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Proximity and risk perception. Comparing risk perception 'profiles' in two petrochemical areas of Sicily (Augusta and Milazzo)

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Studies on risk perception and 'proximity' usually compare populations living close to or far away from alleged pollution sources. Taking a different perspective, this paper compares the risk perception profiles of populations residing in the neighborhood of two petrochemical sites in Sicily (Italy), in order to check for similarities and differences. Based on the results of a survey carried out in the period 2008–2009 (1222 interviews), risk perception is investigated; finding that on a list of 15 social risks, the two populations show a similar risk perception only as far as hazards that can be retraced to the territorial industrial environment are concerned, while other risks are differently perceived. Specific risk perception indicators are presented and the relationship between risk perception, socioeconomic characteristics, and health is also deepened. The conclusion of this study is that proximity to industrial pollution sources influences risk perception and assimilates risk perception profiles of populations.

Keywords: risk perception; petrochemical industry; health risk; pollution; Sicily

Introduction

The existence of a deep relationship between scientific communication and risk perception has been clearly recognized by theoretical and applied literature (Gregory and Miller 1998; Walker et al. 1999), that stressed 'the difficulty of separating issues of science communication from matters of, for example, institutional legitimacy, risk and uncertainty, political conflict and cultural beliefs' (Irwin 1999). According to this view, assessment of population risk perception dynamics and of its underlying factors is needed to bridge the gap between 'lay perception of risk' and 'experts' views' (Bickerstaff 2004) in order to manage risk reduction strategies (Gerking and Harrison 2006) or responses to specific crisis events, such as the foot-and-mouth disease (Poortinga et al. 2004; Bush et al. 2005; Bickerstaff, Simmons, and Pidgeon 2006).

A huge stream of literature deepened the 'psychometric paradigm' of risk perception (Slovic 2000), taking into consideration socioeconomic, institutional, and cultural variables. As a consequence, not only risk, but also its perception 'is inherently subjective [and, at the same time], it is inter-individually constructed' (Munier

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2004, 130). According to Sjöberg (2000) individual risk perception depends on risk attitude, risk sensitivity, and specific fear, while Arvai (2007) assumes that risk perception is determined by the interaction of three dimensions: (a) potential damage, (b) individual risk-aversion, and (c) the way in which risk information is communicated; these factors determine individual risk acceptability, social concern, and risk-taking behaviour. In industrial contexts where air pollution is particularly noticed by resident populations, risk perception may differ from expert-based quantitative risk assessment, and populations often claim to participate in environmental health policies (Elliot et al. 1999); therefore, the social representation of risk is supposed to be a fundamental component of epidemiological studies (Phillimore 1998; Phillimore and Moffatt 2004; Moffatt et al. 1995), especially in contaminated areas.

Many applied contributions have shown that women, the less educated, and younger people have a higher concern in general or for specific risks (Savage 1993; Flynn, Slovic, and Mertz 1994; Antoñanzas et al. 2000; Lundborg and Lindgren 2002). Personal experience (Rogers 1997; Bickerstaff and Walker 2001), the level of exposure (MacGregor, Slovic, and Malmfors 1999), the proximity to risk sources (Poortinga, Cox, and Pidgeon 2008),[1] as well as 'familiarity' with hazardous technologies (Schlüter and Phillimore 2005), and other demographic and socioeconomic variables (Dosman, Adamowicz, and Hrudey 2001) such as: number of children, income, vote preference, risk information, have also been found to influence risk perception.

In general, individuals are 'rational' in their risk evaluation strategies and distortions may be due to incomplete information (Benjamin and Dougan 1997); individual acceptability of risk is strictly (and directly) connected to expected benefits of risky activities (McDaniels et al. 1997), while preferences regarding mortality risk reduction depend on the lapse of time of the expected effects, being significantly biased towards immediate risk reductions vs. more distant future ones (Alberini et al. 2007).

Comparative research on territorial characteristics of risk has generally confronted perception of populations living close to or far away from hazard sources, reaching ambiguous conclusions (Bickerstaff and Simmons 2009). Differently from this literature, this paper describes and compares the risk perception of populations residing in the two industrial 'risk areas' of Milazzo and Augusta (Sicily, Italy), presenting the main findings of a survey that was carried out in the period December 2008–June 2009 with 1222 face-to-face interviews on individuals aged 18–60 randomly selected from electoral polls. The research investigated risk perception on a list of 15 social risks and 11 territorial risks. Risk perception characteristics of the two areas were compared and socioeconomic determining factors of environmental and health risk perception in contaminated industrial areas were deepened. Results show that, within generally different risk perception profiles, the perception of hazards more directly connected with an industrial 'development model' of the territories (based on the growth of petrochemical and other polluting activities) does not differ. Furthermore, gender, education, parenthood, maternity, income level, and familiarity with alleged environment-based diseases (like asthma or cancers) importantly influence individual risk perception.

The section 'The territories and the survey design' presents the territorial context and survey design. The section 'Methodologies: Risk perception indexes (RPI, ρ, $\rho_{\varepsilon\eta}$) and risk perception "profiles"' introduces methodological aspects and discusses risk perception indexes (RPIs). The section 'Results' describes the results

of the survey and section 'Discussion of results' discusses the main findings and outlines the conclusions of the study.

The territories and the survey design

Respectively, in 1990 and in 2002, the territories around Augusta and Milazzo (on the eastern and the northern coasts of the island of Sicily) were declared 'areas at high risk of environmental crisis' (in short: 'risk areas') by the national and regional governments, a legislative measure that follows: (a) a technical investigation aimed at recognizing the potential damage and the possibility that industrial accidents or natural events might cause to the territory or to the health of the local population; (b) an administrative procedure and negotiation involving national, regional, and local administration governments. The declaration of a territory as a 'risk area' implies constraints to emissions more binding than ordinary low restrictions and reclamation measures; sometimes (as in the case of Milazzo), this declaration is associated with the promise of economic reconversion and 'new' development trajectories for local economies.

