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Media views of the Stromboli 2002–2003 eruption and evacuation: a content analysis to understand framing of risk communication during a volcanic crisis

Laura Calabrò[1*], Andrew J. L. Harris[2] and Jean-Claude Thouret[2]

Abstract

The 2002–2003 eruption of Stromboli (Aeolian Islands, Italy) was one of Stromboli's most important effusive events of the last two centuries and began on 28 December 2002. On 30 December 2002, two days after the beginning of the eruption, a landslide entered the sea and caused a tsunami that struck Stromboli's coastal areas. The events of 30 December led to a "voluntary evacuation" by Stromboli's inhabitants. To understand the role of the media in framing risk and the evacuation, we analyzed the content of five newspapers, including two national newspapers (Il Corriere della Sera and La Repubblica) and three regional newspapers (La Gazzetta del Sud, La Sicilia and Il Giornale di Sicilia), published during the period covering the onset of the eruption, the tsunami and the voluntary evacuation (28 December 2002–18 January 2003). Our aim was to assess the type of hazard information given, how it was delivered, and how this may have helped (or not) with the population's resilience, especially in regard to viewing a potential need to evacuate in a favorable light. News regarding the eruption covered a total area of 12,000 cm^2 for the national newspapers (~ 6000 cm^2/paper) against 41,700 cm^2 for the regionals (14,000 cm^2/paper); making the regional newspapers the more important sources by quantity. For both newspaper categories, most of this area was occupied by interviews with experts, followed by quotes from residents and tourists, and, finally, those involved in the response (i.e., hazard managers, including civil protection and local government). Out of a total of 9286 words analyzed, the most popular was "tsunami" (426 cases), with the word "volcano" being repeated 315 times (the 6th most popular word); so it would have been difficult for the population not to have known there was a potential risk of tsunami associated with the volcano. In texturally framing the eruptive crisis, negative words, such as "fear", "terror" and "apocalypse", were much more frequent than positive words, which were rare and even not present in some newspapers. The reporting focused on the tsunami threat with little link back to the eruption and other hazards, and contrasted with imagery (that took up 41% of the reporting space) which comprised relaxing pictures of a tranquil island surrounded by a calm blue sea. This, coupled with a confused message through selection of quoted expert sources, may have led to an exaggerated and alarmist frame for the eruption and attendant hazards. This was in spite of widespread use of scientific sources, as well as pleas from the

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(Continued from previous page)
population itself, to the journalists and published in the newspapers themselves, to tone the reporting down. The newspaper agenda was, thus, plainly not compatible with effective communication in support of disaster management.

Keywords: Newspaper, Frame, Volcanic eruption, Tsunami, Risk, Reporting

Introduction

Communication during a natural disaster has been described as an exchange of information among experts, public administrations, mass media, interest groups and citizens, with the aim of helping to make appropriate decisions about accepting, reducing or avoiding the risk (Haynes et al., 2008; Leiss, 1996). The management of several infamous volcano eruption crises (e.g., Soufriere de Guadeloupe, West Indies in 1976; Nevado del Ruiz, Colombia, in 1985; and Fuego, Guatemala, in 2018) have shown the importance of communication in positively, or negatively, framing scientific understanding of an eruptive event and the effectiveness of disaster management interventions to the wider public. Bretton et al. (2018) note that poorly-handled scientific communication can cause "social, economic and political problems, and undermine community confidence in disaster management regimes". For example, well-publicised scientific and political disagreements during the 1976 eruption of La Soufrière caused stigma that still has strong influence in framing of future volcanic crises on Guadeloupe, FWI (Hincks et al., 2014) or elsewhere in France or Europe. In contrast, during the lahar events from Nevado del Huila (Colombia) in 2006 effective communication between experts and politicians saved hundreds of people (Fearnley et al., 2018). Because most of the information that people receive on risk is through communication rather than direct experience, correct communication of risk and disaster management measures is a fundamental component of mitigation and for risk reduction (Barclay et al., 2008; Gaillard and Dibben, 2008; Sigurdsson et al., 2015; Loughlin et al., 2015). However, due to the difficulties in comprehension and translation of a risk message during passage of information between different actors in the communication chain, often scientific and disaster management-information becomes distorted and/or misunderstood (Block and Keller, 1995; McClure and Sibley, 2011; Leonard et al., 2014; Linville et al., 2015).

Several studies have shown how mass media can be used as a channel for emergency management agencies (such as civil protection, local government, law and order departments, rescue services, etc.) to inform people on the current status of a crisis or to diffuse information (e.g., Stieglitz et al., 2018; Joseph et al., 2018; Harris and Villeneuve, 2018a; Hicks et al., 2017; Doyle et al., 2014). The media have become, therefore, one of the most powerful, and important, risk communication channels. Due to the frequency, quantity and wide availability of mass media information, the mass media have long been considered able to influence public understanding of, and the way they think about, a topical issue (e.g., Lippmann, 2008; Katzman, 1972; McCombs, 2014), as well as the perception of, and potentially the actions made by, populations in the face of a natural disaster (Wilson, 1995; Boykoff, 2007; Stieglitz et al., 2018) despite well-known credibility concerns. Media professionals, in fact, decide which topics to cover and how much coverage should be dedicated to them (Reese et al., 2001). Placement also influences the importance given to the news by the public, for example, whether the event is reported on the front page versus an inside page in a newspaper (Harris, 2015). Further, the type of words and imagery used to portray the topic will aid in setting the event frame (Harris and Villeneuve, 2018b). In filtering risk communication, the media will thus provide a fundamental role in setting the frame for the natural disaster, as well as the way scientists and hazard management specialists and their communications are perceived (Harris et al., 2012). Fundamentally, to be reported-on the event must fit the news values of the media source (Harcup, 2009). Namely whether the communication is helpful, or not, in terms of effective risk communication, will depend on the media's agenda, and their value systems the publisher wishes to enforce (Katzman, 1972, McCombs and Shaw, 1972; Vu et al., 2014). Unfortunately, these sets of values are not aimed at managing risk, but rather to make stories appealing to the readership so as to—after all—sell the newspaper. The result is often sensationalization, exaggeration, selection and spin (Harris et al., 2012; Harris 2015).

In this paper we thus focus on this issue of risk communication through the media. To do this we further develop a method, based on a merge of media tracking methods and frameworks laid out in Harris (2015) and Harris and Villeneuve (2018a,b), to better understand the quantity and type of information readerships receive during a volcanic crisis. In particular, we focus on how selection and use of text, imagery, sources and data can positively or negatively frame the risk, and lead to media-based distortion. To do this, we conducted a content analysis of five newspapers published during a 22-

day period spanning the first 3 weeks of the 2002–2003 eruption of Stromboli (Aeolian Islands, Italy). We chose this eruption as it was a somewhat unexpected event scenario for which the population, scientists, disaster managers and media were not prepared. Prior to December 2002, this group of actors had been used to Stromboli being associated with regular (13 events/hour), small (less than 6000 kg/event) explosions sending ejecta to heights of only 50–150 m (Ripepe et al., 2008); such events just affected the crater area and were punctuated by occasional (short and small volume) effusive events (Barberi et al., 1993). The summit area, prior to the 2002–2003 eruption, had thus remained open to tourists with no restrictions. The ease of visit to the summit and guarantee of viewing of explosive activity, along with Stromboli's fame as a classic volcanological site, made Stromboli an iconic volcano tourist destination (Struck, 2010), where the tourist industry had developed "with little consideration being paid to the hazards posed by the presence of an active volcano" (Bertolaso et al., 2008a, b). Indeed, by 1989, although the population was only around 421, hotel bed capacity was for 1181 with almost 21,000 tourists staying on the island during the year (Cavallaro and Concotta 1991). Instead, the landslide of 28 December 2002, and the tsunami it generated, required a re-assessment of hazard, risk, response, safety and preparedness (Bertolaso et al., 2009), as well as public perception and access and, hence, communication.

The first three weeks of Stromboli's 2002–2003 eruption and media coverage

Stromboli's 2002–2003 eruption began on 28 December 2002 following several months of heightened summit (normal explosive) activity (Burton et al., 2008). Initial activity involved emission of lava from a fracture that opened between the NE rim of crater area, at an elevation of 750 m a.s.l., and the 600 m elevation on the Sciara del Fuoco (Fig. 1). Lava flow fed at high (up to 280 m^3/s)

