel et al., 2017) and China (e.g. Dai et al., 2015), among other countries. As regards Italy, instead, only few papers deal with the evaluation of the risk associated with natural events, namely, Guzzetti et al. (2005) who estimate the individual and collective risk posed by landslides and floods, evaluating it in terms of mortality rates, Avvisati et al. (2019) who show how historical memory affects risk perception among citizens living in 12 municipalities and 2 territorial unions of Campania Region differently characterized by seismic, volcanic and hydrogeological (floods and landslides) risk and, lastly, Nanni et al. (2021) who present the results of a survey on climate change and urban flooding risk perception, collected from a questionnaire submitted to residents in 11 municipalities in the Simeto River Valley in Sicily. Specifically, they find that "more than 52% of citizens has inadequate knowledge of the correct behavior during flooding events and only 30% of them feel responsible for mitigation of flooding risk". Moreover, a modest willingness to support the construction of sustainable urban drainage infrastructures emerges among the population and greater worry about climate change does not seem to impact significantly either on people behaviour during flooding events or on the willingness to

support financially sustainable solutions. Therefore, our results partly contrast with those documented in Nanni et al. (2021) as we report a relatively high degree of risk perception among respondents, coupled with a high predisposition towards public insurance against the risk of climate change-related events. Moreover, our results confirm that there is a positive correlation between risk perception and past personal experiences with climate change-related events.

3. Data and Sample

The empirical analysis of this paper exploits data collected by interviewing a representative sample of citizens aged eighteen (at the date 31 December 2020) or more and living in five bordering municipalities of Chieti Province (Abruzzo Region), i.e., Castel Frentano, Frisa, Lanciano, Ortona, and San Vito Chietino[2]. The overall population is about 67000 inhabitants and the whole area is over 188 square kilometers. It includes both coastal and hilly towns (with altitudes ranging between 0 and 400 meters), which are characterized by urban and rural areas. The area is characterized by the presence of rivers and water streams, as well as terrain subject to landslides and erosion of the coast. In the past, adverse events, such as overflowing and fires, characterized some of the municipalities here analyzed. We administered a questionnaire (see the Appendix) to interview 1943 inhabitants casually drawn from electoral registers of the municipalities involved in the study, 221 of which completed the questionnaire (see Table A1 in the Appendix for the distribution across municipalities)[3]. Questions included in the questionnaire allowed us to collect information on socio-demographic variables and extreme weather events, while information included in the electoral registers provided supplementary information, such as age, gender, municipalities of residence, and polling station. Definitively we have information on gender, age, height, education, occupational status, presence of children aged 0-14, area of residence, and housing conditions. To account for the role of sensitivity to environmental issues, we asked individuals to indicate whether they participated in environmental initiatives, such as registration with environmental associations, participation in

[2] The sample has been drawn from the electoral lists of the five municipalities under scrutiny. This determines it is not representative of the whole population as younger people are not included in the analysis. The sampling design, however, complied with the essential statistical rules to obtain a random and objective sample.

[3] Interviews were conducted by telephone or web self-completion in the period November 2021 – February 2022.

environmental demonstrations, and so on. Regarding the risk perception of extreme weather events due to climate change, we asked individuals to evaluate the current risk and the related evolution in the last ten years. In addition, we asked individuals to indicate if they suffered damages due to adverse weather events and, in case, to evaluate the value of the damage. Finally, we asked them to specify if they consider it appropriate if the municipalities of residence use part of their financial resources to take out insurance to protect citizens from damages deriving from extreme weather events.

To characterize our dataset, we provide descriptive statistics in Table 1. The sample includes individuals aged from 18 to 92 years old, resulting in average age of respondents of 53[4]. Females represent 49% of the sample. Focusing on educational level, we notice 20.4% hold low education, while 52% are medium educated and 27.6% are highly educated. Looking at occupational conditions, employed individuals represent 46.2% of the sample, not employed are 7.7%, individuals engaged in housework are 7.2%, as well as 7.2%, declared to be students. The remaining 31.7% declare to be pensioners. The average height is 168 centimetres. Looking at familiar variables, we note that more than 50% live in urban areas, about 36% live in the periphery, and the remaining 13% live in rural areas. Further, 67% live in their own home and 36% declare to live with children. Focusing on participation in environmental initiatives, about 64% never participated, 31% participated occasionally, and just 4.5% of interviewed individuals participated habitually.

