

## **Responding to an emergency: the bradyseismic phenomenon and “*Quelli della zona Rossa*”**

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This paper addresses the field of risk communication and the necessity for it to increasingly adopt a person-centered approach. Indeed, the hierarchy of expert - social media - user communication has thinned considerably in recent times. Individuals, through social media, project online what occurs in the offline environment, thus contributing to the spreading of emotions via the sharing dynamics. The objective of this exploratory study is to examine a particular emergency context, the bradyseismic emergency in the Phlegrean area of Naples. The aim is to analyze the perceptions of risk from the point of view of the people themselves and to investigate how these are transferred to the online environment. After the concepts of subjective and objective perceived risk have been operationalised, a mixed approach was used, combining longitudinal, cross-sectional and text analysis. The results will provide insight into the emergency communication in the Phlegrean context between August and October 2023, and potential strategies for improvement in interventions that follow a bottom-up approach.

## 21.1 Introduction

The initial conceptualisation of '*risk communication*' – defined as the interactive exchange of information and opinions concerning hazards and risks, risk-related factors and risk perception (Ministry of Health 2022) – emerged during the 1970s. Its objective was to address the distorted perception of danger, frequently attributed to a lack of information. This scheme operated through a unidirectional flow, in which information was disseminated hierarchically: from experts to the media and finally to the public (Pagano 2001). However, in the year 2000, the British House of Lords, acknowledging that the distortion in risk perception is not solely attributable to a lack of scientific literacy, embarked on a new initiative to bridge the gap between science and society through active participation. Consequently, experts have come to recognise the importance of actively involving the public, thereby moving beyond the mere dissemination of data and statistics (Sturloni 2013).

In the contemporary era, the hierarchy of information dissemination has diminished, with the mass media emerging as the most potent risk communication tool. In 2011, Albanesi et al. asserted in *La comunicazione istituzionale dei rischi. Linee guida* that the internet is a highly relevant medium for communication. In addition to serving as a platform for feedback on information disseminated by traditional media, it is also a primary source of information, potentially leading to an overload for the average user. Furthermore, the mass media have a filtering function (*cf. the SARF-Social Amplification of Risk Framework model*), modulating information and the relationship between the institutional communicators and other stakeholders (partners or recipients). For instance, if a journalist on a web page questions the assessment of a certain risk, the recipients of the message will also question the credibility of the information, potentially triggering a chain reaction. The issue that arises is that, in the majority of cases, the news is presented in an alarmist manner despite the information content, contributing to the propagation of a '*subculture of emergency*'. This subculture is characterised by an exaggerated perception of risk, whereby the damaging effects of an event are not equal across different social systems. Rather, the effects depend on the specific degree of culture possessed by each system with regard to that event (Lombardi 2005, p. 29).

Furthermore, Albanesi et al. provide examples of how the dissemination of digital technologies has significantly altered the perception and engagement with risks and disasters. Many events, like the terrorist attacks of 11 September 2001 in New York, have been represented and interpreted through digital testimonies of citizens and survivors. The abundance and capacity for use of such images, their potential instrumentalisation and the complex dynamics of assembling and transforming them into discourses, practices and representations of risks constitute one of the most significant challenges for risk communication in the near future (McComas 2006; Lupton 2016). An increasing number of studies in the field of disaster risk management indicate that emergency managers are moving away from the traditional top-down approach and towards what is known as the '*people-centred*' approach (Lombardi and Burato 2017). The aforementioned aspects of natural and man-made disasters have been shown to cause considerable psychological and social suffering, with impacts that can compromise mental health and communal wellbeing in the long term. It is therefore imperative that the protection of these aspects be a priority in all respects (Peirone 2017).

This report addresses a specific type of risk that is particularly pertinent to the inhabitants of Campania: the seismic risk and the associated perception of risk in the Campi Flegrei area of Naples. In order to achieve this, it would be beneficial to consider the 2015 paper by Crescimbene and La Longa on risk perception in Italy. The authors note that comprehensive studies on this topic within the Italian context are scarce, and that the findings of such studies are seldom integrated into engineering assessments or utilised to enhance communication between experts and the general public. This omission can be attributed to two primary factors. Firstly, there is a lack of effective integration between the social sciences and the traditional disciplines involved in earthquake research, including physics, seismology, geology and engineering. Secondly, the social sciences face significant challenges in collaborating with other fields, particularly in terms of adopting languages, methodologies and tools that can be understood and shared in multidisciplinary contexts.