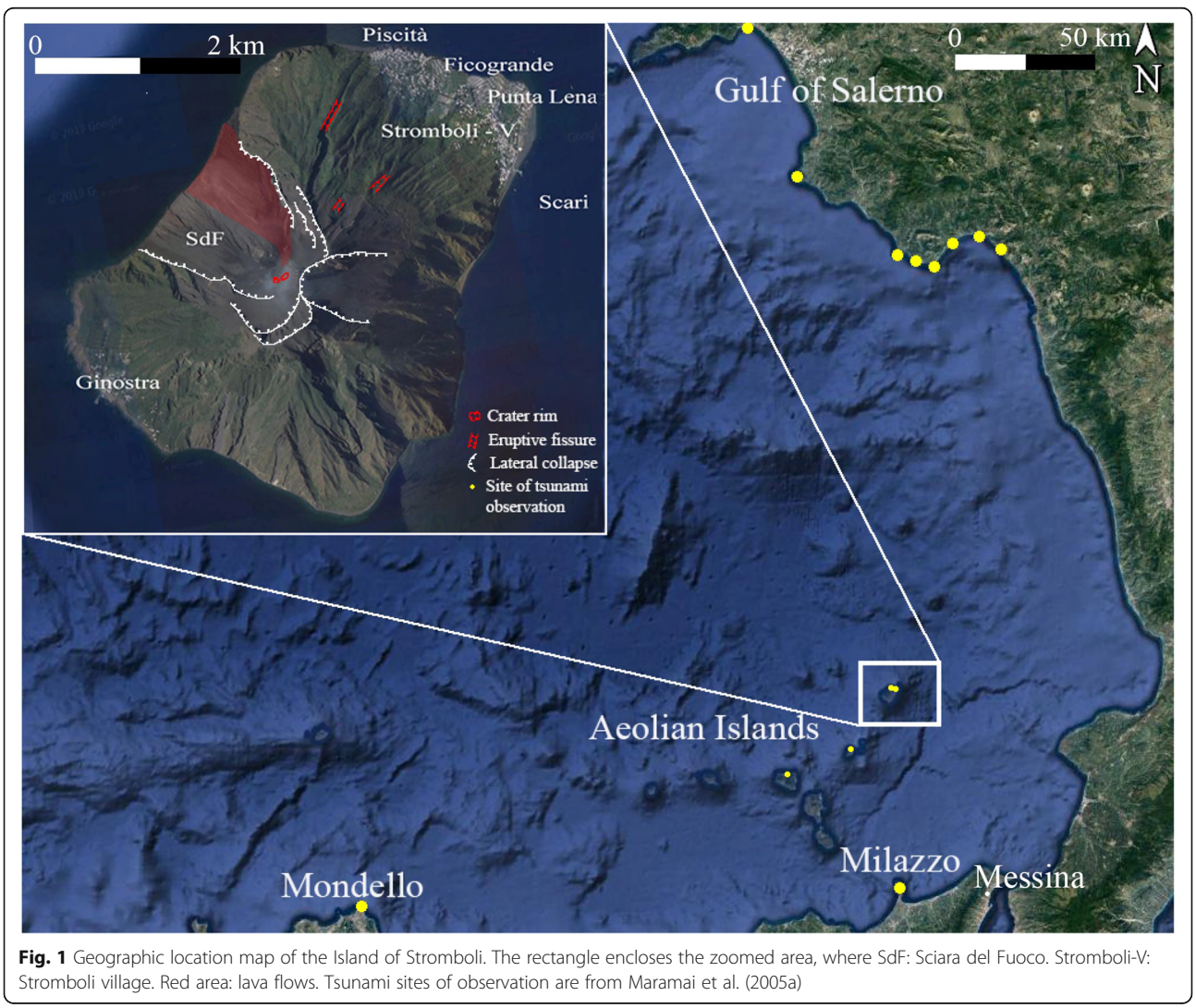


Fig. 1 Geographic location map of the Island of Stromboli. The rectangle encloses the zoomed area, where SdF: Sciara del Fuoco. Stromboli-V: Stromboli village. Red area: lava flows. Tsunami sites of observation are from Maramai et al. (2005a)

effusion rates rapidly advanced to the coast, but remained in the unpopulated collapse scar of the Sciara del Fuoco (Calvari et al., 2005). Such effusive activity was nothing new, previous effusive events having emplaced lava flows between the summit craters and the sea in 1985–1986 (De Fino et al., 1988) and November 1975 (Capaldi et al., 1978). It was thus treated as a spectacular development of the normal activity which, today, furnishes eye-catching images for use in post-card sales (Fig. 2) and guide book entries, as in that of Rachelli (1998) which was widely available on the island at the time of the eruption.

However, on 30 December 2002, 2 days after the beginning of effusive activity, a new fracture formed along the Sciara del Fuoco, causing the detachment of two large (10^6–10^7 m^3) portions from the Sciara del Fuoco (Bonaccorso et al., 2003; Pino et al., 2002). The two landslide bodies detached in events that began at 13:14:05 and at 13:22:38 (local time), respectively (Bonaccorso et al., 2003), and triggered tsunami waves with a maximum run-up of 10.9 m at Spiaggia Lunga on Stromboli (Tinti et al., 2006a, 2006b). These waves injured three people and damaged buildings and boats along the waterfront at Ficogrande, Punta Lena and Scari (Tinti et al., 2006a, 2008), all located on the NE shore of the island (Fig. 1). The waves also reached Panarea, Milazzo in Sicily (causing two oil tankers anchored in the port to break their anchors) and southern Campania as far as 240 km from Stromboli. Although several tsunami events were recorded across the Aeolian Islands between 1919 and 1988, and because the last event on Stromboli occurred back in 1944, this phenomenon was something a little more out-of-the ordinary and worrying (Maramai et al., 2005a, b). Not too surprisingly, no postcards available on Stromboli or guide books depict such high-impact events, but instead focus on an idyllic island set in a calm blue sea (e.g. Rachelli, 1998; Clark and Bonetto, 2017; Marca, 2019; Chua, 2013; Leva, 2000) (Fig. 3).



Fig. 2 All postcards available for sale on Stromboli in September 2018 depicting the eruption of 2002–03. We have left the images as given (without scales) so that the viewer sees all that is available in terms of interpretive information

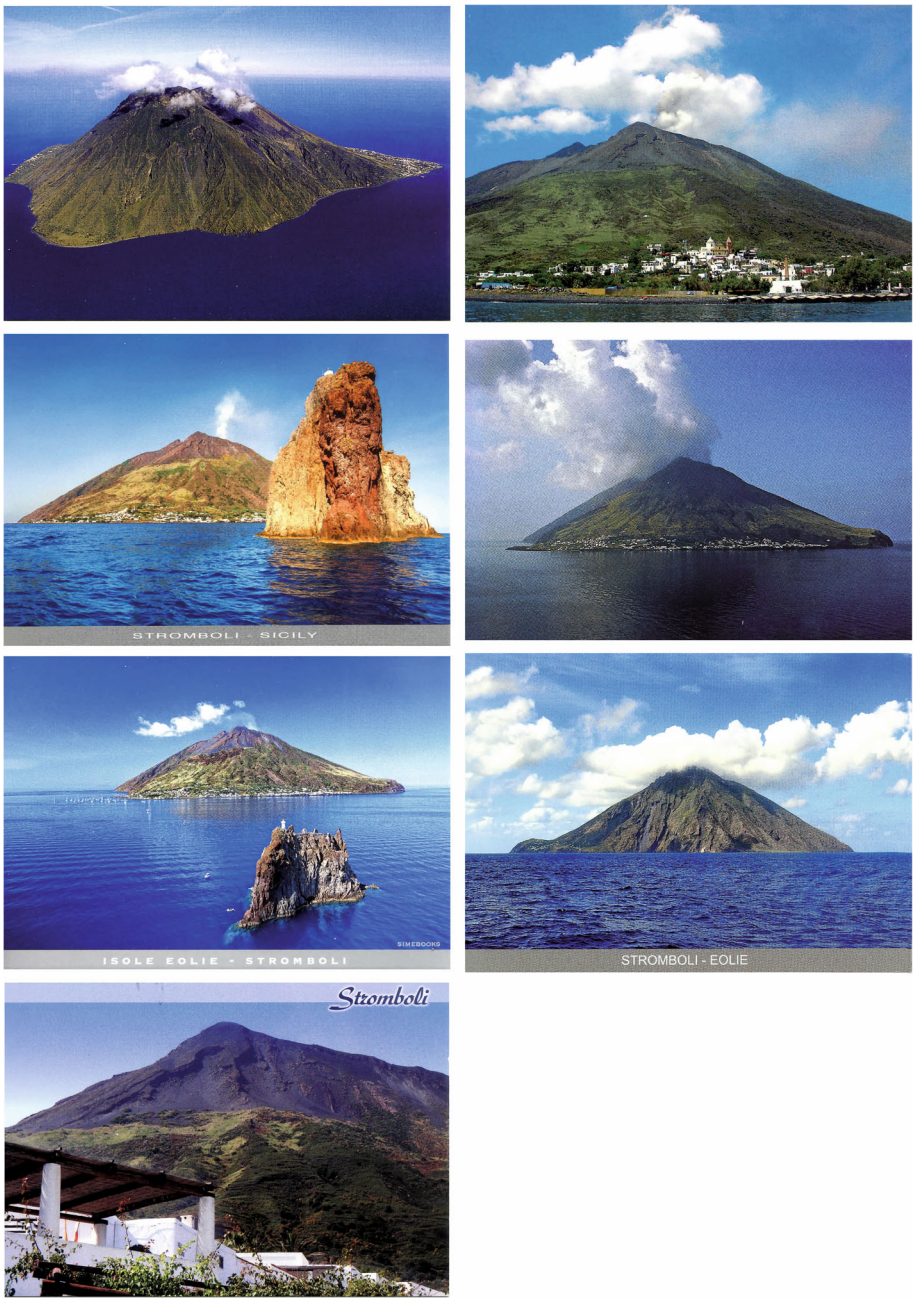


Fig. 3 All postcards available for sale on Stromboli in September 2018 depicting the Island

The same symbolism is even found in fictional writing and children's story books, see for example Di Benedetto (2017). Instead, tsunami warnings and communication are left to formal civil protection-based pamphlets, maps and signage (PMC–DPC, 2008; Bertolaso et al., 2009).

Following the 30 December 2002 event, civil protection intervention was immediate (Bertolaso et al., 2008a, b). The first action was to help residents and provide lodging for those who decided to leave the island spontaneously. On 31 December, about 330 residents decided to evacuate Stromboli; mostly leaving for neighboring islands and Messina where they were catered for by civil protection and the Red Cross. As a result, by January 2003, there were only 50 residents still living on the island, plus the staff of the monitoring facility, the central operations (monitoring) center (COA) that was installed immediately to provide surveillance (Bertolaso et al., 2008b). Only at the beginning of February did the population return to the island, but the island remained closed to non-residents through mid-March (Bertolaso

et al., 2008b), while effusive activity continued until July 2003 (Calvari et al., 2005).

Three regional newspapers cover news on Stromboli, these being: La Gazzetta del Sud (Messina), La Sicilia (Catania) and Il Giornale di Sicilia (Palermo). These three newspapers have a combined circulation of around 86,000 newspapers per day (Table 1). The eruption onset was deemed sufficiently newsworthy to warrant placement on the front page only in La Gazzetta del Sud and Il Giornale di Sicilia on 29 December 2002. The wording of the headlines also highlighted the spectacular feel to, and familiarity with, the initial events, with the Gazzetta del Sud leading with (La Gazzetta del Sud, 29/12/02, p. 1),

"Stromboli awakens: Last night an impressive eruption occurred resembling that of '86",

and Il Giornale di Sicilia printing (Giornale di Sicilia, 29/12/02, p. 1),

"Stromboli eruption record: lava flows into the sea".

La Sicilia, however, did not report on the new eruption. Instead, the landslide and tsunami of 30 December made the front page of all three regional newspapers on 31 December, with the headlines reflecting the shock of the new, high-risk and unexpected turn of events:

"Panic in the Aeolian Islands" (La Gazzetta del Sud, 31/12/02, p. 1).

Terror on Stromboli (La Gazzetta del Sud, 31/12/02, p. 1).

On the run from Stromboli (La Sicilia, 31/12/02, p. 1).