Concerning the question regarding the risk perception of suffering damages due to extreme weather events, we planned five possible ordinal responses, from very low to very high. However, few individuals report a risk perception of very low (2.3%) and quite low (3.2%), so we collapse them into a unique response (low). 29.4% of individuals answered the risk is neither high nor low, 53.9% believe the risk is quite high, while the remaining 11.3% responded the risk is very high. Turning our attention to the medium-long term, we answered an opinion about the evolution of risk perception during the last ten years. No individuals responded that the risk of suffering damage due to extreme weather events lowered in the last decade, 6.8% indicate the risk remained unchanged, while 93.2% believe the risk has increased.

[4] People younger than 18 years are not included in the analysis because our sample is drawn from electoral lists. Since teenagers are more and more engaged in environmental activism, our sample might probably show an underestimate of people with higher risk perception.

Table 1. Descriptive statistics

Variables	Observations	Mean/%
Age	221	53.11
Female	221	49.09%
Education	221	
Low	45	20.40%
Average	115	52.00%
High	61	27.60%
Occupational status	221	
Employed	102	46.20%
Non-employed	17	7.70%
Housewife	16	7.20%
Student	16	7.20%
Pensioner	70	31.70%
Area of residence	221	
Urban area	112	50.70%
Periphery	80	36.20%
Rural area	29	13.10%
Own home	221	66.97%
Number of children	221	0.656
Height	221	167.76
Participation in initiatives	221	
Never	142	64.30%
Occasionally	69	31.20%
Habitually	10	4.50%
Risk perception from extreme weather event	221	
Very high	25	11.30%
Quite high	119	53.90%
Neither high nor low	65	29.40%
Quite low	7	3.20%
Very low	5	2.30%
Evolution of risk perception during last 10 years	221	
Increased	206	93.20%
Unchanged	15	6.80%
Decreased	0	0.00%
Damage suffered during last 10 years	221	25.34%
Amount of the damage	51	4238.24
Insurance	221	87.33%
Expenditure in the last 10 years	221	55.66%
Expenditure without financial constraints	99	73.74%
Municipalities	221	
Castel Frentano	28	12.70%
Frisa	10	4.50%
Lanciano	105	47.60%
Ortona	55	23.90%
San Vito Chietino	23	10.40%

Source: our elaboration on collected data

Focusing on the damages suffered by the interviewed citizens, our descriptive analysis reveals that 25.3% of them declare they suffered damage in the last ten years due to extreme weather events. On average, they quantified damage in about four thousand euros. In the last 10 years, 55.7% of individuals declared to have sustained some expenses connected to climate change, such as the installation of an air conditioning system or a pump and a tank for water, and so on. Among individuals who declared not having sustained any expense, 73.7% of them affirmed this was due to financial constraints. Finally, 87.3% of interviewed individuals maintain that respective municipalities of residence use part of their financial resources to take out insurance to protect citizens from damages deriving from extreme weather events.

Further information regards the most frequent phenomena individuals believe may affect their territory of residence and sectors. Regarding the former, it appears that the adverse phenomena most likely affecting their territory would concern hydrogeological risk, fires, landslides and floods, and, more generally, extreme events (Table A2). Regarding the latter, agriculture, tourism, and health are the sectors most likely believed to be affected by extreme events (Table A3).