In the field of seismology, the concept of risk is determined by the product of three factors: seismic hazard, which refers to the probability of observing certain levels of shaking in a specific period; exposed value, which quantifies the economic, social, and other aspects subject to risk; and

vulnerability, which indicates the propensity of an element to undergo damage or change. With regard to the concept of seismic risk perception, the authors Crescimbene and La Longa (2015) establish a dichotomy between objective risk, calculated by experts considering the probability and the vulnerability of dwellings, and subjective or collective risk, that is to say, the individual or common perception of risk. The integration of the latter concept into the definition of risk would entail the consideration of not only the scientific elements, but also the emotional ones, inherent to a risk assessment by those involved. Indeed, research that has taken subjective risk into account has revealed a discrepancy between the assessments of experts and the general population. This discrepancy creates a gap between the communication of the actual risk and the perceived emotions.

While the direct effects of volcanic activity have been well studied, less attention has been paid to indirect phenomena such as hydrothermal activity and bradyseism, periodic ground vibrations. Historical evidence shows that the Phlegrean coast has experienced submergence and emergence due to bradyseism. The Vesuvius Observatory, founded in 1841, monitors these activities and the Campi Flegrei Civil Protection Plan defines risk zones, with the "*red zone*" covering vulnerable areas such as Monte di Procida, Bacoli and parts of Naples.

This research is of significance in alignment with the assertions put forth by Crescimbene and La Longa, namely that perception research can serve to bolster risk analysis and inform policy decisions by elucidating and anticipating public responses to danger. The objective of this report is to facilitate improvements in the communication and dissemination of information on the subject matter. In order to achieve this, it is necessary to encourage institutions to utilise Citizen Science, which motivates the active collaboration of citizens in the context of research by involving them in the collection of data, which, once measured and validated, can acquire significant scientific relevance. It is also necessary to consider the context in which we are acting, namely the online context. Indeed, this research addresses two key areas: the offline and the online dimensions. The mass media currently plays a pivotal role in risk communication and management (Albanesi et al. 2011). In the context of the emergency situation in the Phlegraean area, an online counterpart can be identified in

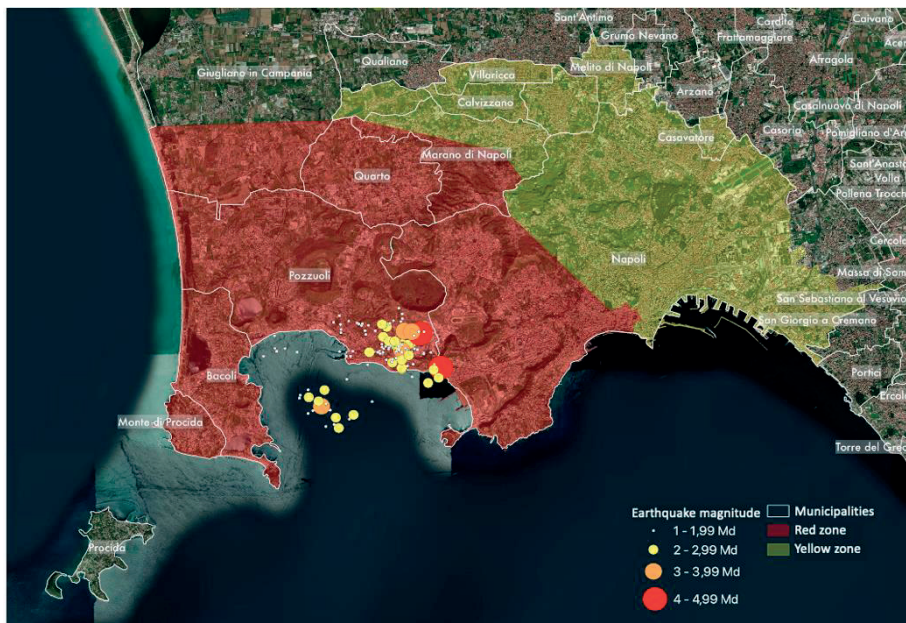
the form of a Facebook group, entitled "*Quelli della zona rossa del vulcano Campi Flegrei*". This group serves as a platform for individuals to disseminate information pertaining to bradyseism and volcanic risk. This give rise to two distinct yet significant research questions: the first concerns the perception of subjective risk in the context of objective risk in the emergency situation of the bradyseism of the Phlegrean area; the second is whether there is a repercussion of the seismic events of the bradyseism of the Phlegrean area on the online behaviour of people within the *Quelli della zona rossa del vulcano Campi Flegrei* Facebook group. In order to gain insight into the recent activity on the Facebook group, it was decided to focus this research on the period between August 27<sup>th</sup> and October 31<sup>st</sup> 2023.