Augusta and Milazzo are two of the three 'petrochemical poles' that have been established in Sicily since the 1960s. The third one is the area of Gela, on the southwest cost of the island, which was declared a 'risk area' in 1990, jointly with Augusta (see Figure 1). Since industrialization plans took place, with the start of oil refineries, the three areas underwent major changes both in the economic structure and in the social relationship (Saitta 2010; Signorino, Gatto, and La Rocca forthcoming), also suffering increasing pollution and damage to human health (La Rocca 2010); evidence of malformation and excess mortality due to various forms of cancer have been detected (DOE 2005, 2008).

On the whole, the two selected areas cover the territories of 14 local administrations (seven close to Milazzo; seven close to Augusta), for a total surface of

Figure 1. Risk areas around the petrochemical poles in Sicily.

826 km^2 (187 in the Milazzo Area; 639 in the Augusta Area), that accounts for the 3.21% of the regional surface, while at this time the population of 279,601 (56,420 in Milazzo Area; 223,181 in Augusta Area – see Table 1) represents 5.54% of the total population of Sicily.

Two representative samples of 519 and 703 (respectively in Milazzo and Augusta) were randomly extracted from electoral rolls and stratified for local resident population (see Table 2).

At a 95% confidence level, sample error for relative frequencies can be estimated applying the standard formula:

$$e = Z\left\{\sqrt{[p(1-p)/n]}\right\} \times \left\{\sqrt{[(N-n)/(N-1)]}\right\}$$

where: $Z = 1.96$ = value of the normal standardized distribution for arithmetic average corresponding to a 0.95 confidence; $p = 0.5$ = expected relative frequency value that maximizes the sample dimension; n = sample observations; N = population.

Table 3 shows that, at a 95% confidence level, sample error is lower than 5% both in Milazzo (4.3%) and in Augusta (3.6%).

Questionnaires had 62 items split into 6 sections[2] and were administered in a face-to-face manner. In order to check for individual attention, two different versions of the questionnaire had been prepared, modifying the position of Sections 2 and 3.

Methodologies: Risk perception indexes (RPI, ρ, $\rho_{\varepsilon\eta}$) and risk perception 'profiles'

There were 26 items on risk perception and the section progressed from general and social risk perception (questions 1–2) to risk conceptualization (3–4), territorial risk perception (6–7), and personal exposure evaluation (5, 8–12). Direct experience of risk and connected behavior (13–16), risk management information (17–20), personal judgment on the quality of information and trust in public authorities (21), and evaluation of environmental quality and territorial vulnerability (22–26) were also investigated. Relative to the different kinds of social and territorial risks, a scale of 4 (most worried, very worried, moderately worried, not worried) was submitted. Risk perception was studied and compared between the two samples: (a) constructing a synthetic RPI relative to all kinds of risks; (b) comparatively

Table 1. Municipalities and populations of the two risk areas.

Milazzo risk area local admin.	Resident population (1 January 2010)	Augusta risk area local admin.	Resident population (1 January 2010)
Condrò	493	Augusta	34,393
Gualtieri Sicaminò	1852	Floridia	22,938
Milazzo	32,655	Melilli	13,197
Pace Del Mela	6341	Priolo Gargallo	12,157
S. Lucia del Mela	4788	Siracusa	12,3768
S.Filippo del Mela	7295	Solarino	7748
S.Pier Niceto	2996	Sortino	8980
Total	56,420	Total	223,181

Data source: ISTAT, http://demo.istat.it/pop2010/index.html.

Table 2. Sample composition by municipalities.

Milazzo risk area	Resident population/total population (%)	Observations	Local observations/ total observations (%)	Augusta risk area	Resident population/total population (%)	Observations	Local observations/ total observations (%)
Condrò	0.87	6	1.16	Augusta	15.41	115	16.36
Gualtieri Sicaminò	3.28	24	4.62	Floridia	10.28	70	9.96
Milazzo	57.88	299	57.61	Melilli	5.91	43	6.12
Pace Del Mela	11.24	54	10.40	Priolo Gargallo	5.45	40	5.69
S. Lucia del Mela	8.49	42	8.09	Siracusa	55.46	366	52.06
S.Filippo del Mela	12.93	63	12.14	Solarino	3.47	25	3.56
S.Pier Niceto	5.31	31	5.97	Sortino	4.02	44	6.26
Total	100.00	519	100.00	Tot	100.00	703	100.00

Table 3. Sample error by sample dimension.

Milazzo $N = 55{,}504^*$			Augusta $N = 209{,}352^*$		
n	Sample error (%)	% Change in sample error	N	Sample error (%)	% Change in sample error
50	13,853	–	50	13,858	–
100	9791	−4.06	100	9798	−4.06
150	7991	−1.80	150	7999	−1.80
200	6917	−1.07	200	6926	−1.07
250	6184	−0.73	250	6194	−0.73
300	5643	−0.54	300	5654	−0.54
350	5222	−0.42	350	5234	−0.42
400	4882	−0.34	400	4895	−0.34
450	4601	−0.28	450	4615	−0.28
500	4363	−0.24	500	4377	−0.24
550	4158	−0.20	550	4173	−0.20
600	3979	−0.18	600	3995	−0.18
650	3821	−0.16	650	3838	−0.16
700	3681	−0.14	700	3698	−0.14
750	3554	−0.13	750	3572	−0.13
800	3440	−0.11	800	3458	−0.11
850	3336	−0.10	850	3355	−0.10
900	3240	−0.10	900	3260	−0.09
950	3152	−0.09	950	3172	−0.09
1000	3071	−0.08	1000	3092	−0.08

*ISTAT 2001 Census data.

investigating risk perception 'profiles' (defined as the distribution of the different categories of risk perception relative to single hazards) of the two populations.

