

## Special Issue: Vesuvius monitoring and knowledge

**Vesuvio civil protection exercise MESIMEX: survey on volcanic risk perception**Tullio Ricci<sup>1,\*</sup>, Rosa Nave<sup>2</sup>, Franco Barberi<sup>3</sup><sup>1</sup> *Istituto Nazionale di Geofisica e Vulcanologia, Sezione Roma 1, Rome, Italy*<sup>2</sup> *Istituto Nazionale di Geofisica e Vulcanologia, Sezione di Napoli, Osservatorio Vesuviano, Naples, Italy*<sup>3</sup> *Università di Roma Tre, Dipartimento di Scienze Geologiche, Rome, Italy***Article history**

Received August 7, 2012; accepted November 28, 2012.

**Subject classification:***Risk perception, Volcanic hazards, Civil protection exercise, Risk mitigation strategies.***ABSTRACT**

In October 2006 the European Civil Protection Exercise MESIMEX (Somma Vesuvio Mesimex – Major Emergency SIMulation Exercise) on volcanic risk took place at Vesuvio, promoted by Campania Region and coordinated by the Italian Civil Protection Department. The exercise was focused on the preparedness phase for a major volcanic emergency in the area of Vesuvio. An evacuation of a sample of 1800 inhabitants from the Vesuvio Red Zone was also tested during the drill because the emergency plan ensures the complete evacuation of the population from the higher risk zone before the onset of the eruption. During that event a survey on volcanic risk perception was carried out on the evacuated population in order to compare the results with the ones coming from a previous similar survey, using the same questionnaire, carried out on a wider sample of residents in the Vesuvio Red Zone few months before MESIMEX exercise. The aim was to point out any differences in population's attitude towards volcanic risk after having received detailed information on the emergency plan and on the hazards and risk related to the reactivation of Vesuvio, and experiencing the exercise. 463 questionnaires were distributed to the population evacuated from the 18 municipalities of the Red Zone and participating to the exercise. Main results in comparing data from MESIMEX survey with the Vesuvio previous one, put in evidence how the general level of Vesuvio residents' trust remains quite low, indicating that a continuous and effective effort has to be done by both scientific community and Civil Protection Department. Particular attention should be paid in education and outreach activities and in involving people in risk mitigation procedures, also through more frequent exercises.

**1. Introduction**

Vesuvio volcano is located in Campania Region (southern Italy) and it is characterized by a very high population density. Hundreds thousand people here are exposed to pyroclastic density currents, ash fallout and lahar hazards. The Emergency Plan for Vesuvio, published in 1995 by the Italian Civil Protection Department [DPC 1995], defined three zones related to

different volcanic hazards in case of a sub-plinian event taken as the scenario for the maximum expected event in case of renewed activity in the short–midterm [Rosi et al. 1993, Dobran et al. 1993, Dobran et al. 1994, Barberi et al. 1995].

The Red Zone, the area exposed to pyroclastic flows and lahars, includes all the 18 municipalities around the volcano, where presently ca. 550,000 people live. The area outside the Red Zone, exposed to pyroclastic fallout, was called Yellow Zone and the population at risk varies from approximately 150,000 to 200,000, depending on the sustained column height and the wind conditions at the moment of the eruption. The Blue Zone, included in the Yellow one, is mainly exposed to lahar and flood hazards. The Vesuvio emergency plan provides that the 550,000 residents of the Red Zone will have to be evacuated before the onset of the eruption.

The present study was carried out during the MESIMEX exercise following a more complete research by Barberi et al. [2008] on volcanic risk perception in the Vesuvio population. Volcanic risk perception studies have been carried out in the last decades in order to assess population at risk real knowledge and their risk perception, and the role of communication in people's preparedness in facing with an emergency [Kartez 1982, Perry 1990, Johnston et al. 1999, Dominey-Howes and Minos-Minopoulos 2004, Gregg et al. 2004, Davis et al. 2005, Carlino et al. 2008, Gaillard 2008, Haynes et al. 2008, Paton et al. 2008, Perry and Lindell 2008, Solana et al. 2008, Bird 2009, Njome et al. 2010].