## 21.2 Methodology

To answer both questions adequately, the research was divided into two parts, for which we will explain in detail the methods and procedures chosen, the techniques used, the reference population and the origin of the data. Firstly, the foundations were laid to obtain a general background of the chosen context, both in terms of space and time, and then to go deeper and understand the phenomenon in its entirety. The research carried out is based on mixed methods, taking into account the data already provided by the institutions, while trying to integrate the results of quantitative and qualitative analyses, with the aim of describing, evaluating and explaining the most minute facets of the object under study. The type of design used is sequential explanatory with a follow-up model, which starts with an initial quantitative phase that lays the foundations for the research and continues with a qualitative part to clarify and analyse in depth the data obtained. As theorised by Janice Morse (2003), in our research it is possible to identify the core method in the quantitative approach and the complementary method in the qualitative approach. In this way, we first understood how the different administrations handled the emergency situation and then, with a qualitative approach, fully understood the issue of the perception of the emergency risk according to a people-first approach.

### 21.2.1 The offline context

With regard to the first research question, which aims to investigate how the perception of subjective risk varies with respect to the objective risk in the bradyseism emergency situation in the Phlegraean Fields, the unit of analysis considered is the aggregate (ecological or territorial units), since the data used refer to the municipalities of the Campania Region. For this specific purpose, they have been grouped according to the red and yellow zone criteria defined by the National Civil Protection Plan for the Phlegraean Fields. These considered units can be seen graphically on the following page (*Map 21.1*).



Sources: Protezione Civile and INGV - Osservatorio Vesuviano

**Map 21.1** Cartogram of zoning and location of earthquake epicentres with relative magnitude (27 August 2023 – 31 October 2023)

According to the theories presented, the research question has two well-defined concepts (objective risk and subjective risk). For the objective risk analysis, therefore, the magnitude, date and time of the seismic events have been considered as variables to place the telluric movements and the red and yellow zones in a temporal context. These data come from the collection of telluric movements extracted from the official website of the *National Institute of Geophysics and Volcanology INGV (Vesuvius Observatory)*, which deals with seismic and volcanic monitoring of the national territory.

About the perception of subjective risk, in order to carry out a quantitative analysis of the level of anxiety or concern diffused in the involved population, the INGV site's questionnaires on the tremors in the Phlegrean area were used, in particular the "*Hai sentito il terremoto?*" service. In this case, the perceived magnitude assessed on the Mercalli scale, the number of questionnaires handed in and the percentage of perceived fear expressed through the questionnaires were taken into consideration as variables. This section was specifically designed to guide the transition from a top-down, didactic model to a more horizontal, communicative approach that places the citizen at the centre of the informative and imaginative process (in line with the principles of citizen science). The enquiry conducted, with the scope of answering the research question, is both longitudinal and cross-sectional, based on a funnel approach (from the general to the particular). Initially, a repeated cross-sectional approach was taken, characterised by multiple cross-sectional surveys at the aggregate level, each conducted with different but equivalent samples. Variables of actual magnitude (Richter scale) and perceived magnitude (Mercalli scale) were compared over the time period considered. For a clearer visualisation, only the most intense seismic events, defined by a magnitude of 2 Richter degrees or more, were selected. Alongside this comparison, the trend in the number of completed questionnaires for each of these seismic events was then visualised. As far as the spatial approach was concerned - and therefore for the visualisation of the maps - we opted for the construction of a Geographic Information System (GIS) - i.e. a system that allows georeferenced data to be processed, managed and returned (Biallo 2005) - using the open-source software QGis. In order to facilitate a comparison of the seismic activity between different municipalities, a single event was

selected for analysis. Following a comparison of the available variables, it was decided that the earthquake with the highest number of completed questionnaires should be considered. This was found to be the earthquake of 2 October, with a magnitude of 4.0.

### **21.2.2 The online context**

In addressing the second research question, the focus shifts to an analysis of online behaviour in relation to the seismic events of bradyseism in the Flegrean area. This analysis encompasses the period between 27 August and 31 October 2023, utilising posts from the public Facebook group "*Quelli della zona rossa del vulcano Campi Flegrei*" which had 20,419 members as of December 13rd, 2023. A mixed methods approach was employed, beginning with a quantitative analysis to gain insight into the context and subsequently followed by a qualitative analysis to elucidate the social interactions and relationships among group members, which the quantitative data could not fully address.

#### *Quantitative approach*

Some variables were derived from the concept of online behaviour, specifically the number of Facebook group members, the number of posts published, and the number of post interactions. This latter subdivision was implemented to provide a comprehensive overview of user participation. A longitudinal analysis was used to address the research question, examining changes in variables over time and comparing them with seismic events. The trend in the total number of group members was examined, then the percentage change in members over a time series was compared with earthquakes of magnitude greater than 1.