The 30 December events also made the front pages of most national newspapers, so that reporting from there-on drew both the regional Sicilian, and wider Italian, public attention to the events unfolding on Stromboli. It also began recording statements from local inhabitants, tourists, politicians, civil protection and scientists, using words and images which would have shaped public opinion while being passed through 'the media filter' (Mathien, 1986; Harris, 2015).

Methods

To analyse the text reported in the five newspapers, we used content analysis. This is a systematic and objective method of describing and quantifying information contained in written and/or oral communication (Krippendorff, 1980; GAO, 1996; Elo and Kyngäs, 2008). In applying a content analysis, the quantity of information and frequency of most-common words is usually recorded (Neuendorf, 2002). The assumption made is that the words that are mentioned more frequently are those that reflect the greatest concerns. Word position in the text can also be evaluated since certain positions have higher impact than others, e.g., those words appearing in the title or first and/or last sentence of an article will have highest impact. Position of the article in the newspaper itself can also determine the impact, e.g., front page versus inner pages (Harris, 2015). The same can be applied to images, which will advertise the main subject (Naccarato and Neuendorf, 1998), where the size, positioning (on the page), placement (in the newspaper) and selection of imagery are all quantifiable metrics, as are the number and length of words in associated headlines (Harris and Villeneuve, 2018b). Qualitative analysis can then be applied to examine what different meanings emerge as a result of selecting and using—and then linking within sentences, paragraphs and articles—certain information, words and/or images (Nuenendorf, 2002).

In applying these analyses, three units can be considered (Krippendorff, 1980): (i) the sampling unit, which is the unit capable of providing the required information; (ii) the context unit, which is that content that can be described quantitatively; and (iii) the recording unit, which includes all information that cannot be quantified. For the sampling unit we took the three regional newspapers that serve Stromboli (La Gazzetta del Sud, La Sicilia and Il Giornale di Sicilia), plus the two most-read national newspapers (Il Corriere della Sera and La Repubblica), examining all 22 issues of each newspaper available during the three week period spanning 28 December 2002 through 18 January 2003 (Table 1). Today's news will appear in tomorrow's newspaper, so the onset of the eruption should appear on 29 December 2002, with reporting then lagging one day behind the

Table 1 Newspapers selected for the content analysis. Paper circulation and population data are from Istat.it (downloaded on 2018-05-28 at 10:14 UTC), and number of pages is as counted for the study period. The total area of all news devoted to Stromboli over the 22-day (28 December 2002–18 January 2003) study period is given

Newspaper	Circulation (newspapers per day)	Circulation (newspapers per day)	Number of pages	Single page Area cm × cm (cm2)	Stromboli Area (cm2)
Il Corriere della Sera	216 569	60 589 445(0.35%)	38 to 46	53 × 38.6 (2046)	8037
La Repubblica	175 237	60 589 445(0.28%)	48 to 52	48 × 35.2 (1690)	4250
La Gazzetta del Sud	52 070	5 056 641(1.02%)	32 to 36	52 × 34.2 (1778)	23979
La Sicilia	19 846c	5 056 641(0.39%)	43 to 48	56 × 38 (2128)	8373
Il Giornale di Sicilia	14 527	5 056 641(0.28%)	36 to 48	47 × 28.2 (1325)	8618

occurrence of the actual event or statement (e.g., Harris and Villeneuve, 2018a, b). For each case, the edition most local to Stromboli was selected, this either being Messina or Catania in Sicily; these being the editions in which most information regarding the eruption crisis on Stromboli should be reported. The newspapers from this period are not available in digital format, but were all available in original hard copy format at the Messina regional library archive. There all issues were searched, and any article reporting on Stromboli recorded into an excel-based log sheet, and a digital photograph taken of the page containing the report. Data recording was completed in the newspaper language (Italian), and later translated to English. From herein we use the English translation, but the full data set in original language is given in Electronic Data Supplement 1 and translations of key headlines and phrases are given in Table 2.

Context unit: coding and classification for quantitative analysis

To quantify the information contained in each report, we first recorded the metadata for each article. This involved recording of the host newspaper, date of publication, page number, headline, article number (one being assigned to the first report focusing on Stromboli on any day in the newspaper under analysis, and n being the n^{th} report on that day), and report area (in cm^2). The total page size and number of pages in the newspaper on the day of publication was also recorded. Images were measured separately, and the caption recorded in place of the headline. Because the importance of the news will be reflected by the location of the report in the newspaper, news reported on the front page will have a greater weight than news 'hidden' in the inner pages. Front page news was thus highlighted, and checked as representative of information contained within the newspaper.

Each element of the content of each article was then coded depending on the levels of information contained within the report, with the report being broken down as follows:

Level 1: Headline, sub-title or image caption associated with reporting on Stromboli.

Level 2: Any picture, sketch or map linked to the report;

Level 3: Body text of the article;

Level 4: Quotes and interviews related to the Stromboli eruption.

For levels 1, 3 and 4, all words were recorded and used to carry out word counts and frequency analysis, and all images were photographed and saved for qualitative classification. In addition, for level 4 information, the name and institute/affiliation/domicile of any source (if given) was recorded. From the word lists, we then extracted all words relating to a hazard, activity or response and placed them into five classes, these being:

Class 1: General volcanic (including "activity", "the island", "the village" and "Stromboli"—island or village);

Class 2: Explosive (including normal Strombolian activity and larger events);

Class 3: Effusive (including "lava" and "flow");

Class 4: Landslide (including structural issues and sector collapse);

Class 5: Tsunami (and sea/ocean waves of all types);

Class 6: Response (including mitigation, management measures and evacuation).

All locations and dates/times of occurrence (i.e., any factual information) related to each class was also recorded along with the source of the information (if given). In doing this, synonyms for each class, were recorded and placed into the most appropriate word group. For example, in the Giornale di Sicilia, different synonyms were used to indicate the tsunami, such as "tidal wave", "harbor wave", "anomalous wave", "wall of water" and/or, simply, "wave"; these were all placed into the "tsunami" parent group. As such, for the word frequency count, synonyms were counted as grouped into single parent word categories.

Record unit: coding and classification for qualitative analysis

To assign meaning, association and/or connotation of any phrase, each context unit needs to be checked against any given qualifier (Webber, 1990). We thus linked all words extracted as context units to their nearest modifier, qualifier, adverb, hyperbolic phase or superlative. This was completed at the level of the phrase in body text sentences (or headlines). We then classified all such cases as either negative, i.e., alarming (e.g., "worse", "hell", "terror") or positive, i.e., reassuring (e.g., "better", "paradise", "quiet"). In addition, images were classified in terms of the dominant theme (island, eruption, volcano), color/tone (blue, red, orange, green, grey, black) and feeling (tranquil, relaxing, frightening, stressful). In this regard, words as well as images can be categorized into groups of similar meaning or connotation (Webber, 1990), and used to assess whether the content has been exaggerated or suppressed (Rowe et al., 2000). Finally, the source of any quoted material was assigned a group, these being:

Source 1: Hazard manager (civil protection plus local-regional-national government);

Source 2: Responders (search and rescue, health and security, police/military, etc.);

Source 3: Scientists (observatory staff, invited scientists, academic experts);

Table 2 Key type 1 (headlines and sub-headlines), 3 (body text) and 4 (quotes), with source for all type 4 information. The original phrase is given, with translation to English. Reference links the entry to the call out in the work here, where Rep = La Repubblica; CdS = Il Corriere della Sera; GiS = Il Giornale di Sicilia; GdS = La Gazzetta del Sud; SiC = La Sicilia

Journal	Type	Date	Page	Source	Italian	English	Ref
Rep	1	2002/12/31	1		Un'onda anomala terrorizza Stromboli	Freak wave terrorizes Stromboli	1
CdS	1	2002/12/31	1		Esplosione sul vulcano, fuga da Stromboli	Explosion on the volcano. People escape from Stromboli	2
Rep	4	2002/12/31	14	Residen	Sembrava l'inferno della Divina Commedia	It looked like hell from the Divine Comedy	3
CdS	3	2002/12/31	8		… Una nube da girone dantesco che galleggia nell'aria per un tempo indefinito e piomba giù con forza quando è ormai fango…	A cloud from Dante's peak that floats in the air for some time before turning to mud which swoops down with considerable energy	4
GiS	1	2002/12/29	1		Stromboli, eruzione record. La lava si riversa in mare	Stromboli eruption record: lava flows into the sea	5
GdS	1	2002/12/29	1		"Si risveglia lo Stromboli"	Stromboli awakens	6
GdS	1	2002/12/29	35		Ieri sera l'imponente eruzione che ricorda quella dell'85. Allertata la Protezione Civile	Last night an impressive eruption occurred resembling that of '85. Civil Protection alerted	7
GiS	3	2002/12/29	1		…ha eruttato scorie incandescenti che sono finiti sugli abitati	…it has erupted incandescent scoriae that ended up on the houses	8
GiS	3	2002/12/29	3		pioggia di sabbia	Rain of sand	9
S	1	2002/12/31	1		In fuga da Stromboli	On the run from Stromboli	10
GdS	1	2002/12/31	1		Panico nelle Eolie	Panic in the Aeolian Islands	11
GiS	1	2002/12/31	1		Terrore a Stromboli	Terror on Stromboli	12
Sic	4	2003/01/03	3	Mayor	Voglio dire, con la massima semplicità ai media, di non creare allarmismi inutili, e di non provare ad amplificare tutto per inseguire lo scoop	I want to say, with the utmost simplicity to media not to create unnecessary alarmism, to try to amplify everything to chase the scoop	13
GdS	4	2003/01/04	26	Mayor	Non è possibile estrapolare frasi da discorsi completi su rischi teorici e riportarli come eventi incombenti	It is not possible to extrapolate phrases from complete discourses on theoretical risks and take them up and disclose them as a looming event	14
Sic	1	2003/01/03	1		Stromboli, i turisti non hanno paura prenotazioni boom"	Stromboli: tourists are not afraid, boom in bookings	15
CdS	1	2003/01/04	1		C'è una nuova frana, Ore di paura nelle Eolie	A new landslide: hours of fear in the Aeolian Islands	16
Rep	1	2003/01/04	1		Stromboli, travolti dal panico – Due nuove frane, tutti in fuga: Eolie ora è psicosi	Stromboli, overwhelmed by panic – Two new landslides, all are fleeing: Aeolian Islands now in a state of psychosis	17
CdS	3	2002/12/31			"… arrestra in un risucchio biblico, riprende forza e rigurgita con furia contro la costa abbattendosi come un maremoto. È da questa sciara infuocata che è partita l'apocalisse"	"... the wave ends with a biblical backwash, gains strength and furiously crashes against the coast, breaking like a tidal wave. This apocalypse started at the fiery Sciara	18