4. Descriptive analysis

The present section offers a descriptive analysis of the association between risk perception of suffering damage because of extreme weather events and some variables we defined in the questionnaire (Table 2). In particular, we consider two outcomes, the current risk perception and its evolution during the last 10 years. The former has been re-coded by collapsing responses very low and quite low, so it results in an ordinal variable with four possible outcomes (low, neither high nor low, quite high, very high). The latter consists of a binary variable with two possible outcomes, increased and unchanged, considering no individuals believe the risk of suffering damage decreased during the last 10 years. The first row of Table 2 reports the distribution of response variables. Comparing the overall distribution with those conditional to specific socioeconomic and environmental variables, allowed us to highlight the presence of some regularities in the data.

4.1 The current risk perception

We now compare the overall distribution of current risk perception with the conditional distribution. Looking at the female distribution of current risk perception, we do not note any marked difference with the general one, suggesting that gender is not a characteristic affecting in any particular manner the distribution of current risk perception. On the contrary, age appears to be quite effective in affecting the current risk perception. Considering individuals who answer "high enough" and "very high", the current risk perception follows a non-linear trend concerning age. In particular, 20% of individuals aged 18-35 answered that the risk of suffering damage from extreme weather events is very high. This percentage drops to 5% among individuals aged 66-92. About 75% of individuals aged 36-50 consider the risk high, with responses "very high" and "high enough" that have been aggregated. Among individuals aged 51-65, the related percentage is around 58%. In sum, older individuals appear to perceive relatively less the current risk from extreme events.

Significant differences emerged concerning the living area. 70% of individuals living in rural areas believe the risk of suffering damage from extreme events is quite high, while this percentage declines to 50% for individuals living in urban areas. This gap holds even when aggregating the response "very high". This finding possibly indicates that the propensity to consider substantial risk of suffering such damage is connected with direct experiences of changes observed in the neighbourhood. This is possibly easier for individuals living in rural areas. Another explanation is possibly linked to the working sector of individuals. Individuals working in the agricultural sector, who in turn are more likely to live in rural areas, experienced damage from extreme events, with consequences for risk perception.

No substantial differences seem to be due to the employment status, except for students and houseworkers, with the former declaring that the risk of damage connected to adverse events can be particularly relevant. However, this result should be treated with caution due to the few observations relating to these two subgroups. Education plays a non-negligible role in determining the perception of the risk of possible damage from adverse events. In particular, although people with a low level of education declare a low risk more rarely than those highly educated, over 40% of them believe that this risk is neither high nor low and this subgroup is less represented among those who perceive a quite or very high risk (about 55%) compared to holders of a degree and, above all, a high school diploma (about 70%). The presence of children seems to increase the frequency of

responses quite slightly and is very high compared to the current risk of harm related to extreme events.

Interviewed people stating occasional or habitual participation in environmental initiatives show a greater propensity to respond that the risk of damage from adverse weather events is high. In particular, for these subgroups, the responses high enough and very high occur in 77% and 90% of cases, respectively, while the percentage drops to 57% for those who have never participated. Such a high correlation testifies that participation in environmental initiatives is a suited variable to capture how attention to environmental issues affects the perception of risk. Individuals who are more sensitive to these issues may likely be more likely to declare themselves concerned about events related to climate change. The use of this variable as a control in a multiple regression model could therefore be useful for capturing effects related to individual sensitivity to the issue of climate change.

The propensity to respond that the perceived risk is quite or very high (about 80%) is greater among people who have suffered damage from adverse events in the last 10 years, than in the rest of the respondents (about 60%). Finally, looking at answers based on the municipality of residence, individuals who show a greater propensity to consider the perceived risk to be quite or very high are those living in small municipalities. Indeed, the percentage of people with a quite or very high perceived risk is between 70% and 75% in Castel Frentano, Frisa, and San Vito Chietino and around 60% in Lanciano and Ortona.

4.2 The evolution of the risk of suffering damage from extreme events

Columns 7-8 of Table 2 report information on how the perceived risk of suffering damage from extreme events has evolved over the past 10 years. Since no individual stated that such risk decreased (even if contemplated as a possible answer in the questionnaire), the columns related to this sub-analysis are only two, corresponding to the answers "stable" and "increased". Individuals believing that the risk increased in the last 10 years represent the vast majority of the sample (93.21% of the total). Compared to this evidence, some heterogeneities related to socio-demographic and economic characteristics emerge, even if the variability related to the evolution of the risk is certainly less marked than that observed in the assessment of the current risk.