Our research assesses the volcanic risk perception of MESIMEX Vesuvio Red Zone participants, mainly through the evaluation of their level of knowledge of volcanic hazard and risk, education and preparedness, and level of information received.

463 questionnaires were distributed on October 22, 2006, at the four checkpoints settled for the exercise, one for each family participating. The totality of the distributed questionnaires was recollected, even though only 427 were suitable to be analyzed. For an inexplicable pitfall in the distribution system no questionnaires were handed out to Boscoreale residents.

Results of the MESIMEX survey are compared with the ones for Vesuvio Red Zone presented in Barberi et al. [2008].

## 2. The survey

### 2.1. Survey instrument

The questionnaire used was the same developed for the study on volcanic hazards perception at Vesuvio [Barberi et al. 2008]. It consists in a 46 items questionnaire designed to investigate issues such as salience of the hazard (the tendency to spontaneously mention volcanic hazards as a problem relative to other concerns, and the amount of time spent thinking about the threat); risk perception (ratings of both the likelihood and severity of future eruptions as well as one's level of anxiety about a potential eruption and feelings of personal vulnerability to the effects of a potential eruption); feelings of self-efficacy (feelings of control regarding one's ability to protect him/herself and his/her family from the effects of an eruption); knowledge of the hazard and of hazard mitigation strategies (factual information concerning past eruption events and measures taken to protect the public from future eruptions); perceived preparedness of and trust in officials (confidence in the government's level of preparedness and in the ability of government officials, scientists and the media to provide accurate information about potential eruptions); sources of received information about volcanic hazards and the emergency plan and preferred methods of receiving such information; sense of community (the degree to which residents feel bonded to their commu-

nity was measured using the 18 item Italian Scale of Sense of Community by Prezza et al., [1999]); demographic questions (sex, age, highest level of education achieved, marital status, etc.).

The questionnaire includes some open-ended questions, in order to get qualitative data, useful to a better elaboration and interpretation of the quantitative responses. Data entry was facilitated using the ICR (Intelligent Characters Recognition) and the OMR (Optical Marks Recognition) methodologies.

### 2.2. Distribution procedures

The distribution of questionnaires took place at the arrival of the evacuated population at the registration desk of each checkpoint. The questionnaires were handed out to no more than one selected member for each family or group of people, in order to achieve the most homogeneous sample in terms of age, genre and cultural background. All the procedures were managed by personnel belonging to the Civil Protection Department expressly trained for the distribution of the questionnaires.

The distribution and filling processes were completed after the educational activities addressed to the evacuated population.

## 3. Results

### 3.1. Sample characteristics

Respondents of the 427 analyzed questionnaires are 56.1% men and 43.9 % women. The age of the respondents ranged from 11 to 86 yr, with a mean of 49.7 yr and a standard deviation of 18.1 yr. 18% were single, 59.5% were married, 15.7% were divorced or widowed and 6.8% failed to report their marital status. With regard to the highest level of education completed, 28.7% had an elementary school education, while 31.7% were junior high school graduates, 32.9% were high school graduates, and 6.7% had a university degree.

### 3.2. Hazard salience

Hazard salience concerns the extent to which the volcanic threat is prominent on the minds of residents. To measure the salience of the hazard, one of the first questions of the survey was an open-ended item asking respondents to list the three greatest problems facing their community. All the different kinds of problems listed by respondents were then grouped in 17 categories. As shown in Table 1, problems such as lack of public services, crime, unemployment, trash, and traffic were the issues most frequently mentioned by respondents from each community. Vesuvio was mentioned as a problem by 8.4% of respondents (Table 1). No sig-

MESIMEX	%	Barberi et al. [2008]	%
1) Public services	53	1) Public services	55
2) Trash/Pollution	35	2) Trash/Pollution	46
3) Crime	22	3) Crime	43
4) Unemployment	20	4) Traffic	26
5) Traffic	15	5) Unemployment	13
7) Vesuvio	8.4	7) Vesuvio	9

**Table 1.** Rankings of the most frequently mentioned community problems. Numbers in the table indicate the percentage of residents who mentioned each problem. The rank and percentages of those who mentioned Vesuvio as a problem are included for comparison.

nificant difference was found in comparison with the previous study.