Table 2 Key type 1 (headlines and sub-headlines), 3 (body text) and 4 (quotes), with source for all type 4 information. The original phrase is given, with translation to English. Reference links the entry to the call out in the work here, where Rep = La Repubblica; CdS = Il Corriere della Sera; GiS = Il Giornale di Sicilia; GdS = La Gazzetta del Sud; SiC = La Sicilia *(Continued)*

Journal	Type	Date	Page	Source	Italian	English	Ref
CdS	4	2003/01/02		Resident	L'ho vista l'onda. Altissima, smisurata, potente. Come in un film. E sono scappato appena in tempo per non essere investito dall'acqua..."	"I saw the wave. Very high, immense, powerful. Like in a movie. And I escaped just in time so as not to be hit by the water ... "	19
GiS	4	2002/12/31	2	Resident	Per tutta la mia vita non potrò mai dimenticare quello che ho visto	For all my life I will never forget what I saw	20
GiS	3	2002/12/31	2		Nel secolo scorso il vulcano aveva seminato morte e terrore. Ecco la cronaca di quella terribile mattina	In the last century the volcano had sown death and terror. Here is the chronicle of that terrible morning	21
GdS	4			Resident	Abbiamo visto arrivare un'onda enorme che ha travolto tutto e tutti. Per fortuna non ha fatto vittime. Poteva essere una tragedia. Vuol dire che doveva andare così	We saw a huge wave arrive that overwhelmed everything and everyone. Fortunately, there were no victims. It could have been a tragedy. That's the way it goes	22
GiS	3				…L'onda anomala? Ricordo la mareggiata dell'31, spazzò via addirittura il pontile di Scari. Ma ricominciò tutta normalmente, come accadrà anche quest'anno. Il danno più che il vulcano rischia di farlo la disinformazione dei tg…	… The tidal wave? I remember the tidal wave of '31, it destroyed the jetty at Scari. But after that everything returned to normal, and the same will happen again this year. The major source of damage will more likely be the misinformation from the television news rather than the events related to the volcano ...	23
Rep	4	2003/01/02		Civil protection	Le case vicine ai luoghi dove ci potrebbero essere dei crolli e che potrebbero essere colpite da massi sono state fatte abbandonare. Non c'è alcun ordine di evacuazione, ma pensiamo di vietare l'accesso nell'isola…. Certo chi vorrà potrà tornare ma noi invitiamo la gente a restare fuori	Houses close to places where collapses can occur and houses that could be hit by boulders have been abandoned. There is no evacuation order, but we are considering prohibiting access to the island .... Of course, those who have left will want to come back, but we advise people to stay away"	24
CdS	4	2002/12/31	8	Resident	Una grande paura. Adesso molti vanno via. Ma come si fa a lasciare la nostra isola la nostra casa? E' qui che abbiamo tutto…	Extreme fear. Now many leave. But how do you leave our home, our island? It is here that we have everything ...	25
Sic	4	2003/01/03		Resident	Siamo abbastanza "incazzati" con i giornalisti perché continuano a scrivere fesserie, tipo che siamo scappati tutti, che l'isola rischia di andare a fondo e roba di questo genere. Chi se n'è andato non è scappato, ma ha fatto una scelta su invito alla prudenza da parte protezione civile"	We're pretty "pissed off" with journalists because they keep writing nonsense, like we've all escaped, that the island risks to sink to the bottom of the sea and stuff like that. Those who left did not escape but made a prudent choice based on the advice of civil protection	26
GdS	4	2003/01/04		Resident	Non si possono estrapolare frasi da discorsi complessivi sui rischi teorici e assumerli e divulgarli come evento incombente	You can't extrapolate phrases from complex discussions about theoretical risks, take them and portray them as a looming event	27
Rep	1	2002/12/31	14		Sballottati da Lipari a Milazzo, Aiuto, un'altra onda anomala	Tossed from Lipari to Milazzo: Help! Another freak wave	28
Sic	3	2003/01/03			È vero, da tempo i colleghi dell'Osservatorio Vesuviano hanno individuate nel ventre della parte sommitale dello Stromboli una camera magmatica superficiale del diametro di 300 metri circa. Ma da qui a dire che questa possa esplodere ce ne corre. Purtroppo l'organo di stampa in questione ha aggiunto enfasi allo studio scientifico, facendo allarmismo"	It's true, for a long time the Vesuvian Observatory identified a shallow magma chamber, of about 300 m in diameter, in the heart of Stromboli's summit. To say, from this basis, that it can explode is a bit of a stretch. Unfortunately, the press agency in question has added emphasis to such scientific studies, only exaggerates alarm	29
GdS	1	2003/01/03			"Può accadere di tutto"	Anything can happen	30
Sic	4	2003/01/05	4	Health minister	"Non è Pompei, troppo allarmismo fa più danno del vulcano stesso"	"It is not Pompeii, too much alarmism does more damage than the volcano itself"	31
GdS	1	2003/01/05	31		La Sciara del Fuoco sembra l'inferno di Dante	The Sciara del Fuoco looks like Dante's hell	32

Source 4: Population, which was separated between (a) resident (including guides and tourist operators), and non-resident (i.e., tourists).

These groups broadly follow the call down flow chart of Bertolaso et al. (2009) in which the reporting, assessment, decision making and communication chain for a natural disaster on Stromboli is given. However, this chain omits "journalists" (see Fig. 3 in Bertolaso et al., 2009) whose writing will reach, in the case considered here, nearly half a million people (Tabl 1).

Results and discussion

News regarding the crisis covered a total page space of 53,700 cm^2 across the five newspapers considered (Table 1). This is equivalent to an average of around 0.25 m^2 of information per day (over the three weeks study period) which was disseminated to almost half a million people. Of this content 12,000 cm^2 of information was contained in the two national newspapers to reach almost 400,000 readers, while 41,000 cm^2 of information was published in the three regional newspapers to reach just over 86,000 readers. Of these, the Gazzetta del Sud reported by far most news, accounting for 43% of the total page space devoted to reporting on the crisis across all five newspapers considered (Table 1). In total 173 reports appeared over the three week-long analysis period, with 138 reports appearing in the regional newspapers, and 35 appearing in the nationals. In all newspapers, peak coverage occurred on 31 December 2002 (Fig. 4). Although the

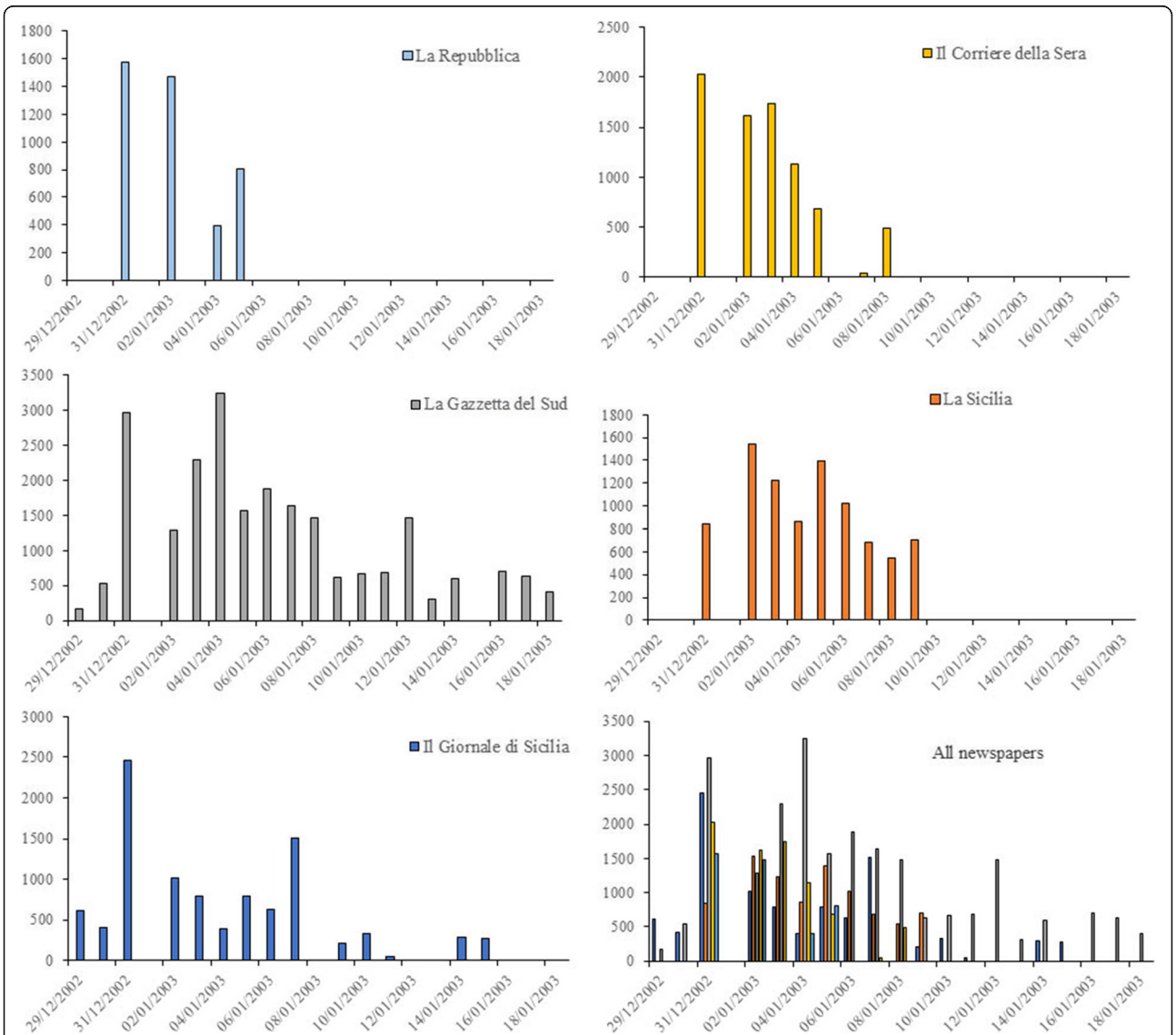


Fig. 4 Daily area of reporting in each newspaper (in cm^2) devoted to the Stromboli volcanic crisis between 28 December 2002 and 18 January 2003. The last plot is of the total for all reporting across all five newspapers

onset of the eruption was only reported in Il Giornale di Sicilia and La Gazzetta del Sud, all newspapers reported the flank collapse and tsunami of 30 December 2002, accounting for this first peak. A second peak in reporting occurred during 2–6 January (Fig. 4). Thereafter, reporting in La Repubblica, Il Corriere della Sera and La Sicilia died out, the last reports occurring on 5, 8 and 9 January in the three newspapers respectively; the crisis was, however, regularly reported in both Il Giornale di Sicilia and La Gazzetta del Sud through to the end of the study period (Fig. 4). Considering all newspapers, we see a rapid rise to peak reporting between 31 December 2002 and 4 January 2003, followed by a steady, waning trend through 18 January (Fig. 4). In terms of information sources, we counted a total of 281 citable sources, where information provision was dominated by scientists (41%) and the resident population and tourists (46%), with hazard managers being under-represented (Fig. 5).