Below we illustrate the heterogeneity concerning the average data of the individual characteristics considered. With respect to gender, women

indicate a more marked increase in risk in the last 10 years than men (97.22% versus 89.29%). For age, older people respond less frequently, although with always very high levels and the risk has increased in the last 10 years (about 85% against 97% -100% of the younger groups). Contrary to what emerged for the current risk, the area of residence does not imply significant differences with respect to declaring an increased risk in the last 10 years. Following data on age, pensioners are associated with a lower predisposition to respond that the risk has increased (about 85%). Similarly to the results on current risk, the low level of education is also associated with a lower frequency of responses characterized by worry about extreme events: about 84% of them respond that the risk has increased in the last 10 years against 96% of graduates. The presence of children is more frequently associated with the belief that the risk has increased in the last 10 years (100% versus about 90%). As expected, individuals who have occasionally or habitually participated in environmental initiatives are more likely to see an increased risk of damage from extreme events than those who have never participated. Those who suffered damage from events related to climate change in the last 10 years are more inclined to believe that the risks associated with extreme events have increased (98.2% against 91.5%). Finally, there is a certain homogeneity between the municipalities, with peaks in the municipalities of Ortona and San Vito where over 95% of respondents believe that the risk of damage from extreme events has increased over the past 10 years and the exception of Frisa where this percentage is "only" 80%.

4.3 The demand for municipal insurance

The last issue concerns the analysis of what citizens think about the introduction of municipal insurance to protect them from damages resulting from extreme weather events (columns 9-10). The general outcome shows a strong aptitude towards this solution: about 87% of individuals respond favourably to the question. Also in this case, however, there are some sources of heterogeneity. Concerning gender, the differences are relatively small (90.7% for women and 83.9% for men), while by age the heterogeneity in the responses is more marked (97.6% for young people versus 82.2% for the elderly). The same can be said for the area of residence: individuals living in rural areas like municipal insurance more than residents of central or peripheral areas (96.5% against 85% - 86%). About the employment conditions, employed and retired are associated with a lower request for municipal insurance (about 84%), against values between 93% and 100% for the other subgroups of the unemployed.