#### *Qualitative approach*

In the qualitative phase, the data underwent textual analysis using NVIVO software, which facilitated the conceptualisation and coding of the data. A longitudinal approach was employed to examine the evolution of units of meaning in response to seismic events, with a particular focus on posts made within 24 hours after three identified bands of seismic activity: low level (initial earthquake on August 27<sup>th</sup>), medium level (magnitude between 2.9 and 3.6), and high level (magnitude greater than 3.6). The evaluation

process was informed by *Grounded Theory*, which facilitated the coding of text extracts and the identification of common themes. This entailed a process of reading the data and a subsequent direct emergence of the code categories (Charmaz 2008). This approach resulted in the identification of three macro-dimensions: information and purpose, and expert source.

## 22.3 Results

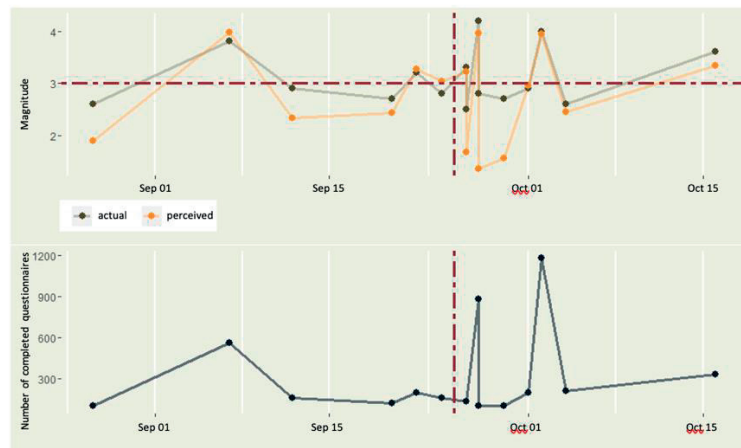
### 22.3.1 The perception of risk in the offline context

To respond to the initial research question, a longitudinal analysis was conducted with the objective of understanding how the perception of subjective risk (in this case, considering the variable of perceived magnitude according to the Mercalli scale) has evolved over time in relation to objective risk. For purposes of enhanced visualisation and analysis, only seismic events with a magnitude of 2.5 or greater on the Richter scale were considered.

To enable comparison, a visualisation was created showing the number of completed questionnaires from residents in red and yellow zones, correlated with the seismic events.

Considering the Graph 21.1, the y-axis represents the temporal variable, thereby facilitating the arrangement of seismic events in a chronological sequence. The two dots on the same day indicate that the seismic event in question exhibited two distinct magnitudes. The dark green dot represents the actual magnitude of the event, while the orange dot indicates the perceived magnitude. In order to facilitate a more accurate interpretation of the data, two additional lines have been superimposed on the graph. The analysis reveals two key trends in the perception of seismic events. Firstly, a magnitude of 3.0 on the Richter scale acts as a threshold, whereby below this magnitude, people tend to underestimate the earthquake's strength, while above this threshold, perceptions align more closely with the actual magnitude. Secondly, following September 26<sup>th</sup>, the perceived magnitude of tremors was found to consistently decline in comparison to the actual magnitude, which is likely attributed to a process of habituation to the frequent seismic activity. This reduced concern is linked to familiarity with the tremors and the absence of severely negative experiences, a

phenomenon previously described by Lima (2004) as cognitive adaptation to risk.



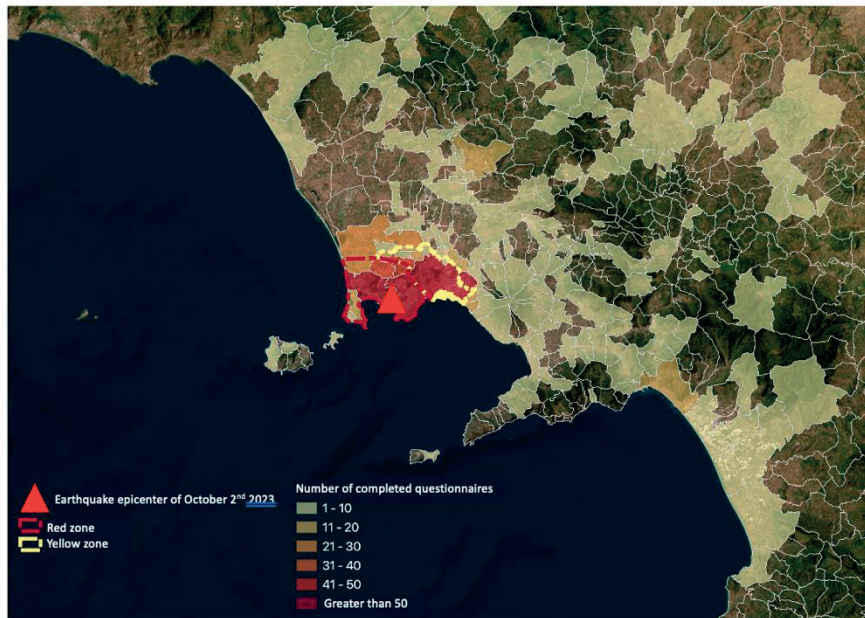
Source: INGV - Osservatorio Vesuviano

**Graph 21.1.** Comparison of time series of actual and perceived magnitude of seismic events and time series of the number of completed questionnaires