A second survey item that measured the salience of the hazard asked residents to indicate how often they think about the possibility of an eruption using a 5 point Likert scale, with 1 indicating “almost never” and 5 indicative of “almost always”. The mean rating for this item was 2.47 (SD = 1.09), indicating relatively low levels of salience regarding the volcanic threat as in the previous survey (M = 2.26, SD = 0.97).

### 3.3. Perception of risk

Risk perception is a general term that encompasses a number of different aspects of how people may view their risk from a particular hazard. These include the perceived likelihood of a disaster event, perceptions of how serious such an event might be and how personally one might be affected, and how worried one is about a potential threat. A number of items in the survey were designed to measure these different aspects of perceived risk. First, respondents were asked to judge the likelihood that a future eruption would affect their community, as well as how serious the consequences of such an eruption might be for their town in general, and for themselves and their families personally. They were also asked to rate how much they worry about a potential eruption. All ratings were made on 5 point Likert scales, with higher numbers indicating greater perceived likelihood and severity of consequences concerning an eruption, and greater worry about such a possibility.

On three out of four measures the ratings comparison between MESIMEX and the previous survey indicate similar high feelings of respondents concern. Nevertheless, there is a significant difference in worry about an eruption, lower in the people involved in MESIMEX exercise (Table 2).

### 3.4. Feelings of self-efficacy

One of the survey questions asked to rate personal control and ability to protect from the effects of a potential eruption. This item was designed as a domain-specific measure of self-efficacy [Bandura 1977]. Self-efficacy has been recognized as an important variable related to the likelihood that an at-risk population will take self-protective measures [Paton 2003]. Responses to this question were made on a 5 point scale, with higher numbers representing a stronger sense of self-efficacy regarding someone’s ability to protect themselves from the effects of an eruption. Overall, residents participating to MESIMEX exercise demonstrated a higher level of self-efficacy respect to the one expressed in Vesuvio previous survey (Table 3). This increased level of self-efficacy is probably due to the par-

ticipants’ opportunity to play an active role in risk mitigation measures.

### 3.5. Knowledge of the hazard

Among the items about the knowledge of the hazard asked to respondents the most significant finding is related to the knowledge about the volcanic activity (presence of active volcanoes and their last eruption, most threatening volcano, and judgments on the severity of six volcanic phenomena). In particular, one open-ended item asked respondents to name an active volcano in their area and to indicate the year of its last eruption. In response to this question, 89% correctly named Vesuvio and 64.4% correctly identified 1944 as the year of the last eruption. While results coming from the two surveys are similar in identifying the active volcano in the respondents’ area (93.5% in Barberi et al. [2008]), the knowledge of the last eruption date is quite lower in the previous study (45% in Barberi et al. [2008]).

How likely do you think it is that there will be an eruption affecting your town?	MEAN	SD
MESIMEX	3.43	1.06
Barberi et al. [2008]	3.64	0.99
If there is an eruption, how serious do you think the effects would be for your community?	MEAN	SD
MESIMEX	4.16	1.00
Barberi et al. [2008]	4.33	0.84
If there is an eruption, how serious do you think the effects would be for you and your family?	MEAN	SD
MESIMEX	3.96	0.94
Barberi et al. [2008]	3.96	0.93
How worried are you about the possibility of an eruption?	MEAN	SD
MESIMEX	3.42	1.30
Barberi et al. [2008]	3.80	1.15

**Table 2.** Likelihood, severity and concern about future eruptions. Ratings were made on a 5 point scale, with higher numbers indicating higher levels of likelihood, severity and worry.

How much control do you feel you have to protect yourself and your family in case of an eruption?	MEAN	SD
MESIMEX	3.40	1.20
Barberi et al. [2008]	2.95	1.19

**Table 3.** Self-efficacy regarding future eruptions. Ratings were made on a 5 point scale, with higher numbers indicating higher levels of self-efficacy.