National newspapers

The total space dedicated to the crisis in La Repubblica and Corriere della Sera covered areas of 4250 cm^2 and

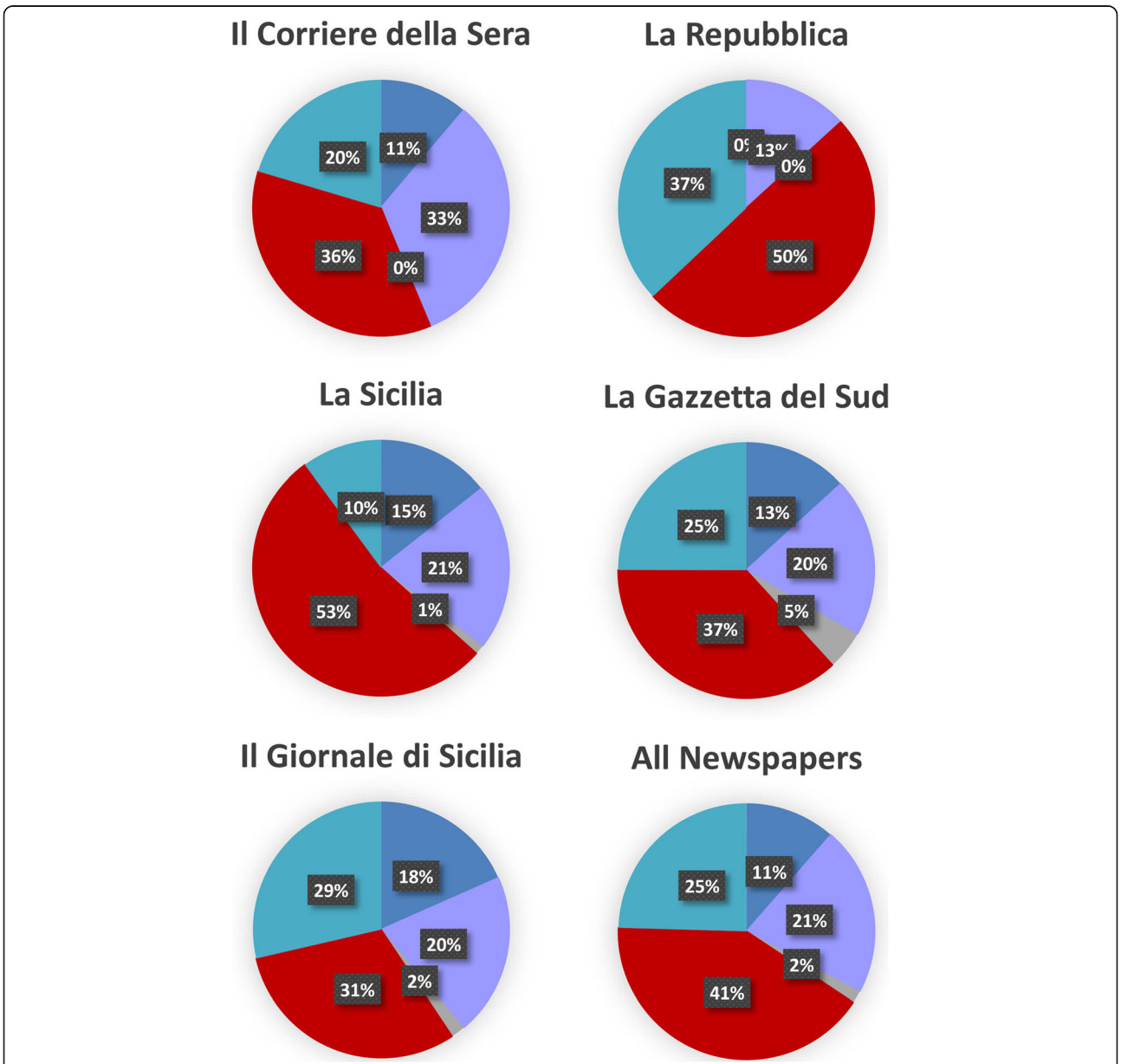


Fig. 5 Relative contribution of each source to all quotes in the newspapers. Red = Scientists; Blue = Miscellaneous (mostly tourists); Dark blue = Hazard managers; Purple = Population; Grey = Responders

8000 cm^2, respectively (Table 1). In both newspapers, the first article appeared on 31 December 2003 following the flank collapse and tsunami of 30 December, meaning that the onset of the eruption was not reported (i.e., the former event was considered newsworthy, yet the latter was not). Continued high levels of coverage were recorded through 5 January, and were related to follow-up on the tsunami event. Sources were dominated by scientists and the population / tourists, with hazard managers not being quoted at-all in La Repubblica (Fig. 5).

A total of 971 words were counted in La Repubblica, and these could be divided into 103 unique meanings, of which 17 words groups accounted for 486 (i.e., 50%) of all words used (Table 3). These words mostly refer to places/locations and involve terms related to natural phenomena and hazards, with the first four most common words being "*Stromboli-Volcano-Terror-Sea*"; "collapse" is 6th (with 35 uses) and "tsunami" 7th (30 uses), with "lava" being the only other eruption-related word at equal 14th (15 uses). Instead, a total of 1262 words were counted in Corriere della Sera. These could be divided into 121 unique meanings, of which 19-word groups accounted for 629 (i.e., 50%) of all words used (Table 4). These words, as for the La Repubblica, focused on places/locations and natural phenomena, with the first four being "*Stromboli-Tsunami-Volcano-Sea*"; after which the only two volcanic hazard words in the list were "landslide" (7th, 31 uses) and "collapse" (19th,17 uses). This reflects a focus on the flank collapse and tsunami, and its local impact, with the eruption itself receiving, instead, secondary attention. This trend was mirrored in the hazard words used in the two newspapers, where the top three were "*tsunami-volcano-landslide*" for Corriere della Sera and "*volcano-collapse-tsunami*" for La Repubblica (Fig. 6).

Descriptive words were almost entirely negative. Words such as "fear" and "alarm" appeared 40 and 12 times in La Repubblica. The same two words appeared 30 and 20 times in Corriere della Sera (Fig. 7). We see this effect in the overall word count, where "terror" was the third most used word in La Repubblica (Table 3). A few words with positive connotations, such as "hope" or "luck" appeared in La Repubblica, but only on three and two occasions, respectively. "Optimism" was the only positive word used in Corriere della Sera, a word that appeared just twice.

The reporting focus was thus on the landslide and tsunami, with the events described in negative and alarmist terms, in sensationalized phrases, as can be seen from the headlines and body text phrases themselves. Take the following examples,

Table 3 Top ranked words appearing in La Repubblica, with percentage of all words accounted for by each word group

Rank	Words	Counts	%
1	Stromboli Island	89	9.2
2	Volcano	48	4.9
3	Terror / Fear	40	4.1
4	Sea	38	3.9
5	Lipari	36	3.7
6	Collapse	35	3.6
7	Tsunami	30	3.1
8	Civil Protection	29	3.0
9	Sciara del Fuoco	25	2.6
=10	Stromboli Village	19	2.0
=10	Ship	19	2.0
12	Ginostra	17	1.8
13	Aeolian Islands	16	1.7
=14	Lava	15	1.5
=14	Port	15	1.5
=14	Coast	15	1.5
=14	Surveillance	15	1.5
Sum		486	51.6

Table 4 Top ranked words appearing in Corriere della Sera, with percentage of all words accounted for by each word group

Rank	Words	Counts	%
1	Stromboli Island	84	6.7
2	Tsunami	64	5.1
3	Volcano	55	4.4
4	Sea	43	3.4
5	Stromboli Village	40	3.2
6	Civil Protection	38	3.0
7	Landslide	31	2.5
=8	Ship	30	2.4
=8	Terror / Fear	30	2.4
=8	Expert	30	2.4
=11	Sciara del fuoco	27	2.1
=11	Residents	27	2.1
13	Lipari	24	1.9
14	Aeolian Islands	23	1.8
=15	Houses	21	1.7
=15	Civil Authorities	21	1.7
=15	Coast	21	1.7
18	Alarm	20	1.6
19	Collapse	17	1.4
Sum		629	51.2

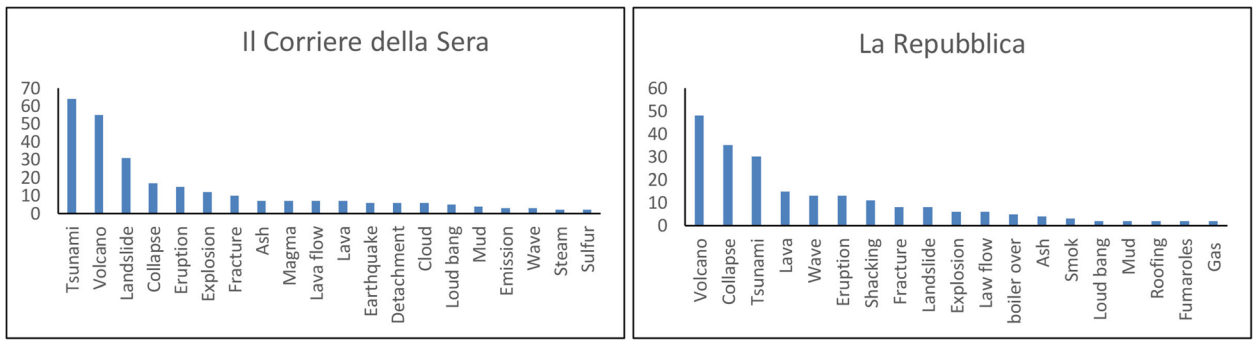


Fig. 6 Frequency distribution of hazard terms used in Corriere della Sera and La Repubblica

- "An anomalous wave terrorizes Stromboli" (Reference 1 (Abbruzzese, 1935), Table 2);
- "Explosion on the volcano, escape from Stromboli" (Reference 2, Table 2).