The RPI was obtained applying the following formula:

$$\mathrm{RPI} = \left[\left(\sum\nolimits_i n_i \pi_i\right)/N \times 3\right]$$

where: n_i = absolute frequency of i-th category (most worried; very worried; moderately worried; not worried/does not know); π_i = i-th category score (3 = 'most worried;' 2 = 'very worried;' 1 = 'moderately worried;' 0 = 'not worried/does not know'); N = total number of observations.

If all N respondents indicate the highest risk perception level, the index would be: $3N/3N = 1$. If all respondents choose the 'no worry' option, the index value would be: $0N/3N = 0$, so that $0 < \mathrm{RPI} < 1$, and values of RPI increasing from 0 to 1 show that risk perception increases within the population. RPI is independent from the scale and is suitable for comparative studies.

However, as RPI is a weighted average of different levels of concern within the population, it is possible that similar average risk perceptions are associated with different relative distributions of answers, such as in the example of Table 4 and Figure 2, where series 1 and 2 provide identical RPI, though in the second series the frequencies relative to extreme categories (most worried, not worried) are more numerous than in the first:

The distribution of relative frequencies is what we define 'risk perception profile' of a population. Different risk perception profiles can be due to different levels of information about an environmental situation or health hazards, and may

Table 4. Simulation of risk perception profiles: populations with identical RPI.

		Frequencies	
Answer	Weight	Series 1	Series 2
Most worried	3	10	20
Very worried	2	30	20
Moderately worried	1	35	25
Not worried	0	25	35
Total		100	100
RPI		0.416667	0.416667

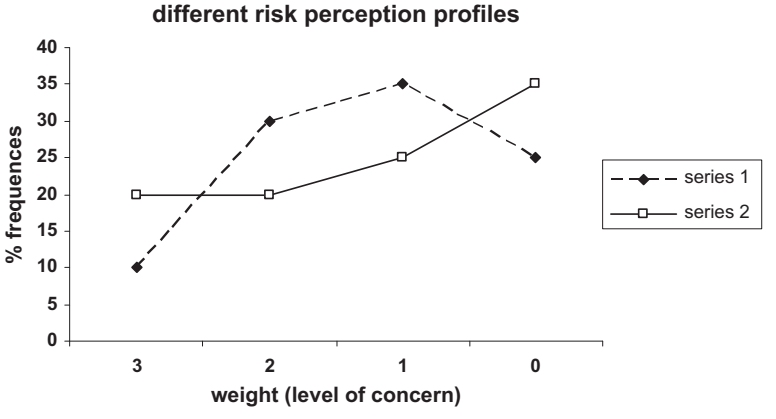

Figure 2. Simulation of risk perception profiles: relative distribution of concern within two different populations.

reveal differences in territorial vulnerability, such as hypersensitivity or risk underestimation which may determine inappropriate reactions of people if there is danger.

In order to compare different population risk perception 'profiles,' a χ^2 test for differences in relative frequencies is provided: contingency tables are built in order to confront the hypothetical identical relative frequencies and actual observations in the two samples, and a χ^2 statistics is obtained, based on the differences between observed and theoretical frequencies.[3]

Section 4 compares the perception of social and territorial risks in the two areas by estimating RPI index and confronting risk perception 'profiles,' showing differences and similarities between the two contexts. Analyzing the survey results, a RPI has been calculated at an individual level, weighting the frequencies of the declared degree of concern relative to each of the 15 social hazards exposed in the questionnaire.

The individual general RPI (ρ) is the following:

$$\rho = \left[\left(\sum\nolimits_j \pi_{ij}\right)/15 \times 3\right],$$

where suffix $j = 1, 2, \ldots, 15$ indicates the specific hazard; as above, $\pi_{ij} = 0, 1, 2, 3$ is the weight assigned to the intensity of concern expressed by the interviewee (0 = not worried; 1 = moderately worried; 2 = very worried; 3 = most worried) relative to the jth risk. Alternatively, focusing on the three questions 'Environmental

Deterioration,' 'Serious Illnesses,' and 'Industrial Catastrophes,' an 'environmental and health' RPI ($\rho_{\varepsilon\eta}$), has also been estimated.

$$\rho_{\varepsilon\eta} = \left[\left(\sum\nolimits_j \pi_{ij}\right)/3\ 3\right],$$

where $j = 1, 2, 3$ is restricted to the above mentioned environmental and health hazards.

Results

Social risks

A comparison between risk perception and risk perception profiles in the populations of Augusta and Milazzo relative to the first list of 15 'social risks' submitted to the interviewees' evaluation showed important results:

(a) Average risk perception is high and very similar in the two areas (RPI = 0.670 in Milazzo; RPI = 0.665 in Augusta) (see Table 5).
(b) Grouping hazards by RPI, (lower than 0.6, between 0.6 and 0.75, equal or higher than 0.75) three clusters are obtained that contain the same items both in Milazzo and in Augusta. Health, Environment, Industrial Accidents, Unemployment are the most perceived risks (RPI $\geqslant$ 0.75); Car Accidents, Poverty, Precariousness, Addictions, Natural Catastrophes, War and Terrorism remain in the intermediate group (0.6 < RPI < 0.75); Food Hazards, High and

Table 5. Hazards by RPI in Milazzo and Augusta.