3.6. Knowledge of the Emergency Plan and confidence in emergency measures

Four survey items asked respondents to indicate whether they were aware of the emergency plan for their city in the event of an eruption and evacuation order, as well as how much confidence they had in the plan and how useful they judge emergency simulations in people’s preparedness in case of a volcanic event.

56.3% of MESIMEX respondents stated they were familiar with the emergency plan for their city in case

	MESIMEX %	Barberi et al. [2008] %
None	2.1	10.1
Very little	12.9	26.7
Moderate	18.6	18.4
Enough	39.9	29.3
Completely	26.5	15.5

**Table 4.** Usefulness of civil protection exercises involving residents.

How prepared are the authorities in your town to deal with a potential eruption?	MEAN	SD
MESIMEX	2.87	1.14
Barberi et al. [2008]	2.19	1.03
How prepared is Civil Protection Department to deal with a potential eruption?	MEAN	SD
MESIMEX	3.50	1.08
Barberi et al. [2008]	2.58	1.06
How much confidence do you have in scientists’ ability to provide accurate information about future eruptions?	MEAN	SD
MESIMEX	3.54	0.94
Barberi et al. [2008]	3.34	0.96
How much confidence do you have in local and regional authorities’ ability to provide accurate information about future eruptions?	MEAN	SD
MESIMEX	3.11	0.97
Barberi et al. [2008]	2.65	0.94
How much confidence do you have in the media’s ability to provide accurate information about future eruptions?	MEAN	SD
MESIMEX	3.18	1.00
Barberi et al. [2008]	2.87	0.97

**Table 5.** Confidence in public officials and media. Ratings were made on a 5 point scale, with higher numbers indicating higher levels of perceived preparedness and confidence.

of a future eruption of Vesuvio. 23.6% were not aware of the emergency plan while 20.1% failed to respond. In comparison the respondent ratings of the previous study were 41%, 55%, and 4%, respectively.

Respondents who stated that they were familiar with the plan were then asked two additional questions about the evacuation procedures and the location where Vesuvio Red Zone residents will be evacuated. Among those respondents who indicated that they were familiar with the plan, 84.3% correctly stated that the evacuation would be organized rather than spontaneous and 89.2% correctly identified the Italian Region to which they would be evacuated. For comparison, respondents’ ratings in Barberi et al. [2008] were 83 and 53% respectively.

Two follow-up questions asked respondents to rate on a 5 point scale both their degree of confidence in whether a successful evacuation could be completed and the usefulness of emergency simulation exercises by Civil Protection Department that involve the general public. 40.1% of respondents stated that they had “little” or “no” confidence in the plan while 30.6% had “a lot” or “complete” confidence in its success. For comparison respondents’ ratings in Barberi et al. [2008] are 67.5% and only 10.9% respectively.

The positive respondents’ attitude showing higher levels of confidence in the plan success can be related to people’s involvement in risk mitigation actions, as also testified by the high levels of usefulness of civil protection exercises stated in a specific questionnaire item (Table 4).

3.7. Confidence in officials

A number of survey items asked residents to evaluate the preparedness of local government authorities and Civil Protection Department to deal with a potential eruption, and also asked respondents to rate their confidence in scientists, government, and the media’s ability to provide accurate information about future eruptions. These data are presented in Table 5.

Regarding perceptions of how prepared local and Civil Protection authorities are to deal with a volcanic crisis, MESIMEX respondents scores are higher than the corresponding ones in Barberi et al. [2008], especially for Civil Protection preparedness. However the mean ratings for local authorities remained below 3 (M = 2.87) on a 5 point scale.

In evaluating the accuracy of information respectively provided by scientific community, local authorities, and media, MESIMEX respondents confirm scientists as the more reliable source of information, giving anyway higher scores also to local authorities and media in comparison to previous survey.

3.8. Information about volcanic hazards

Some survey items concerned the amount of information that residents feel they have regarding the volcanic hazards they face, and the most common sources of these information. As the data in Table 6 show, 36.3% of respondents feel that the information they have is either “very little” or “insufficient”, while 19.5% say it is “enough” or “too much”. Overall, even if a significant better response was given by MESIMEX respondents in comparison with the previous study, the amount of information received is still poor.