Journalistic style also resulted in construction of evocative phrases linked to famous historical books, for example,

- "It looked like the hell of the Divine Comedy" (Reference 3, Table 2);
- "A cloud from Dante's circle that floats in the air for an indefinite time and swoops down with force when it is by now mud" (Reference 4, Table 2).

Regional newspapers

Total space dedicated to the crisis in Gazzetta del Sud, Il Giornale di Sicilia, and La Sicilia was 24,000, 8600 and 8400 cm^2 in the three newspapers, respectively (Table 1). In both Gazzetta del Sud and Il Giornale di Sicilia, the first article appeared on 29 December reporting the eruption onset. In Gazzetta del Sud the eruption was announced with the front-page headline:

"Stromboli, record eruption. The lava flows into the sea" (Reference 5, Table 2).

Likewise, the front-page headline in Il Giornale di Sicilia read:

"Stromboli awakens" (Reference 6, Table 2).

Inside, the activity was compared with the effusive eruption of 1985 (References 7–9, Table 2). La Sicilia did not begin reporting on the crisis until the flank collapse and tsunami of 30 December, where reporting in all three regionals peaked on 31 December. Thereafter, Gazzetta del Sud and Il Giornale di Sicilia reported on the eruption through the end of the study period, but La Sicilia followed the nationals in only reporting until 9 January (Fig. 4). As with the national newspapers, sources were dominated by scientists and the population / tourists, with hazard managers again being underrepresented (Fig. 5).

A total of 3017, 1939 and 2065 words were counted in Gazzetta del Sud, Il Giornale di Sicilia, and La Sicilia, respectively. In Gazzetta del Sud, Il Giornale di Sicilia, and La Sicilia, 21, 13- and 19-word groups accounted for by 1537, 956 and 1030 (i.e., 50%) of all words used (Tables 5, 6 and 7). The words used between the three regional newspapers were similar, and the dominant themes were those of the national newspapers. In support of this, the top four words in Gazzetta del Sud, Il Giornale di Sicilia, and La Sicilia were:

- Stromboli Island, Tsunami, Lipari, Sea, Civil Protection (Table 5);
- Stromboli Island, Tsunami, Volcano, Civil Protection, Sea (Table 6);
- Stromboli Island, Tsunami, Sea, Residents, Civil Protection (Table 7).

The main volcanic hazard focused-on was, as in the national newspapers, collapse, tsunami and local impact, with the word "eruption" not appearing at-all in the most-used word group listings of Tables 5, 6 and 7. This, again, was reflected in the hazard words used in each of the newspapers, where the top three were "*tsunami-volcano-collapse*" for all three newspapers (Fig. 8). However, unlike in the national newspapers, the regional newspaper listings began to record words associated with disaster management and response, such as "civil protection", "residents", "evacuation", "surveillance" and "helicopter", as well as "boats/hydrofoil" (i.e., the means by which people can be taken off of the Island) (Tables 5–7).

All the same, as in the national newspapers, descriptive words were almost entirely negative, with "terror" and "fear" again placing highly (Fig. 7). Descriptive terms were also prone to exaggeration, the voluntary evacuation, for example, being termed an "exodus", the "great escape" or the "great emigration"; and events being

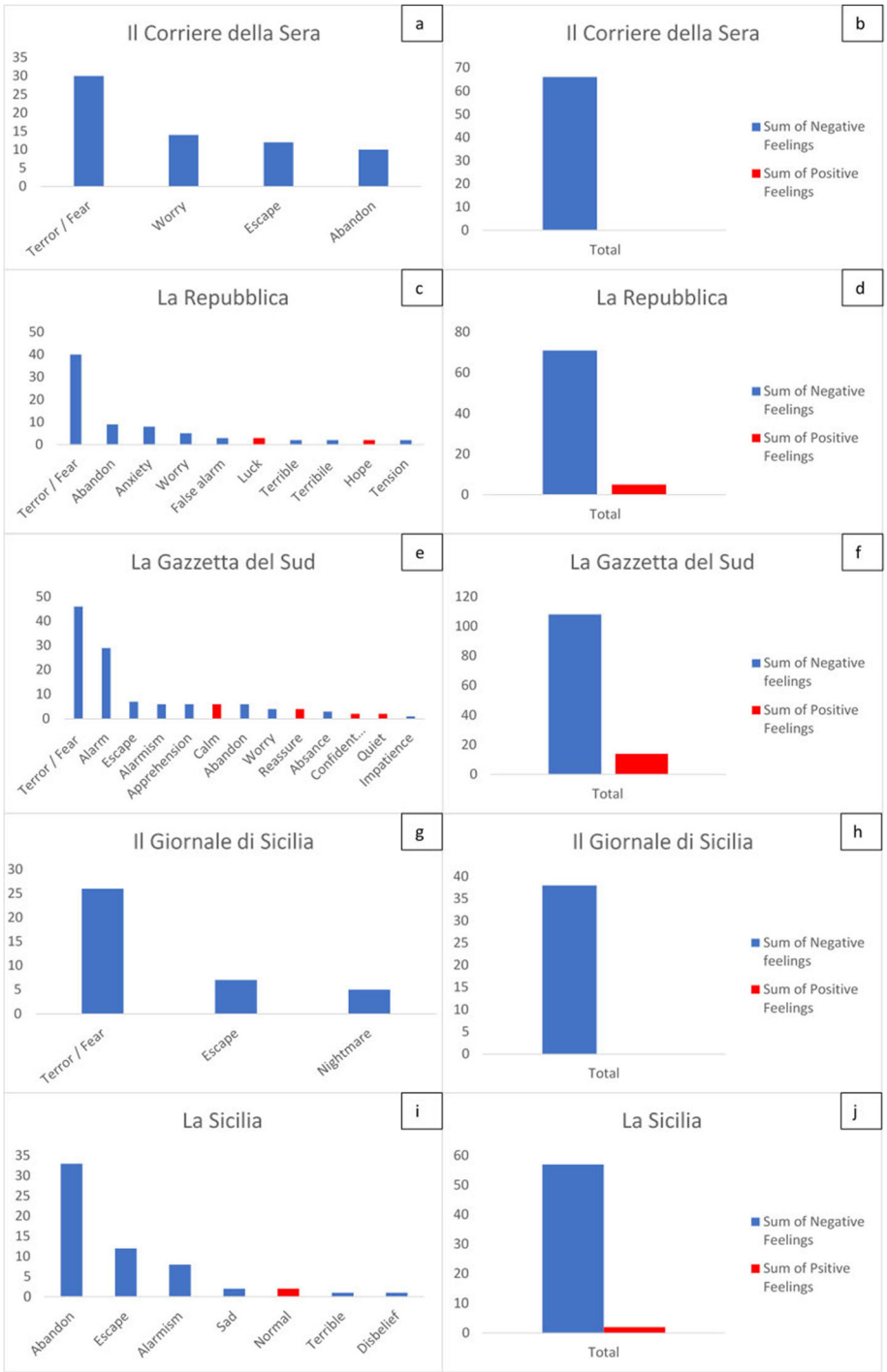


Fig. 7 Frequency distribution of all descriptive terms found in each of the five newspapers analyzed, with classification into "negative" and "positive" connotations

"apocalyptic". Again, this was reflected in the phraseology of headlines and body text. This can be seen, for example, in:

- "On the run from Stromboli" (Reference 10, Table 2);
- "Panic in the Aeolian Islands" (Reference 11, Table 2);
- "Terror in Stromboli" (Reference 11, Table 3).

We note, however, that the tendency to use negative, exaggerated terms only began after the events of 30

Table 5 Top ranked words appearing in Gazzetta del Sud, with percentage of all words accounted for by each word group

Rank	Words	Counts	%
1	Stromboli Island	291	9.9
2	Tsunami	143	4.7
3	Lipari	130	4.2
4	Sea	115	3.8
5	Civil Protection	104	3.4
6	Ginostra	78	2.6
7	Sciara del Fuoco	77	2.5
8	Residents	76	2.5
9	Stromboli Village	71	2.3
10	Volcano	62	2.0
11	Emergency	52	1.7
12	Aeolian Islands	48	1.6
13	Collapse	48	1.6
14	Terror/Fear	46	1.5
15	Yesterday	45	1.5
16	Phenomena	43	1.4
17	Helicopter	37	1.2
18	Messina	36	1.2
19	Damage	35	1.1
20	Lava	33	1.1
21	Landslide	33	1.1
Sum		1537	52.3

Table 6 Top ranked words appearing in Il Giornale di Sicilia, with percentage of all words accounted for by each word group

Rank	Words	Counts	%
1	Stromboli Island	262	13.5
2	Tsunami	110	5.7
3	Volcano	85	4.′
4	Civil Protection	81	4.2
5	Sea	76	3.9
6	Residents	56	2.9
7	Lipari	53	2.7
8	Ginostra	49	2.5
9	Sciara del fuoco	49	2.5
10	Experts	48	2.5
11	Boat	45	2.3
12	Collapse	42	2.2
13	Houses	42	2.2
Sum		956	51.5

Table 7 Top ranked words appearing in La Sicilia, with percentage of all words accounted for by each word group

Rank	Words	Counts	%
1	Stromboli Island	230	11.1
2	Tsunami	79	3.8
3	Sea	75	3.6
4	Residents	70	3.4
5	Civil Protection	66	3.2
6	Volcano	65	3.1
7	Collapse	55	2.7
8	Lipari	51	2.5
9	Sciara del Fuoco	48	2.3
10	Stromboli Village	44	2.1
11	Terror / Fear	36	1.7
12	Aeolian Islands	34	1.6
13	Landslide	33	1.6
14	Surveillance	30	1.5
=15	Evacuation	29	1.4
=15	30/12/2002	29	1.4
=17	Boat + Hydrofoil	28	1.4
=17	Lava flow	28	1.4
19	Earthquake	27	1.3
Sum		1030	51.2

December, whereas reporting on 29 December was more soberly phrased (cf. References 5–9 with 10–12, Table 2). This tendency was actually remarked on by interviewees where, for example, the mayor of Lipari was quoted as saying, on 3 January, "I want to say, with the utmost simplicity, to the media not to create unnecessary alarmism, not to try to amplify everything to chase the scoop" (Reference 13, Table 2; see also References 14–15). However, this did not stop the journalistic trend in which we continued to encounter phrases frequently containing the words "fear", "panic", "furiously", "terrible", and "freak" (e.g., References 16–15, Table 2).