Table 2. Distribution of outcomes by individual characteristics

		Risk of damages from extreme events				Risk evolution		Insurance	
		Low	Neither high nor low	High enough	Very high	Stable	Increased	No	Yes
All		**5.43**	**29.41**	**53.85**	**11.31**	**6.79**	**93.21**	**12.67**	**87.33**
Gender	Men	7.14	25.00	58.04	9.82	10.71	89.29	16.07	83.93
	Women	3.70	33.33	50.00	12.96	2.78	97.22	9.26	90.74
Age	18-35	2.44	29.27	48.78	19.51	2.44	97.56	2.44	97.56
	36-50	5.77	19.23	63.46	11.54	0.00	100.00	15.38	84.62
	51-65	6.06	36.36	45.45	12.12	7.58	92.42	12.12	87.88
	66-92	6.45	30.65	58.06	4.84	14.52	85.48	17.74	82.26
Area of residence	Urban area	5.36	36.61	50.00	8.04	6.25	93.75	13.39	86.61
	Periphery	7.50	22.50	53.75	16.25	7.50	92.50	15.00	85.00
	Rural area	0.00	20.69	68.97	10.34	6.90	93.10	3.45	96.55
Occupational status	Employed	6.86	28.43	50.98	13.73	3.92	96.08	15.69	84.31
	Non-employed	5.88	29.41	52.94	11.76	5.88	94.12	0.00	100.00
	Housework	0.00	50.00	50.00	0.00	0.00	100.00	6.25	93.75
	Student	0.00	25.00	50.00	25.00	0.00	100.00	0.00	100.00
	Pensioner	5.71	27.14	60.00	7.14	14.29	85.71	15.71	84.29
Educational level	Compulsory	2.22	42.22	46.67	8.89	15.56	84.44	17.78	82.22
	High school	5.22	24.35	57.39	13.04	3.48	96.52	11.30	88.70
	University	8.20	29.51	52.46	9.84	6.56	93.44	11.48	88.52
Presence of children	No	5.67	30.50	51.77	12.06	10.64	89.36	12.06	87.94
	Yes	5.00	27.50	57.50	10.00	0.00	100.00	13.75	86.25
Participation in initiatives	Never	7.04	35.21	50.70	7.04	9.15	90.85	12.68	87.32
	Occasionally	1.45	21.74	59.42	17.39	2.90	97.10	10.14	89.86
	Habitually	10.00	0.00	60.00	30.00	0.00	100.00	30.00	70.00
Damage suffered during last 10 years	No	5.45	33.94	49.70	10.91	8.48	91.52	13.33	86.67
	Yes	5.36	16.07	66.07	12.50	1.79	98.21	10.71	89.29
Expenditure in the last 10 years	No							16.33	83.67
	Yes							9.76	90.24
Municipality	Castel Frentano	0.00	25.00	60.71	14.29	7.14	92.86	10.71	89.29
	Frisa	0.00	30.00	50.00	20.00	20.00	80.00	10.00	90.00
	Lanciano	9.52	27.62	49.52	13.33	7.62	92.38	12.38	87.62
	Ortona	1.82	38.18	50.91	9.09	3.64	96.36	12.73	87.27
	San Vito Chietino	4.35	21.74	73.91	0.00	4.35	95.65	17.39	82.61

Source: our elaboration on collected data

A low educational qualification is also associated with a lower request for municipal insurance (about 82% against 88% and more of individuals with higher educational qualifications), while the presence of children in the family does not seem to influence the propensity to take out municipal insurance. Interestingly, agreement with the hypothesis of municipal insurance is less frequent among those who usually participate in

environmental initiatives (only 70%). Furthermore, having suffered damage in the last 10 years is only weakly associated with the request for municipal insurance (89.3% against 86.7%). The differences are more marked if we consider the individuals who in the last 10 years have incurred expenses related to changed climatic conditions (over 90% among those who have incurred expenses and 83.7% among those who have not incurred expenses). Finally, a certain homogeneity emerges at the municipal level regarding the opportunity to take out insurance by the municipality, with a peak relatively below the average in San Vito Chietino (about 82%).

5. Quantitative analysis

5.1 Econometric model

Since we aimed to determine socio-demographic and residential factors affecting the risk of suffering damage from extreme weather, in order to provide a detailed analysis of evaluating damage from adverse weather events (high risk or low risk), we applied a discrete choice probit model for binary choice responses to the risk perception question that allows for intragroup correlation. The probit model is a statistical probability model with two categories in the dependent variable. Probit analysis is based on the cumulative normal probability distribution. The binary dependent variable, y, takes on the values of zero and one. The probit analysis provides statistically significant findings of which socio-demographic and residential variables increase or decrease the probability of risk perception.

The probability of choosing any alternative over not choosing it can be expressed as

$$P_i = \text{Prob}(Y_i = 1|X_{i1}, X_{i2} \dots, X_{ik}) = \Phi\left(\sum_{j=1}^{k} \beta_j X_{ij}\right)$$

where Φ represents the cumulative distribution of a standard normal random variable, X_{ij} is the *j*-th independent variable and β_j is the corresponding regression coefficient. The effect of a specific variable on the outcome is interpreted by means of the marginal effect, which accounts for the partial change in the probability.

5.2 Estimation results

Estimates of the probit model for the probability of considering high the risk of suffering damage from extreme weather events are given in Table 3. To make the interpretation of our results easier, we compute and report average marginal effects (AME) rather than estimated coefficients.