Milazzo area			Augusta area		
	Hazard	RPI		Hazard	RPI
1	Serious illnesses (AIDS, cancer, …)	0.82	1	Unemployment	0.86
2	Environment degradation	0.81	2	Serious illnesses (AIDS, cancer, …)	0.82
3	Unemployment	0.77	3	Environment degradation	0.79
4	Industrial catastrophes	0.75	4	Industrial catastrophes	0.75
5	Car accidents	0.68	5	Natural catastrophes	0.69
6	Misery, social exclusion	0.68	6	Car accidents	0.67
7	Insecurity and precariousness	0.67	7	Misery, social exclusion	0.67
8	Addictions	0.66	8	Insecurity and precariousness	0.67
9	Natural catastrophes	0.64	9	Addictions	0.65
10	War	0.63	10	War	0.64
11	Terrorism	0.62	11	Terrorism	0.63
12	Food hazards	0.59	12	Food hazards	0.59
13	High frequency electromagnetic fields	0.58	13	Nuclear hazard	0.55
14	Nuclear hazard	0.57	14	High frequency electromagnetic fields	0.52
15	Low frequency electromagnetic fields	0.56	15	Low frequency electromagnetic fields	0.47
	Average RPI	0.67		Average RPI	0.665

Low Frequency Electromagnetic Fields, Nuclear Hazard are the least worrying topics (RPI < 0.6) (see Table 5).

(c) Despite similar and in some cases, a lower average RPI in Milazzo than in Augusta, Milazzo shows more polarized answers, with higher relative frequencies both of 'most worried' and 'no worry' occurrences for all of the 15 social risks; this result is probably due to a lower level of information and studies relative to the Milazzo area and indicates the possibility that different 'risk perception profiles' characterize the two populations.

(d) A χ^2 test for differences in relative frequencies shows that risk perception profiles differ in the two areas for all risks, apart from Health, Environment, and Industrial hazards (see Table 6).

These results imply that, within a similar level of general alarm and different risk perception profiles, two populations that share an identical 'development' model (centered on the growth of 'heavy' manufacturing activities that produce a major impact on environment and health) have the same risk perception as far as environment, health, and industrial hazards are concerned.

Territorial risks

In addition to the above mentioned 'social' or 'general' risks, the survey proposed to respondents a list of the risks more specifically related to their own territory conditions and natural phenomena or to human pressure connected to productive activity; in particular, the interviewee was asked to specify: (a) how much he/she felt him/herself to be directly exposed to each suggested hazard on a four entry Likert scale in the decreasing order: 'very much,' 'much,' 'little,' 'at all;' (b) the first three risks the respondent felt him/herself to be directly and personally exposed to.

Table 6. Chi-sq. test of independence on social risks.

		Estimated	Tabular	
	Hazard*	χ^2	χ^{2**}	Risk perception profile
1	Car accident	13.18937	7.815	Different
2	Food hazard	10.77809	7.815	Different
3	Addictions	38.79818	7.815	Different
4	*Environmental degradation*	5.024103	7.815	Similar
5	War	28.38464	7.815	Different
6	Misery, social exclusion	36.71902	7.815	Different
7	Natural Catastrophes	27.67738	7.815	Different
8	Terrorism	28.26872	7.815	Different
9	*Unemployment*	*8.931898*	*7.815*	*Different (Similar at $\alpha = 0.025$)*
10	*Serious illnesses (AIDS, cancer, ...)*	3.418838	*7.815*	Similar
11	Nuclear hazard	24.00586	7.815	Different
12	*Industrial catastrophes*	*5.45766*	*7.815*	*Similar*
13	Insecurity and precariousness	32.25804	7.815	Different
14	Low frequency electromagnetic fields	37.88141	7.815	Different
15	High frequency electromagnetic fields	14.72383	7.815	Different

*in italic types, hazards showing similar risk perception profiles.
**Degrees of freedom = 3; $\alpha = 0.05$.

The 11 suggested hazards were: 'Flooding,', 'Noise,' 'Hazardous materials transportation,' 'Hazardous waste' (e.g. chemical, radioactive), 'Air pollution,' 'Serious weather phenomena' (e.g. hurricanes, tornados), 'Fires and accidents (of any type),' 'Water pollution' (e.g. sea, rivers, water table), 'Dangerous firms,' 'Earthquakes,' and 'Slumps and mudslides.'

The application of the RPI as described above, together with the analysis of concern in the highest categories and the comparison of risk perception profiles (population independence test), gave the following results (see Table 7).

With respect to medium and marginal warning levels as perceived by the two populations, Table 7 confirms conclusions illustrated in the previous paragraph as far as 'social risks' are concerned:

(a) The mean value of the risk perception and the scale order of single hazards is very similar within the two areas.
(b) Milazzo shows a higher fraction of extreme 'most worried' and 'not worried' people.
(c) Risks more strictly linked to the productive structure of the territory (Air pollution, Dangerous firms, Water pollution and, even if placed after Earthquakes, Hazardous wastes), are those that are more perceived by populations of the two areas, furthermore.
(d) Among natural risks, 'Earthquake' is the most worrying, while 'Floodings' and 'Slumps and mudslides' are the least perceived risks in absolute terms by both populations.

As far as natural risks are concerned, the different territorial morphology and a more recent seismic activity which occurred in the Augusta area explains why the higher value of the index detected within this area is relative to the risk of 'Earthquake.'

Instead, contrary to what has been revealed in the analysis of social risks, territorial risk perception profiles are substantially different within the two areas (see Table 8).

Table 7. High concern answers (social risks).