Front pages

Out of the 53 newspaper editions analyzed, 44 reported the eruption of Stromboli in their front page. Of these front page entries, 12 were linked to the landslide risk (as the cause of an "anomalous wave"), followed by the tsunami itself (appearing 8 times), collapse (independent of wave generation, 6 times), the eruption (4 times), weather (3 times), lava (2 times), evacuation (1 time) and explosion (1 time). Analyzing the words in front page headlines, we obtain the following word frequencies (in order of most-to-least used words):

1. Stromboli (21 times)

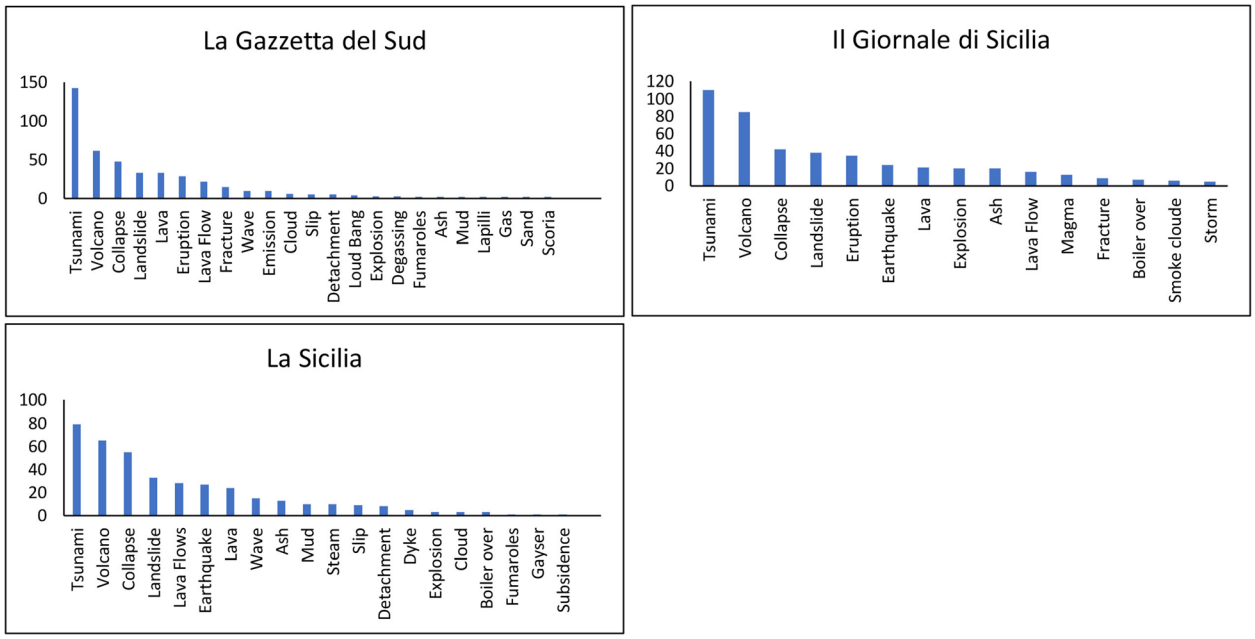


Fig. 8 Frequency distribution of hazard terms used in La Gazzetta del Sud, Il Giornale di Sicilia and La Sicilia

2. Risk (6 Times)
3. Tidal wave (6 times)
4. Fear-Terror-panic (5 times)
5. Alert (4 times)
6. Collapse (4 times)
4. Aeolian Islands (3 times)
7. Escape (3 times)

Thus, again, the key theme delivered by the front page was the landslide/tsunami hazard, with a frame of "fear", "terror" and "panic" being promoted, to engender the need to "escape"; with all words intimately tied to "Stromboli".

Twenty-seven of the front pages carried an image. These could be divided into four groups:

1. Volcano (13 cases): All images belonging to this group portrayed a cloud of steam rising from the sea at the ocean entry, with active lava flow on the Sciara del Fuoco. Predominant colors were the red-orange of the lava, the grey or purple of the cloud, and the dark colors (dark brown and black) of the Sciara del Fuoco.
2. Damage (3 cases): These images showed the damage caused by the passage of the tsunami, including boats turned upside down near the walls of houses and gutted houses. They were only shown on 31 December.
3. Evacuation (3 cases): These involved photos of people and means of transportation (helicopter, boats and trucks) used for the rescue, as well as the public figures involved in the response (such as the Mayor of Lipari and head of Civil Protection).
4. The Island (7 cases): This group portrayed Stromboli Island, taken from a distance (off-shore), showing a tranquil island under blue skies with calm seas.

Thus, unlike the text, front page imagery focused on the spectacular lava, the evacuation and the beauty of the island; a theme which was repeated in imagery used for inside page reports. The tsunami and damage thus became a secondary theme in the imagery used, with the main imagery (of categories 1 and 4) reflecting post-cards for sale on the island (Figs. 2 and 3).

Sources

In all five newspapers, there was four categories of sources of information:

1. Scientists, mostly from (Istituto Nazionale di Geofisica e Vulcanologia (INGV) and Centro Nazionale di Ricerca (CNR)) whose communications were divided into two types: quotes and interviews. In the quotes, information related to flank instability and the dynamics of landslides and tsunami were given, with verbatim interviews giving more detailed explanations
2. Government representatives (from Civil Protection, the municipality of Lipari and the Sicilian regional government), where bulletins regarding "action

plans" implemented for the "Stromboli emergency" were also quoted regularly
3. Rescuer actions (by Carabinieri, the fire department, Guardia di Finanza and the municipal police) to help island residents
4. Verbal histories from interviews of residents and tourists, focusing on their impression (feelings, perception) of the emergency

Statements from scientists took up 50% of the quoted material in La Repubblica and La Sicilia, compared to 30% in the three other newspapers investigated (Fig. 5). These differences reveal a more technical focus to reporting in La Repubblica and La Sicilia.

Framing actions

Our analysis reveals that two main hazard types were focused on during the first 3 weeks of Stromboli's 2002–03 eruption. These were the out-of-the-ordinary events: the landslide/collapse of 30 December, the ensuing tsunami, and the "evacuation". The more common explosive and continuing effusive activity were much less well represented (if reported-on at-all). Subsequently, all events became framed by reports that assumed alarmist tones; the reporting style being of a negative rather than positive tone, engendering "fear" and "terror". This was in spite of an apparent use of sources that focused on scientists, as well as hazard managers and the local population who, at times, were actually quoted as asking the journalists to tone the reporting down.

Landslide/collapse frame

Although the onset of the eruption itself was only reported in two of the five newspapers considered, the events of 30 December 2002 appeared in all newspapers on 31 December 2002. On this date, several statements by experts appeared explaining the dynamics of the collapse, where some of these statements were linked to illustrative sketches to help readers understand the phenomenon: as, for example, on page 14–15 of La Repubblica on 31 December. Other images, instead, showed spectacular views of the Sciara del Fuoco with clouds of white steam and red/orange lava flows, consistent with the postcard image of Stromboli (Fig. 2).

With the second collapse on 3 January 2003 (which did not actually generate a tsunami), the frame changed. News regarding the second landslide appeared in all newspapers on 4 January with alarmist titles such as,

> *"A new landslide: hours of fear in the Aeolian Island"* (Reference 16, Table 2),

or

> *"Stromboli, overwhelmed by panic - Two new landslides, all fleeing: Aeolian now it is psychosis"* (Reference 17, Table 2).

Negative words including "fear" and "terror", or phrases such as "high tension" and "anxiety" also began to dominate the text of the regional newspapers.

Tsunami frame

The tsunami was characterized by images showing the damage caused by the waves, including pictures of damaged boats and houses, streets covered with debris and images of wounded people. This event was negatively framed, by newspapers, with headlines all carrying negative descriptors, such as,

> *"Freak wave terrorizes Stromboli" (*Reference 1 (Abbruzzese, 1935), Table 2);
> *"Panic in the Aeolian Islands"* (Reference 11, Table 2); and
> *"Terror in Stromboli"* (Reference 12, Table 2).

The description of the tsunami was mainly reported through the eyes of the residents and tourists, the tsunami being framed as an "apocalyptic" event heralding the "end of the world". The "end of the world" frame was fueled by the exaggerated and poetic style employed by the journalists themselves. For example, one report contains the following description:

> "... the wave ends with a biblical backwash, it gains strength and furiously crashes against the coast, breaking like a tidal wave. This apocalypse started at the fiery Sciara" (Reference 18, Table 2).

Similarly-worded reports can be found across all three regional newspapers examined here, in which use of phrases such as "apocalyptic scenes", the "fury of the elements", and the "rage of fire and the sea" were common. Some articles included superlative-filled eye-witness accounts to support the frame, such as:

> "I saw the wave. Very high, immense, powerful. Like in a movie … " (Reference 19, Table 2; see also Reference 20).

Comparison with previous events was made by the newspapers, in particular with the tsunami generated by Stromboli's eruption of September 1930. However, this was a very different event to that of 2002 and was associated with a paroxysmal explosion associated with pyroclastic density currents that stopped just short of Stromboli village, and tephra fallout which were the cause of four deaths, several injuries, and fires; with the

tsunami coincident with the explosion accounting for a further two fatalities (Maramai et al., 2005). The 1930 event was, truly, terrifying (La Colla, 1930), and has been ascribed to a depopulation of Stromboli, where the population fell from 2500 to 659 people between 1911 and 1951 (Archivio Storico Eoliano). Based on the comparison with the 1930 lethal event, these negative images were (unjustly) associated with the 2002 eruption, giving little comfort to an already "frightened" population. For example,

> "In the last century the volcano had sown death and terror. Here is the chronicle of that terrible morning …" (Reference 21, Table 2).