Primarily, we are interested in evaluating how having suffered damage from adverse weather events in the previous ten years affects the probability an individual reports a high level of risk perception. In this respect, we also account for a set of control variables, which are likely to affect individual risk perception.

Focusing on the role of past damage, we note that individuals who suffered such damage in the last ten years are about 21 percentage points (p.p.) more likely to report a high-risk perception. This is indicative of the importance of past individual experiences to identify possible risks deriving from extreme weather events. This finding confirms what emerged from the descriptive analysis and holds even after controlling for a varied set of covariates (i.e. area of residence, age, sex, education, participation in environmental initiatives), and is consistent with evidence raised from several contributions including Spence et al. (2011) and Frondel et al. (2017). Looking at the covariates, our results confirm that risk perception is heterogeneous across areas of residence. Individuals who live in rural areas are 17.6 p.p. more likely to consider high the risk of suffering damage from extreme weather events concerning the base category (i.e. living in urban areas). For individuals living in peripheral areas, the probability of reporting high risk is 15 p.p. greater than the base category. This finding suggests the importance that direct adverse experiences may have on individual risk perception. On the one hand, individuals living in rural or peripheral areas are more likely to have a direct experience with changes and events affecting the natural environment, which, in turn, may influence risk perception. On the other hand, individuals employed in the agricultural sector are more likely to live in rural areas and work on family-based farms. Given the agricultural sector has suffered greater damage from extreme weather events, the association between high-risk perception and living in rural areas is possibly based on the underlying relationships.

Turning our attention to the role of age, we note that related AMEs are relatively small and that any age group significantly differs from the base category (i.e. 18-35). This means that differently from what emerged in the descriptive analysis, the current risk perception is quite homogeneous along the life course. This finding may partly depend on compositional effects. For

example, looking at the interaction with the living area, it emerges that the current risk perception is particularly marked among young people living in rural areas and among older people living in the periphery of urban zones. This non-linearity may explain, through compensative effects, the homogeneity in risk perception across age groups.[1]

Table 3. Probit model estimation results

	AME	s.e.	P-value
Damage suffered last 10 years			
Yes	0.209	0.057	0.000
Area of living			
Urban		Base-category	
Periphery	0.150	0.061	0.014
Rural	0.176	0.091	0.053
Age group			
18-35		Base-category	
36-50	0.042	0.096	0.665
51-65	-0.042	0.097	0.665
66-92	0.023	0.096	0.809
Sex			
Female	-0.045	0.054	0.412
Education			
Low		Base-category	
Medium	0.160	0.089	0.074
High	0.048	0.099	0.632
Participation in enviromental initiatives			
Never		Base-category	
Occasionally	0.222	0.062	0.000
Habitually	0.356	0.081	0.000
Wald chi2		52.3	
Prob > chi2		0.000	
Pseudo R2		0.134	
Observations		220	

Source: our elaboration on collected data. Note. We control for municipalities' dummy variables. Observations were clustered at the level of the polling station

Similar considerations may be made for the sex indicator, being the calculated AME -0.045 and the P-value over 0.41. Based on these statistics we cannot conclude there are gender differences in current risk perception. Education matters for current risk perception and it shows a non-linear effect along the schooling distribution. Individuals with medium educational levels are 16 p.p. more likely to report high-risk perceptions concerning individuals

[1] Related estimates including age group-area interaction dummies are available upon request.

with low educational levels (our base category). Individuals with high educational levels are more likely to report higher current risk perception, but the magnitude of AME is smaller than that we found for the medium educated and it is not statistically significant. Finally, we add in the model specification a variable that shapes the engagement of individuals in environmental activities, particularly the regularity with which individuals participate in environmental initiatives. This control variable is important to account for possible bias in risk perception responses because of different sensitivity concerning environmental issues. In line with expectations, individuals who occasionally (+22.2 p.p.) and habitually (+35.6 p.p.) are much more likely to report a high-risk perception concerning individuals who never participated in environmental initiatives.