The lower map illustrates the number of completed questionnaires by residents of the Phlegraean region in response to tremors, which exhibits a strong correlation with the actual earthquake magnitudes. The peaks in questionnaire submissions coincide with the strongest earthquakes, particularly on September 27<sup>th</sup> and October 2<sup>nd</sup>, when 900 and 1,200 responses were recorded, respectively. Two distinct trends emerge from the data: firstly, a threshold magnitude is identified which is associated with a greater number of responses; secondly, there is an increase in contributions after September 26<sup>th</sup>, despite the magnitudes being similar. This increase in participation is likely attributable to a growing familiarity with the situation, which has prompted more individuals to complete the questionnaire irrespective of the actual risk level.

Following the longitudinal analysis of risk perception, which enabled the identification of changes over time, it is possible to observe the

characteristics of a single seismic event, namely that of October 2<sup>nd</sup>, 2023. The distribution of completed questionnaires at the municipal level in Campania, as illustrated in *Map 21.2*, provides insight into the variation observed in this event.



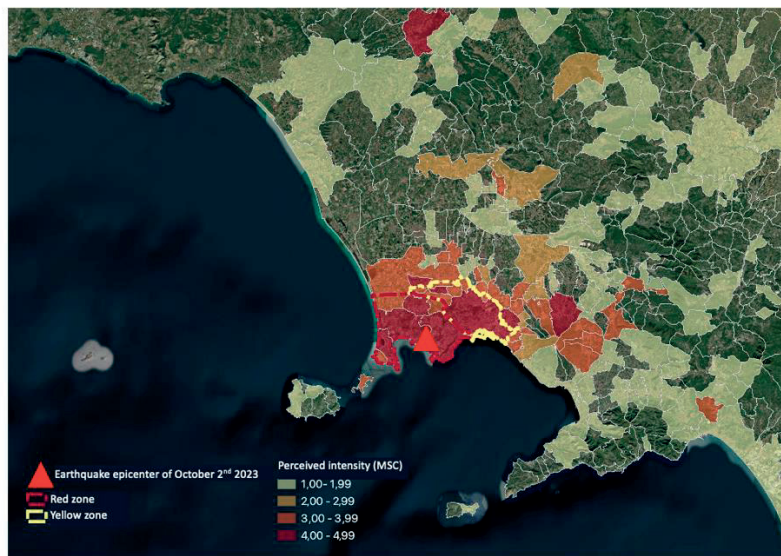
Source: INGV (*Hai sentito il terremoto?*)

**Maps 21.2.** Distribution of completed questionnaires at municipal level

A considerable number of questionnaires were completed within the zones delineated by the civil protection plan, with the highest rates of return observed in Naples (922) and Pozzuoli (72). A total of 182 municipalities participated outside the designated risk zones, with five municipalities submitting between 11 and 20 questionnaires each. This serves to illustrate the efficacy of the Citizen Science approach, whereby citizens proactively engage in data collection activities, extending beyond the boundaries of officially delineated risk zones. It is worthy of note that the municipality of Salerno, really far from the designated zones, submitted 15 questionnaires.

The analysis now turns to an examination of the distribution of perceived seismic intensity across municipalities, as illustrated in *Map 21.3*.

This enables a comparison between the objective risk limits and the perceptions of those affected by the seismic event. The data indicates that the majority of perceived intensities within the red and yellow zones fall within the 4.00–4.99 Mercalli scale category. Outside the aforementioned zones, a number of municipalities, including Qualiano, Somma Vesuviana, and Vairano Patenora, also recorded high perceived intensities. In addition, other municipalities, both within and beyond the aforementioned zones, are categorised at a lower intensity, with 20 municipalities falling within the 3.00–3.99 range and eight municipalities within the 2.00–2.99 range. These findings emphasise the necessity of integrating social and personal factors, in addition to natural ones, into the comprehension of risk, as even individuals situated at a considerable distance from the epicentre were able to perceive the earthquake.