When asked from which sources they had received the majority of their information on volcanic hazards, the two most common sources cited were Civil Protection Department (45.2%) and television (38.9%). These results are quite different from the ones presented in Barberi et al. [2008] (Table 7).

When asked from which organization they would most like to receive information about volcanic hazards, respondents indicated Osservatorio Vesuviano (National Institute of Geophysics and Volcanology, Naples section), Civil Protection Department, and local government.

Respondents were also asked to indicate their favourite channel to get information on volcanic risk. As in the previous study, public meetings scored the highest ratings followed by radio/television and pamphlets (Table 8).

3.9. Sense of community

Results of Sense of community were derived by averaging responses made on each of the 18 items of the Italian scale of Sense of community [Prezza et al. 1999]. Scores range from a low of 1 to a high of 4, with higher numbers indicating a stronger bond to one’s community. The mean for the entire sample was 2.86, with a standard deviation of 0.48 and did not differ substantially from the previous study (2.61 and 0.37 respectively).

4. Conclusions

On the basis of the results coming from the study conducted during MESIMEX exercise on the Red Zone residents the most remarkable aspects are:

- the high feelings of respondents’ concern about a future eruption must be taken into account in education/information strategies in order to get an appropriate population response in case of a volcanic emergency;
- the great acknowledgement of civil protection exercises involving residents;
- the improvement of people’s emergency plan knowledge;
- the increasing of people’s self-efficacy in facing a future volcanic emergency;
- the tripling of the emergency plan success confi-

dence in comparison with the results of the previous study;

- the significant increasing of people’s confidence in civil protection rather than the one expressed for local government and media;
- the improvement of the amount of information received about volcanic hazards, even though most part of respondents defined it still not adequate;
- Osservatorio Vesuviano, Civil Protection Department, and local government are confirmed to be

	MESIMEX %	Barberi et al. [2008] %
Insufficient	8.8	23.9
Very little	27.5	36.7
Moderate	44.1	28.9
Enough	15.8	8.8
Too much	3.7	1.7

Table 6. Amount of information received regarding the effects of a possible eruption.

MESIMEX	%	Barberi et al. [2008]	%
1) Civil Protection Dep.	45.2	1) Television	55.2
2) Television	38.9	2) Newspapers	31.0
3) Local government	20.4	3) Civil Protection Dep.	16.4
4) Newspapers	14.8	4) Acquaintances	15.9
5) Osservatorio Vesuviano	13.1	5) Osservatorio Vesuviano	14.3
6) Radio	6.79	6) Local government	12.1
7) Public meetings	6.09	7) Schools	11.9
8) Schools	4.45	8) Public meetings	6.4
9) Acquaintances	3.98	9) Radio	4.7
10) Provincial government	2.81	10) Provincial government	2.9

Table 7. Most common sources of information regarding volcanic hazards. Numbers indicate the percentage of responses mentioning each source of information. Respondents were able to check more than one source; therefore percentages do not total to 100%.

MESIMEX	%	Barberi et al. [2008]	%
1) Public meetings	44.0	1) Public meetings	44.0
2) Radio/Television	26.7	2) Pamphlets	35.4
3) Pamphlets	23.9	3) Radio/Television	29.3
4) Audio-visually	20.1	4) Audio-visually	24.1
5) Newspapers	8.7	5) Newspapers	14.9

Table 8. How respondents would like to receive information about volcanic hazards. Numbers indicate the percentage of responses mentioning each source of information. Respondents were able to check more than one source; therefore percentages do not total to 100%.

the respondents' favourite source of information;

– the confirmation of public meetings as people most appreciated way in receiving information about volcanic hazards.

The above listed aspects put in evidence the importance of civil protection exercises and the increasing of people involvement request, also in designing risk mitigation strategies. This fundamental outcome must be put in practice through a systematic education and information policies, and making civil protection exercises ordinary events instead of sporadic ones as they are nowadays.

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