For robustness, we accounted for the level of trustworthiness of the institutions involved in climate risk management. Particularly, we include electoral results at the municipality level obtained, respectively, in the 2018 and 2022 parliamentary elections, considering that ideology and party affiliations, in fact, partially account for the mentioned issue. Despite introducing this alternative control variable, we note that the AMEs related to covariates of interest remain substantially unchanged.

6. Concluding remarks

The reference literature has highlighted that the perception of risk is a key element in guiding the processes of adaptation and prevention (purchase of insurance, investments for the insulation of houses, and other measures) of damage related to climate change by families (see O'Connor et al 1999, Zaalberg et al 2009). The perception of risk varies substantially both between countries and at the individual level (Botzenet al., 2016) due to multiple factors. Since climate change is often perceived as a distant phenomenon, both temporally and spatially, the risks associated with it are often underestimated, resulting in low pressure on public opinion toward public interventions aimed at favoring adaptation policies (e.g. Dai et al., 2015; Frondel et al., 2017), undermining the adoption of adequate law enforcement policies. In this preliminary study, an attempt was made to identify which factors may contribute to determining the perception of the risks associated with climate change in the population of five municipalities of Central Italy (Castel Frentano, Frisa, Lanciano, Ortona, and San Vito Chietino, in Abruzzo Region). A descriptive analysis of data collected by administering a questionnaire to a sample of citizens residing in the aforementioned area is

proposed. In light of the results presented above, we offer some concluding reflections. Individuals surveyed believe that the risk of suffering damage from extreme events is relatively high. About 2/3 of the interviewees, in fact, state that they currently consider this risk to be quite or very high. In addition, more than 90% believe that the risk has increased in the past 10 years. The interviewed citizens believe that the adverse phenomena most likely affecting their territory concern hydrogeological risk, fires, landslides and floods, and, more generally, extreme events. Agriculture, tourism, and health are the sectors most likely believed to be affected by extreme events. The collected data suggest that starting from the general picture mentioned above, some factors increase or reduce the perception of current risk and its evolution. Younger people, for example, more frequently believe that the risk is higher and has increased over the past 10 years. The same trend is found among those who live in small municipalities and peripheral areas and, above all, rural areas. Conversely, individuals with low educational qualifications are less likely to believe that the risk is high and that it has increased over the past 10 years. Finally, among individuals who claim to have suffered damage in the past 10 years from extreme weather events, it is more common to observe a high perception of the risks associated with extreme events and claims of increased risk in the past 10 years.

These results are largely confirmed by an additional analysis conducted through the application of a regression model for non-linear response variables. In particular, we use a probit model with observations clustered at the level of the polling stations and account for different sensibility for environmental issues. Our results stress that having suffered previously of damage because of extreme weather events increases by 21 p.p. the probability of declaring a high-risk perception. In addition, we note that those who live in rural areas are 17.6 p.p. more likely to declare a high-risk perception.

The proposed analysis seems to suggest that direct experience with adverse events is an important element in modifying the perception concerning the risk associated with extreme events related to climate change. This result is consistent, for instance, with the evidence emerging from the contribution of Frondel et al. (2017) related to the German case. The proposed analysis also investigated the predisposition of the citizens towards the hypothesis that the municipality of residence could take out insurance to cover residents in the event of damage from extreme events. The propensity for an affirmative answer is very high since over 87% respond positively to the question. The predisposition seems to be higher, in particular, for young people, not employed, and among those who have incurred expenses

attributable to changed climatic/meteorological conditions rather than among those who have suffered damage.

To conclude, we remark how important it is to shed further light on people's awareness about climate change. In a sense our results confirm both that direct experience with adverse events can change people's perception of the risks of climate change and also that such perception may be affected by many other socio-economic variables. In particular, areas of residence seem to play an important role as our results both differ from those documented in other Italian regions (e.g. Nanni et al., 2021) and, also within our sample, we show heterogeneity between individuals living in rural areas and those living in the urban ones. Albeit direct experience with climate related events may partly explain some of these heterogeneities, we cannot trust in extreme weather events to increase citizens' awareness. On the contrary greater effort should be probably put in correct and effective communication policies that may help citizens in improving their consciousness about climate change and ultimately may favour their support for climate policy.