Answers to the question: 'To what extent do you feel personally exposed to the hazard of …' (on a decreasing scale of 4: 3 = 'very much;' 2 = 'much;' 1 = 'not much;'0 = 'not at all/no answer')			% Answers 'very much'	
Risk	Milazzo	Augusta	Milazzo	Augusta
Dangerous firms	0.85	0.80	63.4	43.4
Air pollution	0.83	0.78	59.3	49.4
Water pollution	0.69	0.74	36.9	38.6
Earthquakes	0.65	0.72	35.4	33.1
Hazardous wastes (chemical, nuclear, …)	0.57	0.61	24.5	22.5
Fires and accidents (of any type)	0.57	0.60	23.3	19.0
Hazardous materials transport	0.43	0.45	12.4	7.9
Serious weather phenomena	0.41	0.44	12.6	9.2
Noise	0.40	0.36	10.6	5.0
Floodings	0.31	0.20	7.5	2.3
Slumps and mudslides	0.30	0.17	8.0	2.2
Media	0.379167	0.370139		

In particular, in the Augusta area there is widespread concern, while in Milazzo there is stronger concern among those individuals who state that they feel personally exposed in a sensitive way to each of the suggested risks.

Table 9 shows the incidence within both samples of those answers that indicate high levels of concern: columns 'VM + M' aggregate the percentage of those who answered that they feel personally 'Very Much' or 'Much' exposed to each risk, while columns 'VM,' report only the percentage of those interviewed who claim to feel 'very much' exposed to each risk.

Once again, in Milazzo there is a bigger fraction of population expressing the highest degree of concern (answers 'VM'), especially referring to 'Air Pollution' and 'Dangerous Firms,' that are personally perceived as a direct threat at top level by more or nearly 60% of the population, while considering the aggregate of generally 'worried' people (the sum of 'VM' and 'M' answers), Augusta presents a higher percentage in seven cases

Table 8. Chi-sq. test of independence on territorial risks.

	Risk category	C	χ^{2*}	Perception profile
1	Floodings	45.24569	7.815	Different
2	Noise	14.116866	7.815	Different
3	Hazardous materials transportation	33.591229	7.815	Different
4	Hazardous wastes	32.710452	7.815	Different
5	Air pollution	51.21337	7.815	Different
6	Serious atmospheric phenomena	25.224287	7.815	Different
7	Fires and accidents (of any type)	29.465858	7.815	Different
8	Water pollution	32.440572	7.815	Different
9	Dangerous firms	18.000591	7.815	Different
10	Earthquake	36.675418	7.815	Different
11	Slumps and mudslides	55.517613	7.815	Different

*Tabular χ^2 with 3 df, $\alpha = 0.05$.

Table 9. High concern answers (territorial risks).

	Milazzo		Augusta	
Hazard	VM + M*	VM**	VM + M*	VM**
Floodings	21.8	7.5	12.4	2.3
Noise	34.5	10.6	29.8	5
Hazardous material transportation	38.8	12.4	49	7
Hazardous wastes	60.5	24.5	72.2	22.5
Air pollution	92.8	63.4	91.2	43.4
Serious atmospheric phenomena	34.4	12.6	44.3	9.2
Fires and accidents (of any type)	56.3	23.3	67.3	19
Water pollution	75.6	36.9	87	38.6
Dangerous firms	90.9	59.3	92.7	49.4
Earthquake	68.2	33.1	81.7	35.4
Slumps and mudslides	25.6	8	10.5	2.2

*cumulative% of answers 'very much' + 'much.
**% of answers 'very much.'

It is worth noticing that in both areas, more than 90% of respondents declare that they are 'very' worried about personal exposure to air pollution and dangerous firms. Similarly, the percentage of individuals who express high levels of concern about personal exposure to water pollution is very high both in Augusta (87%) and in Milazzo (75.6%).

In general terms, people feel a higher personal exposure to hazards associated with industrial activities and anthropic pressure (including hazardous wastes and hazardous material transportation) in Augusta than in Milazzo.

Comparing the results of risk perception analysis, we conclude that:

(a) evaluating the incidence and perception of territorial risk within a list of general 'social' risks, the presence of environmental impacting industrial plants leads to similar risk perception profiles between the two populations in relation to those risks derived from the industrialization model;
(b) this similarity disappears when the analysis is focused on risks perceived as characteristics of each own territory;
(c) in the Augusta area, we find an awareness of higher risks, with particular reference to those associated with productive activity and characterized by less evidence and echo from a communication point of view (i.e. hazardous material transportation; hazardous wastes, fires, and accidents of any type);
(d) despite the more widespread concern of Augusta, in the Milazzo territory the 'sensitive' population is more extended, in fact in this area the percentage of the population which claims to feel 'very much' worried is in general sensitively higher.

Factors that influence environmental, health and social risk perception

In the above sections, RPI has been estimated to elucidate an average population's degree of concern, weighting the frequencies of answers according to the degree of concern.

However, as already stated in section 'The territories and the survey design,' the RPI can be implemented to evaluate *individual* risk perception by calculating a weighted average of perception for 15 risks proposed to interviewed people. In doing so, it is possible to estimate (within the two samples) a general individual RPI (ρ); further, focusing on the risks: 'Environmental Deterioration,' 'Serious Ill-

Table 10. 'General' and 'Environmental and Health' risk perception – statistics.

		General risk perception (ρ)	Environment and health risk perception ($\rho_{\varepsilon\eta}$)
N	Valid	1221	1221
	Missing	1	1
Mean		.6876	.7945
Median		.6889	.7778
Mode		.67	1.00
Minimum		.33	.33
Maximum		1.00	1.00
Percentiles	25	.5778	.6667
	50	.6889	.7778
	75	.8000	.8889

nesses,' and 'Industrial Catastrophes,' an 'environmental and health' RPI ($\rho_{\varepsilon\eta}$), has also been estimated.