Source: INGV (*Hai sentito il terremoto?*)

**Map 21.3** Distribution of intensity felt by population at municipal level and based on the scale Mercalli

### 21.3.2 The perception of risk in the online context

#### *Quantitative approach*

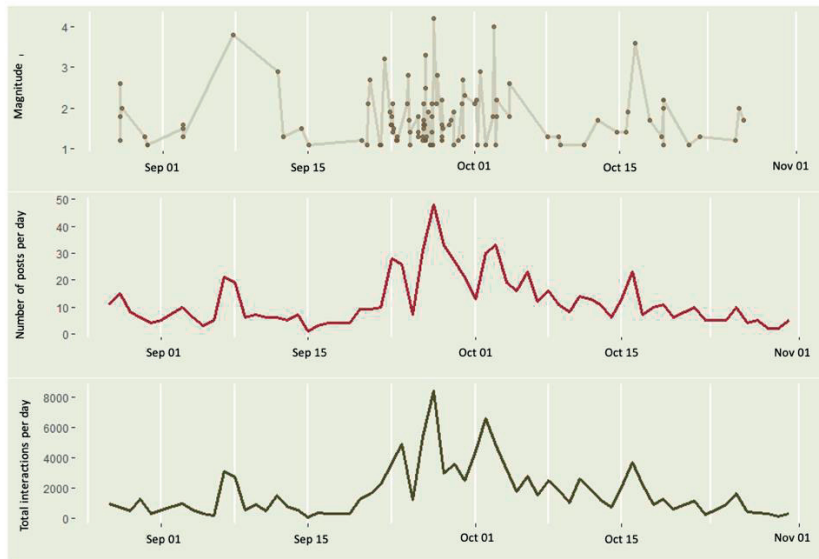
To address the second research question, namely the impact of the bradyseismic crisis in the Phlegraean Fields on online behaviour, the Facebook group "*Quelli della zona rossa del vulcano Campi Flegrei*" was subjected to analysis. This entailed an examination of the group's membership numbers, posts and interactions.

From August 27<sup>th</sup> to October 31<sup>st</sup>, the statistical ratio of relative variation was employed to evaluate alterations in group membership. The calculated percentage change in membership was compared with a time series of seismic events with a magnitude of 1.0 or greater on the Richter scale. The analysis demonstrates that the most notable variation in membership occurs concurrently with an increase in seismic activity. During the period between September 20<sup>th</sup> and October, 4<sup>th</sup> there were 93 tremors (representing the 67.6% of the total number recorded during the 64-day period). It is noteworthy that an increase occurred following the tremor that occurred on August 27<sup>th</sup> (magnitude 2.6), which was likely due to media coverage. Furthermore, another peak was observed on September 28<sup>th</sup>, which correlated with a higher magnitude tremor of 4.2 that occurred on September 27<sup>th</sup>.

These findings serve to reinforce the connection between seismic events and changes in emergency responses and online behaviour among group members.

We now proceed by comparing the tremors of magnitude greater than or equal to 1 with two additional time series: the number of posts published per day and the sum of total interactions per day (*Graph 21.2*).

It is pertinent to highlight the striking similarity between the time series representing the number of published posts per day and the number of total interactions per day, particularly in terms of their peaks and general trend. This suggests that individuals in this group do not exhibit a preference for one type of behaviour over another in emergency.

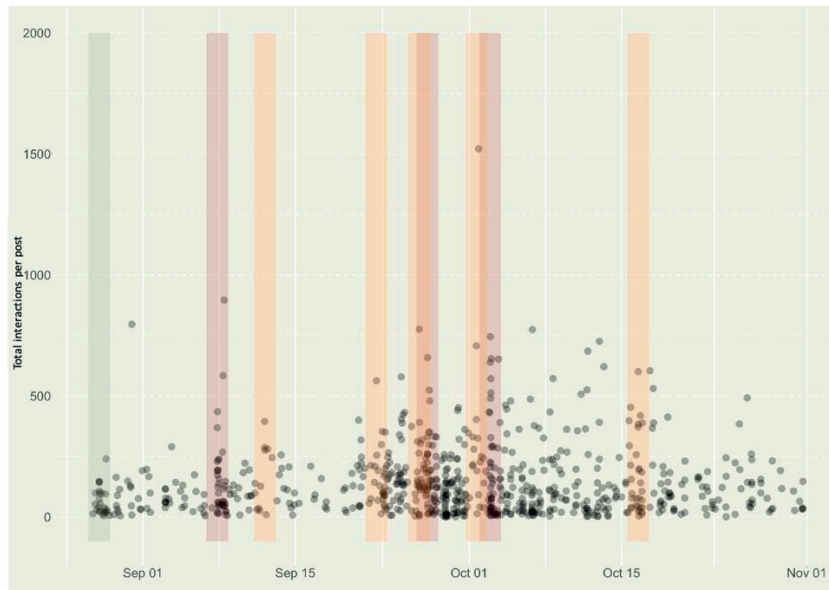


Sources: INGV - Osservatorio Vesuviano and Facebook group "Quelli della zona rossa del vulcano Campi Flegrei"

**Graph. 21.2** Comparison of seismic events of magnitude greater than or equal to 1 with time series of the number of posts per day and total interactions per day from 27 August to 31 October 2023