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Appendix

Table A1. Reference population, sample and respondents

	Population	Sample	Respondents	Response rate
Caste Frentano	4236	131	28	21.37%
Frisa	1613	59	10	16.95%
Lanciano	34153	964	105	10.89%
Ortona	22242	662	55	8.31%
San Vito Chietino	5149	128	23	17.97%

Source: our elaboration on collected data

Table A2. The more frequent phenomenon in the territory of residence

Type of event	Observations	%
Hydrogeological risk	221	80.09%
Rise in sea levels	221	7.34%
Heat waves	221	9.05%
Loss of biodiversity	221	6.79%
Salinization of water	221	1.36%
Landslides and floods	221	45.25%
Desertification	221	3.62%
Increase in alien species	221	4.52%
Fire	221	57.01%
Loss of natural heritage	221	15.38%
Erosion	221	9.95%
Extreme events	221	46.61%

Source: our elaboration on collected data

Table A3. The sector most affected in the territory of residence

Sector	Observations	%
Tourism	221	45.70%
Agriculture	221	73.76%
Health	221	60.18%
Forest	221	25.79%
Fishing	221	35.29%
Infrastructure	221	20.36%
Energy	221	9.95%
Habitability	221	10.86%

Source: our elaboration on collected data

Questionnaire

1. **Please, indicate your educational level:**
   a. Compulsory school
   b. High school
   c. University degree
2. **Please, indicate your occupational status:**
   a. Employed
   b. Non-employed
   c. Unpaid housework
   d. Student
   e. Pensioner
3. **Please, indicate your area of residence:**
   a. Urban area
   b. Periphery
   c. Rural area
4. **Are you the owner of your house?:**
   a. Yes
   b. No
5. **Are there any children living in your family?:**
   a. Yes. How many? _____
   b. No
6. **Please, indicate your height in cm:**
   a. _____
7. **Have you ever participated in environmental initiatives (membership of, financial contributions to environmental associations, participation in environmental demonstrations, etc.):**
   a. Never
   b. Occasionally
   c. Habitually

8. **At the present, your risk of incurring in damages caused by atmospheric events is:**
   a. Very high
   b. High enough

c. Neither high nor low
d. Low enough
e. Very low

9. With respect to 10 years ago, your risk of incurring in damages caused by atmospheric events is:

a. Increased
b. Unchanged
c. Lowered

10. Have you borne material damages caused by extreme atmospheric events during the last 10 years?

a. Yes
b. No

11. Can you tell how much was the damage?

a. _____ (Approximately)

12. Would you be in favour of an insurance covering private damages caused by extreme atmospheric events and financed by the public budget of your municipality?

a. Yes
b. No

13. During the last 10 years have you afforded expenses that in some way can be due to changes in climatic or atmospheric conditions (installation of air conditioners, water pumps and tanks, etc.)?

a. Yes
b. No

14. If you answered 'No' to question 13. Would you afford some of those expenses if your budget would allow it?

a. Yes
b. No

15. According to you, what among the following phenomenons could strike more frequently the territory where you live? (max 3 answers)

a. water crisis and availability of drinkable water
b. sea level rise
c. heat waves
d. loss of biodiversity

e. salinization of aquifers
f. landslides and floods
g. desertification
h. more alien species and displacement of local species
i. fires
j. loss of natural, landscape, and historical heritage
k. erosion
l. more frequent extreme atmospheric events (storms, thunderstorms, waterspouts, strong winds, etc.)

16. According to you, what are the socio-economic sectors that could bear more damages from climate change related phenomena? (max 3 answers)

a. Turism
b. Agriculture
c. Health
d. Forests
e. Fishery and aquaculture
f. Infrastructures
g. Energy
h. Housing

17. Do you know what power and instruments municipalities and the local public sector have to address climate change challenges?

a. Yes
b. No
c. I would like to deepen it