As shown in Table 10, the $\rho_{\varepsilon\eta}$ index shows higher statistical values as compared to the ρ index: mean value = 0.79 vs. 0.69; median = 0.78 vs. 0.69; mode = 1.00 vs. 0.67; percentile values (0.67 vs. 0.58; 0.78 vs. 0.69; 0.89 vs. 0). In particular, the mode highlights that, at an individual level, people living in the two 'risk areas' have a much higher sensitivity to environmental and health hazards than to other social risks.

Taking into consideration that most perceived risks in the two examined areas are:

(a) environmental and health risks associated with the presence of industrial poles and
(b) unemployment, we focused on factors which most affect perception of the above risks by searching, among the individual characteristics of respondents, those which had greater capacity to discriminate people's concern.

During the preliminary phases of the research, a set of four focus groups had been held in Milazzo (Gatto et al. 2009; Saitta and Gatto 2009). Groups were homogeneous for gender and age and balanced with respect to working conditions. In particular, groups were composed of:

(1) young men (employed and unemployed);
(2) adult and old men (employed and retired);
(3) young women (employed and housewives with and without children);
(4) adult and old women (employed and housewives with and without children).

In order to avoid that university graduates could assume a leadership position or inhibit other people's communication, the highest education grade admitted was the secondary school.

The number of people involved in the focus groups was 24.

From an analysis of focus groups, we obtained the indication that gender, age, and parenthood conditions may differentiate individual risk perception, with a higher perception among women than men, among mothers compared to women without children, and among adults and elderly people compared to young people. Absence of a distinction for education level in group composition, did not allow the inference of any preliminary evaluation about this variable.

Consequently, the questionnaire was compiled and the results analyzed with the aim of evaluating the effects of the above variables on risk perception.

Given that, as already established in the previous section, 'Environmental Degradation,' 'Serious Illnesses,' 'Industrial Catastrophes,' and 'Unemployment' (i.e. the four hazards that appear to be more directly connected with the industrialization model of the territories) show statistically identical 'perception profiles,' observations in Augusta and Milazzo were pooled in order to analyse the influence of socio-economic variables on risk perception on the total sample of 1222 respondents.

Table 11 shows the results of χ^2 test, applied to verify if gender, education, working conditions, household dimension, age, class, parenthood conditions, and maternity have an effect on the perception of highly perceived risks and on risks

Table 11. Risk perception and socio-economic characteristics of respondents.

	Gender	Education	Working condition	Household's number of components	Age	Parentality	Maternity
Environmental degradation	$\chi^2 = 3.756$ df = 2 Sig. = 0.153	$\chi^2 = 8.226$ df = 6 Sig. = 0.222	$\chi^2 = 16.969$ df = 12 Sig. = 0.151	$\chi^2 = 9.998$ df = 10 Sig. = 0.441	$\chi^2 = 18.564^{**}$ df = 4 Sig. = 0.001	$\chi^2 = 6.578$ df = 4 Sig. = 0.160	$\chi^2 = 5.503^{*}$ df = 2 Sig. = 0.064
Serious Illness	$\chi^2 = 22.891^{**}$ df = 2 Sig. = 0.000	$\chi^2 = 21.436^{**}$ df = 6 Sig. = 0.002	$\chi^2 = 30.084^{**}$ df = 12 Sig. = 0.003	$\chi^2 = 10.735$ df = 4 Sig. = 0.379	$\chi^2 = 1.879$ df = 4 Sig. = 0.758	$\chi^2 = 11.127^{**}$ df = 4 Sig. = 0.025	$\chi^2 = 8.831^{**}$ df = 2 Sig. = 0.016
Unemployment	$\chi^2 = 8.993^{**}$ df = 2 Sig. = 0.011	$\chi^2 = 31.534^{**}$ df = 6 Sig. = 0.000	$\chi^2 = 46.856^{**}$ df = 12 Sig. = 0.000	$\chi^2 = 11.719$ df = 6 Sig. = 0.304	$\chi^2 = 3.504$ df = 4 Sig. = 0.477	$\chi^2 = 10.756^{**}$ df = 4 Sig. = 0.029	$\chi^2 = 10.681^{**}$ df = 2 Sig. = 0.005
Industrial Catastr.	$\chi^2 = 14.634^{**}$ df = 2 Sig. = 0.001	$\chi^2 = 20.080^{**}$ df = 6 Sig. = 0.003	$\chi^2 = 14.676$ df = 12 Sig. = 0.260	$\chi^2 = 4.350$ df = 6 Sig. = 0.930	$\chi^2 = 8.108^{*}$ df = 4 Sig. = 0.088	$\chi^2 = 10.288^{**}$ df = 4 Sig. = 0.036	$\chi^2 = 7.698^{**}$ df = 2 Sig. = 0.021

related to the presence of plants or to labor dimension (Environmental Deterioration, Unemployment, Industrial Disasters). Cells report χ^2 estimated value, degrees of freedom and the asymptotic significance level of the test. The presence of one or two asterisks on the estimated χ^2 value, implies that the null hypothesis of equality of risk perception among the groups that categorize the variable is rejected at 90 and 95% confidence level, respectively, and therefore the observed character affects risk perception. Hence, a double asterisk on the χ^2 value relative to the variable 'Gender' along the 'Serious Illnesses' row shows that this variable is relevant as far as health risk perception is concerned, as there is a statistically significant difference in risk perception between the male and female population at a 95% confidence interval.