In the subsequent graph (*Graph 21.3*) each dot represents a published post. The data are ordered in the abscissa according to the date and time of publication and in the ordinate according to the total number of interactions that each post has received. The bands highlighted by different colours, on the other hand, indicate a 48-hour time range in which a certain seismic event occurred. The first band (green), despite the lower magnitude, shows the day of the seismic event on August 27<sup>th</sup>, that is to say, the day on which the posts began to arouse public interest and generate media attention. The orange bands indicate earthquakes with a magnitude ranging from 2.9 to 3.6 on the Richter scale. Finally, the red bands indicate earthquakes with a magnitude greater than 3.6. It was decided that the period under consideration should include the 24 hours preceding and the 24 hours following the earthquake. This was deemed necessary in order to take into account any posts published prior to the earthquake, given that the high

number of interactions may be attributable to reactions from individuals occurring in the subsequent 48 hours.



*Sources: INGV - Osservatorio Vesuviano and Facebook group "Quelli della zona rossa del vulcano Campi Flegrei"*

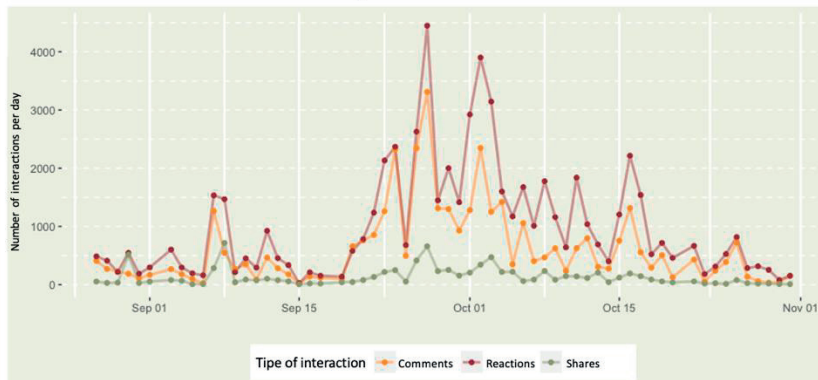
**Graph 21.3.** Comparison of total interactions per post to seismic events from 27 August to 31 October 2023

The point cloud reveals a notable prevalence of posts within the designated seismic event range. These posts exhibit a superimposition, forming discernible lines across the bands. This suggests the occurrence of multiple posts published in close temporal proximity, potentially reflecting a surge in activity following the earthquake. Furthermore, it can be observed that these lines are markedly more discernible and conspicuous in the aftermath of earthquakes with a magnitude exceeding 3.6, as indicated by the red bands.

The subsequent analysis reveals that the publication of posts and interaction with them has increased since September 20<sup>th</sup> and did not stop

on October 4<sup>th</sup> (the end of the period considered the peak of bradyseismic activity). We must consider that the number of members in that period increased to over 18,000, which resulted in an increase in the average number of posts.

We will now conclude with a time series (*Graph 21.4*) comparing the various forms of interaction employed by group members during the period under consideration. In particular, the focus is on comments, reactions and shares. It can be stated that reactions are the most frequently employed behaviour, followed by comments and then by shares. A review of the data reveals that the patterns observed in the use of these behaviours during the period under consideration are similar when considering reactions and comments. However, the use of shares is so minimal that it is challenging to discern a discernible trend. The peaks observed between September 20<sup>th</sup> and October 4<sup>th</sup>, as previously discussed, can be explained by the same rationale.



Source: Facebook group "Quelli della zona rossa del vulcano Campi Flegrei"

**Graph 21.4.** Number of total interactions per day broken down by comments, reactions and shares from 27 August to 31 October 2023

*Qualitative approach*

The introduction emphasised the pivotal function of risk perception research in informing political decision-making by offering insights into public responses, which facilitate the implementation of preventive measures. This concluding section will examine the findings pertaining to the role of Citizen Science as a crucial factor in fostering active citizen participation in scientific pursuits. The Facebook group in question has witnessed considerable engagement from its members, and the data shared and the methods by which individuals utilise this platform in the aftermath of seismic events can make a significant contribution to scientific enquiry.

To analyse these aspects, the types of information present in the posts were classified. The majority of the content is user-generated (151 excerpts), followed by expert information (120 excerpts) and system information (5 excerpts). A significant proportion of the information presented as expert content consists of links and images sourced from external sources, including *L'Osservatorio Vesuviano* and major newspapers. These are often shared by community members without any accompanying original commentary. Therefore, the data indicates that most of the user-generated content reflects posts authored solely by users, which serves to highlight the significant level of participation exhibited by group members.