In order to avoid, in the contingency table, the presence of cells with less then five frequencies (that would invalidate the test), some categories of the variables have been merged. In particular, for what concerns risk perception degree, answers have been divided into: 'very much concerned,' 'much concerned,' 'moderately or not concerned,' so distinguishing high levels of worry from low or no worry. Similarly, for the 'working conditions' variable, observations on 'unemployed' and 'in search of first job' have been pooled, as well as 'ineligible,' 'not active,' 'other working conditions;'[4] the 'number of household members' variable presents the following categories: households with 1–2 members, 3, 4, 5, '6 or more members;' the 'education Level' variable groups into a single question individuals without any education and people with primary school education[5]; the 'age' variable is made up of three groups: young (18–30 years old), adults (31–60 years old), elderly people (over 60 years old); the variable 'parenthood' distinguished between individuals without children, men without children and women without children; the 'maternity' variable discriminates women with children from the rest of the interviewees.

Columns of Table 11 show that maternity, gender, parenthood and education significantly affect risk perception; less evident is the influence of working conditions and age (affecting respectively risk perception of 'serious illnesses' and 'unemployment' the former, and risk perception of 'Environmental Degradation' and 'Industrial Catastrophes' the latter).

Additionally, number of household members does not affect perception of any risk.

Analyzing Table 11 by rows, we conclude that:

(1) Differences in: gender, education, working conditions, and household dimension do not produce significant diversities in the perception of 'Environmental Degradation' risk, while age and maternity do; in particular, adults are more worried than young and old people, and mothers, even to a lesser degree, than fathers and people without children.
(2) Serious Illnesses risk is strongly perceived by women compared to men, by parents (both mothers and fathers) compared to people without children, by housewives, unemployed, and employed people, compared to retired people.
(3) Unemployment risk is perceived highly by women compared to men, by individuals with no or lower education compared to individuals with a university degree, by mothers compared to fathers, and individuals without children, by unemployed people, students, housewives, and flexible workers compared to employed people (full-time or part-time).

(4) Surprisingly, comparing 'fathers' and 'mothers' with 'people without children' the group of 'fathers' seems to be the least worried about unemployment; this is probably due to the fact that maternity, (eventually linked to the status of housewife) makes mothers more worried about their children's future; fathers (who have a higher permanent employment rate than other groups) feel less exposed to the risk of unemployment; while, among individuals without children (where a higher fraction of young people, students, unemployed, and temporarily employed people is found) unemployment risk perception is higher than fathers.
(5) Finally, Industrial disaster risk is more perceived by women than men, by parents (fathers and mothers) than people without children, by people with no or little education and, even, despite weaker evidence, by adults than young people; working conditions instead, does not change industrial disaster risk while household dimension does not affect the perception of any of the four analyzed risks.

Reading Table 11 by columns, and deeper differences, we find that socioeconomic variables that more significantly affect individual risk perception are: maternity, parenthood, gender, and education; in particular, the most worried groups are:

- women (and, particularly, mothers);
- people with a lower educational level;
- unemployed and housewives.

Furthermore:

- students seem to be worried about unemployment;
- adults express a higher risk perception compared to other groups (young and elderly people) for Serious Illness and Industrial Disasters;
- household dimension does not affect individual risk perception.

Poverty and risk perception

The questionnaire also allows households to be surveyed for poverty conditions by cross tabulating information on household dimension and on family income. Based on average consumption, official 'relative poverty lines' are obtained by means of 'equivalence coefficients,' which are used to define poverty thresholds according to the number of household components (ISTAT 2007). In the questionnaire, household income has been surveyed according to the scheme shown in Table 12.

Table 12. Income ranges.

(1) 0–600 Euro	□	(8) 2.400–3.000	□
(2) 600–1.000	□	(9) 3.000–4.000	□
(3) 1.000–1.300	□	(10) 4.000–5.000	□
(4) 1.300–1.600	□	(11) 5.000–6.000	□
(5) 1.600–1.900	□	(12) 6.000–7.500	□
(6) 1.900–2.100	□	(13) 7.500–9.000	□
(7) 2.100–2.400	□	(14) more than 9.000	□

Where, for each income class up to the seventh, the upper bound of the income rage approximately reproduces poverty 'thresholds' corresponding to a different number of household members. In other words, 600€ approximately corresponds to the official poverty line of a one member household; 1000€ is approximately the poverty threshold for a family of two members, and so on. It is easy to notice that, for each income class, the ranking position corresponds to the number of household members associated to each poverty line: option 1 marks the poverty threshold of a one person household, option 2 provides the poverty line of a two member family, and so on. As a result, considering also that generally income is higher than consumption, a household can be assumed to be poor when the number of its components is higher than the ranking number of its income. Defining n = number of household members and i = the family's income category (i.e. the ranking number), the difference $\delta = (i - n)$ indicates poverty status: household are classified as 'poor' when $\delta \leqslant 0$ and 'not poor' when $\delta > 0$.

In total, nearly 35% of the sample families lie in a condition of poverty. This result is higher than the average value of 'poor' families in Sicily (ISTAT 2007), that is comprised between 26.2 and 31.6% of total resident families (ISTAT 2007), suggesting a possible under-representation of family life conditions. Although it is not possible to exclude this phenomenon, we must consider that more than a quarter of the interviewees (26.4%) refused to answer this question and missing answers come prevalently from families that are likely to be in a condition of 'no poverty.' In fact, families of interviewees that refused to answer the question about income show, on average: (a) a greater number of earned incomes, (b) a lower number of members, and (c) a higher level of satisfaction as far as family economic standard is concerned. As a consequence, missing answers bias estimated results by producing a higher incidence of poverty compared to reality.

In order to evaluate the relationship between poverty and the perception of environmental and health risks, individual values of the above mentioned $\rho_{\varepsilon\eta}$ index have been divided into quartiles, thus creating four classes of identical dimension; risk perception classes (with increasing value from 1 to 4) have been cross tabulated with household wealth/poverty classes. Results suggest that poor or border-line families show a significantly higher sensitivity to environmental and health risk compared to families that overcome the poverty line.

Within the group of individuals who show smaller levels of concern, 27.3% of families are comprised into the income class from 0 to -2 (families lying below the poverty line) and 36.5% are in the income class > 0 (no poverty); on the contrary, within the group that expresses maximum levels of concern, 29.3% of families pertains to a low-income class and 19% of families belongs to a positive income class.[6]

Health status and its effect on risk perception

According to the survey results, people rate very highly the probability of contracting specific illnesses allegedly due to the fact of residing in a contaminated area. In particular, after showing a list of nine health problems, the questionnaire states the following question:

> In your opinion, how likely is it, for those who live near a contaminated area, to contract the following pathologies: (1) allergies; (2) temporary damage to the respiratory

tract; (3) permanent damage to the respiratory tract; (4) temporary damage to organs; (5) permanent damage to organs; (6) liver damage; (7) cancer; (8) leukemia; and (9) genetic malformation to children born to parents exposed to site pollution?

The respondent had to rate his/her answer based on the following entries: (1) sure; (2) very likely; (3) little likely; and (4) not likely at all.

Answers to the above question show a strong sensitivity, as confirmed by the fact that the percentage of individuals who claim to be 'sure' (i.e. 100% probability) of contracting any of the indicated pathologies for living in a contaminated site, goes from a minimum value of 24.8% (liver damage) to a maximum value of 54% (cancer); incidence of 'sure' people for other illnesses are: genetic malformation to children born to parents exposed to site pollution, 47.6%; leukemia, 42%; allergies 40%; temporary and permanent damage to the respiratory tract, 36.3 and 31%, respectively; temporary and permanent damage to organs, 27.4 and 25.1%, respectively. Nearly a quarter of respondents (24.2%) remembers having taken medicines during the last 3 years for respiratory system illnesses, and in particular, 198 cases of bronchitis (16.2%), 82 cases of asthma (6.7%) and 12 cases of pneumonia (1%) were detected. Moreover, 220 respondents (18.1%) claimed to be currently taking drugs for cardiovascular problems. Finally, the questionnaire asks the respondents to declare if, in their family, there had been in the last 5 years cases of illness perceived to be related to the state of the environment. More than a third of respondents (37.7%) rated this question positively, while 4.8% refused to answer and 57.5% answered negatively. Some of the specified pathologies – few cases compared to the total – (Alzheimer's Disease, stones, colitis, strokes, intestinal problems, heart, and liver problems, prostatism, blood pressure, deafness) could actually appear to be less associated with the state of the environment and more related to congenital factors, lifestyle or eventually to particular working conditions; however allergies and cancers/leukemia stand out (respectively 175 cases for 14.3% of respondents and 129 cases for 10.6% of the sample).

This result shows that, within contexts in which there is a widespread experience of pathologies connected to the environment, people tend to attribute health damage to pollution even if illnesses are not directly related to environmental conditions.

Discussion of results

Comparative studies of risk perception generally compare populations living close to of far away from hazard sources. Taking a different perspective this paper describes risk perception within the populations of Milazzo and Augusta 'risk areas.'

The studied populations show different behavior for what concerns the different risk typologies that were presented to the respondents' attention, apart from those hazards that appear to be more directly connected to the presence of industrial poles (Environmental Degradation, Serious Illnesses, Industrial Catastrophes). Within the Milazzo area, we detected on average a smaller level of alarm, but concerned people are 'marginally' more worried, thus suggesting the need to increase and disseminate information and knowledge.

In both populations, some socioeconomic factors significantly affect risk perception. Women (mothers in particular) are more concerned than men; in the same

way – relative to occupational condition – unemployed people, housewives, temporary workers, or people excluded from the labor market (not active or ineligible) show in general a greater concern than employed people, retired, part-time workers, also in relation to environmental and health risks. Education is a significant determining factor of risk perception; in fact, higher education levels are associated with smaller risk perception. Family economic conditions also negatively affect risk perception: family members with higher incomes show risk perception levels inferior to less well-off members.

Furthermore, due to the spread of diseases connected to environmental conditions (cancers, in particular), populations tend to attribute a great number of observed pathologies to industrial pollution and the presence within the family of environment-linked pathologies strongly affects risk perception.

These results are important for risk communication and for the involvement of local populations in risk management plans. Furthermore, they show that, despite a different characterization of the two population's risk perception profiles, proximity to industrial hazardous plants assimilates the social representation and the perception of environmental and health risk.

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Notes

1. 'Exposition' and 'proximity' are not synonymous, as the (increasing) phenomenon of commuting does not allow the notions of 'exposed population' and 'resident population' to be superimposed (Moffatt et al. 1995; Signorino et al. 2011).
2. Questionnaire's sections were: (1) individual characteristics; (2) daily mobility habits and home/word location; (3) risk perception; (4) home characteristics; (5) family socioeconomic status; and (6) living standard. A final section was to be filled by the interviewer in order to provide personal evaluations on judgments, interviewee's reliability, home characteristics, and an open space for general comments.
3. Estimated χ^2 is calculated as follows: $\chi^2 = \sum[(f_o - f_t)/f_t]$, where f_o = observed frequencies and f_t = theoretical frequencies. The null hypothesis that relative frequencies are identical between the compared populations is rejected if $\chi^2 > \chi^2$ at the given probability level.
4. The following working conditions are envisaged: 'Full-time employee,' 'Part-time employee,' 'In search of first job or unemployed,' 'Retired,' 'Student,' 'Housewife,' 'Other, not active, ineligible to work.'
5. Categories are: no education or primary school education, secondary school education, high school education, university degree.
6. This difference in risk perception structure is highly significant (p-value = 0.001, $\chi^2 = 15.622$ with 3 df).

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