A more detailed analysis demonstrates substantial discrepancies between user-generated data and expert-derived information. The content created by users is more diverse, encompassing details on earthquake tremors, affected areas, user analyses, historical seismic data, and information on the Campi Flegrei volcano. In contrast, expert information is primarily concerned with the specifics of the seismic event and the assistance provided in response. It is noteworthy that analyses and historical data, which are typically within the expertise of professionals, are exclusively authored by users, who often assume the role of experts to explain these phenomena. Furthermore, the frequent dissemination of user-generated information has the potential to have adverse consequences. The majority of criticism is directed towards support services (35%) and alarmism (30%), with significant concerns pertaining to the reliability of news (22%), the absence of expert input (9%), and the timing of information dissemination (4%).

The considerable criticism levelled at the dissemination of misinformation and the credibility of news sources is indicative of a public perception of a growing concern regarding the ease with which fake news can spread. This criticism and frustration originate from a deficiency in empathetic and prompt communication, which has resulted in considerable disillusionment and mistrust towards experts.

A further dimension identified in the coding of the posts was that of demand. If the dimension of criticism could be delineated into three macro themes (about the veracity of the information, about the lack of information provided by experts, and about the assistance), these three categories are also consistently evident in the dimension of demand.

The users of the *Quelli della zona Rossa* group pose queries through posts that pertain directly to the following categories: fact-checking (i.e. the determination of the veracity of a specific piece of information), requests for input from experts or institutions, and requests for assistance. The first two categories are again the most frequent. This indicates that the community's desire to receive reliable information is clearly expressed so that they can be informed about the emergency situation. Requests for assistance are also of significant importance and can be further categorised into two sub-types: requests for intervention/safety assistance and requests for psychological assistance.

## 23.4 Conclusion

The analysis leads to the conclusion that there is a debate to be had on the perception of risk in the offline context and how the emergency issue is reflected in the online context. This reflection considers the users' behaviour in the Facebook group *Quelli della zona rossa del vulcano Campi Flegrei*. It was essential to combine the two types of analysis, with a particular emphasis on the use of digital tools for in-depth analysis. The latter enabled access to a complex array of information that would otherwise not be available, including the prevalent sentiment on the subject. This provided the analysis with the requisite added value for achieving a comprehensive yet expedient research outcome. An interdisciplinary approach was employed, integrating diverse forms of

knowledge and methods to address the intricate issue of bradyseism in the Campi Flegrei region of Naples, Italy.

In order to respond to the initial research question, namely how the perception of subjective risk varies in relation to objective risk in the context of bradyseism in the Phlegraean area, the data analysed both in temporal and territorial terms reveal the extent to which the people-first approach remains a distant goal. It is evident that a multitude of factors contribute to the perception of risk. In addition to the actual magnitude experienced during a seismic event, which often does not align with the perceived magnitude, as evidenced by the observed tendency for people to perceive tremors as stronger than they are after a certain threshold value is reached, the frequency of bradyseism also plays a significant role. Furthermore, the objective risk delineated by the Civil Protection Authority, which delineates a red zone and a yellow zone, fails to account for the psychological impact on individuals experiencing bradyseism who reside in areas distant from the epicenters of seismic events.

With regard to the subsequent research question, the analysis of the second part reveals a strong correlation between the seismic events of bradyseism in the Phlegraean area and online behaviour within the Facebook group *Quelli della zona Rossa del vulcano Campi Flegrei*. The results demonstrate that an increase in the frequency and intensity of seismic events is associated with a notable rise in the number of group members. The users' concern about seismic events and their frequency give rise to the necessity of accessing the group in order to obtain information, interact through reactions and comments, and share information with other users. In light of the aforementioned, it can be posited that this virtual space serves as a primary source of support and information sharing during an emergency situation. Consequently, it must be a trusted place, where communication is clear, fast and exhaustive (Comunello 2014). Nevertheless, the analyses conducted indicate that this group still falls short of these conditions. Citizens are unable to compensate for the absence of reliable sources of information, nor are they able to reassure those in distress in such a sensitive situation.

In conclusion, the problem can be traced back to three main factors: the limited amount of information and assistance provided by the institutions, the type of communication provided, which is too formal and apathetic, and

the slow pace of communication and intervention. There is considerable scope for enhancement in the communication of seismic events, in terms of both the used channels and the disseminated content. Information should be provided in greater depth, with greater empathy and accessibility, and with updates occurring with greater frequency. The appointment of mediators to communicate directly with the public via popular channels, such as Facebook groups, could prove an effective means of enhancing outreach.

At the end, this paper also puts forth the proposition that institutions should adopt a Citizen Science approach, underscoring the necessity of contemplating individual emotional states. It emphasises the necessity for collaboration between the natural and social sciences to achieve a comprehensive understanding of risk. In the contemporary era, social media has become the primary conduit for communication and, consequently, the necessity for researchers to invest in appropriate research tools is paramount.

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