Expert statements were reported in less alarmist tones, but quotes confused the readership by highlighting conflicting views among the experts regarding tsunami definitions and possible dynamics. This is a known problem when scientific debate and disagreement is carried out in public during a volcanic crisis (cf. IAVCEI, 1999; Fiske, 1984), where it is the "media appeal of one scientist versus another" that counts. Our study, also, highlights how different words like tidal wave can be used as synonymous by a journalist for a tsunami, when in scientific terms the words do not have the same meaning and in hazard/risk terms very different connotations. This leads to further confusion in the intended meaning of the message released by the experts.

As a result, almost all of the quotations from Island residents pointed to tsunami and the sea (rather than the eruption and the volcano) as their main source of concern. This can be seen, for example, in a statement appearing in Il Giornale di Sicilia on 4 January 2003:

> "No, the volcano does not scare me, he has nothing to do with it; it is the sea that causes me fear".

However, more optimistic declarations were also present:

> "We saw a huge wave arrive that overwhelmed everything and everyone. Fortunately, there were no victims. It could have been a tragedy. That's the way it goes" (Reference 22, Table 2).

Or

> "… The tidal wave? I remember the tidal wave of 31 December, it destroyed the jetty at Scari. But after that everything returned to normal, and the same will happen again this year. *The major source of damage will more likely be the misinformation from the television news rather than the events related to the volcano*" (Reference 23, Table 2).

However, such statements were generally eclipsed by the alarmist and sensationalist tone of the writing regarding the tsunami hazard, which failed to link the hazard to the on-going eruption.

The evacuation frame ("escape from Stromboli")

News of the "evacuation" of Stromboli, which was later clarified as a voluntary evacuation by Civil Protection (Bertolaso et al., 2008a), appeared in all newspaper issues on 31 December 2002. Phrases used to describe the evacuation, besides using the word "escape", were often accompanied by words like "panic" or "terror". Some journalists described it as "the great migration" or an "exodus".

Most of the reported quotes pointed to a confusing picture. On 31 December 2002 La Repubblica reported a statement from the Civil Protection in which a voluntary evacuation plan was described ("A voluntary evacuation plan was triggered" ...). Instead, on 2 January 2003, no mention of evacuation was made, but instead the following statement was given:

> "Houses close to places where collapses can occur and houses that could be hit by boulders have been abandoned. There is no evacuation order, but we are considering prohibiting access to the Island .... Of course, those who have left will want to come back, but we advise people to stay away" (Reference 24, Table 2).

Some statements by the Mayor of Lipari also indicated that there was no evacuation in place, but residents were invited to leave the Island as a preventive measure. In Corriere della Sera, an interview with of one of the residents regarding the evacuation reported that the "voluntary evacuation was more like a forced pack-up and follow of the first 11 volunteers". The frame thus assumed a negative tone due to the confusing information and naturally resistant motives among the residents. For example, one resident was quoted as saying,

> "Extreme fear. Now many leave. But how do you leave our home, our Island? It is here that we have everything ..." (Reference 25, Table 2).

What was not communicated was that scientists, civil protection and the mayor of Lipari were, during the last days of December 2002 and first days of January 2003, working in close collaboration to implement an effective response and surveillance plan (Bertolaso et al., 2008a,b, 2009); resulting in what can be regarded as one of the

most dense monitoring arrays on the planet and a blueprint for surveillance. However, inconsistencies and apparent disagreements between various actors did not help clear this issue up. For example, Corriere della Sera noted disagreement between two experts regarding the instability of the Sciara del Fuoco and on the possible occurrence of other collapses (Corriere della Sera, 31/12/2002, p. 9) writing that "*the statements issued by the two experts, however, are not perfectly in tune*". Likewise, a report published on 3 January 2003, entitled "Explosion Risk? - Separated Scientists" (Giornale di Sicilia, 03/01/2003, p. 3), focused on the different points of view of two scientific groups regarding the potential for a flank failure to generate a major explosive event (see Reference 29 of Table 2). The result was a feeling that "*anything can happen*" (Reference 30, Table 2).

Attempts to address the alarmist frame

Many statements published by the newspapers themselves after 2 January 2003 actually contained complaints against the journalists for creating alarmism and for giving erroneous information about the event. In La Sicilia, for example, statements relating to the quality of the reporting appeared multiple times. On 3 January 2003, the mayor of Lipari accused the journalists of creating too much alarmism and of amplifying the news to increase newspaper sales (Reference 13, Table 2). On 5 January 2003, the health minister accused journalists of damaging Island tourism and the economy (Reference 31, Table 2). In angrier tones, one of Stromboli's residents declared:

> "We're pretty 'pissed off' with journalists because they keep writing nonsense, like we've all escaped, that the Island risks to sink to the bottom of the sea and stuff like that. Those who left did not escape but made a prudent choice based on the advice of civil protection." (Reference 26, Table 2).

In both Il Giornale di Sicilia and La Gazzetta del Sud, residents accused journalists of damaging the Island economy with their "inflated articles" (Reference 32, Table 2) in which they were accused of depicting Stromboli as "a bomb" ready to explode. For example, one resident was quoted as saying,

> "You can't extrapolate phrases from complex discussions about theoretical risks, take them and portray them as a looming event" (Reference 27, Table 2).

Further factual inconsistencies were found in our analysis, and these may lead us to further question newspaper credibility during reporting of the crisis, and these are given in Supplement 2. However, whatever the pressure, all newspaper agendas remained unaltered, with slant and spin remaining alarmist, sensationalist and unsupportive of attempts to calm a "*frightened*" population.

Discussion sum-up

News media are always interested in human stories and conflict, and less so on geophysical events and natural processes, unless they are of particularly high magnitude or impact (Harcup 2009; Harris 2015). Indeed, bad news (stories with negative overtones, such as conflict, tragedy, chaos, confusion and/or suffering), especially involving the "power elite" (i.e., powerful individuals, organizations or institutions) are two of the ten main new values listed by Harcup (2009) as being applied by modern news agencies. As a result, reporters will focus on conflicts between scientists and agencies/institutions, claims about impacts (especially economic), and the suffering of local and visiting (tourist) populations. Thus, it is essential to avoid such conflict in public, which will provide the reporter with the required news value to generate "a story". At the same time, though, the reporter will need to (indeed must and has to) use a language that is not only accessible, but also readable, understandable and entertaining for the layperson. Thus, such language must be used in communications, a language that recognizes the translation need of the media filter. Social media has emerged since the 2002–03 Stromboli crisis as the immediate means of communicating and framing a natural disaster (Williams and Krippner, 2018), as have near-real-time news streams. However, these suggestions equally apply for social media (e.g., individual—tweet style, messages from in-house scientists), press releases, and on-line situation reports. That is, there is a need for all scientists involved in the crisis to echo the same message in terms of situation-reality, rather than voice their own interpretations and disagreements. Scientific debate, albeit healthy, must be kept in-house during the crisis and response itself, and the temptation to trump rival scientific findings avoided. Probably, a press office linked to a regularly uptodated and centralized information site, where the population and journalists know they can find usable, reliable and suitably written/framed information is a good idea (as pointed out as early as in 1999 by the IAVCEI Subcommittee for Crisis Protocols). Because scientists and responders are usually too busy to deal with such outreach during a crisis, it is a recommendation that a competent office (or outreach officer) needs to be charged with this dedicated role, with information provided via a suitably designed and attractive web-site (Christensen, 2010). Scientific publication can then follow, once (as a community together) we have dealt with the crisis.

In the case examined here, the accusations of alarmism from Stromboli's residents are also likely a result of the damage such a frame makes to livelihoods, especially if tourists are frightened away from a small island dependent on tourism. Such an effect was found by Donovan et al. (2018) after the non-eruption of Zao in Japan in 2014–15 where people complained about "rumor damage" from the media and linked this to a lack of robust scientific information from government entities. These issues will be inflated by lack of information, or clarity of information, from the responsible institution; which was case for Stromboli's 2002–03 eruption where information was not reported or communicated by the monitoring and responding community in a clear or consistent way.

In the long run the event did, however, increase awareness of volcanic hazard on Stromboli, and led to changes in hazard management on Stromboli, an enormous improvement of the monitoring network and response system, communication, signage, outreach and education (Bertolaso et al. 2008a, b, 2009). As a result, it seems that, from a cursory analysis of the news media during the events on Stromboli during the summer of 2019, this has had a positive effect (see Appendix). Thus, to assess the effects of improved communication since the 2002–03 eruption, implementation of a content analysis (following the model laid out here) of media-based information sources before and after content analyses, as well as discourse analysis, should be applied to the 2019 eruption.

Conclusion

The coverage of Stromboli's 2002–2003 eruption by the five newspapers considered here was mostly dictated by the scoop-potential of the event. Indeed, the first, low profile effusive phase (28 December 2003) was not deemed sufficiently newsworthy to be covered in three of the five newspapers, including one of the regionals that cover Stromboli in its catchment. The events were likely not sufficiently "out-of-the-ordinary" considering Stromboli's persistent activity. They were deemed simply as a repetition of the 1986 eruption (Reference 7, Table 2), thereby not meeting the news values that would select the event for publication. However, on 30 December 2002 two unexpected, spectacular and damaging events, a landslide and a tsunami, occurred. These two high-impact events were the cause of a sudden increase in reporting, because the events met the news values of all five newspapers. However, this sudden increase in reporting was also associated with exaggeration and sensationalism, the events often being portrayed in poetic and apocalyptic terms.

Further, the scientific sources, despite their widespread use (up to 45% of information sources in some cases) were reported confusingly and in terms of conflicting opinion and argument. The majority of quotes were set-up in an "alarmist" or even "catastrophic" manner, with strong, negative words such as "apocalypse", "hell", and "fear" used as descriptors. A greater amount of material from the hazard management grouping (i.e., government representatives), which typically made up less than 20% of the quoted material, may have aided in setting the record straight. However, this may not have helped—as even self-confessed alarmism and exaggeration (i.e., published complaints about the tone of the reporting) did not affect the reporting slant and spin. Thus, even in well-informed journalism, the newspaper agenda may be so entrenched that reporting in support of effective hazard management may be impossible to expect.

From the analysis of the Stromboli case it appears that newspaper treatment of surprising or out-of-the ordinary events may help with exaggeration and sensationalism. This will be accentuated in national media sources, who will not report the more mundane events, but instead will focus on the out-of-the-ordinary, as was the case here for the under-reporting of the onset of lava flow, but full reporting of the landslide and tsunami. Thus, in such cases, we may need to prepare for, and to some degree expect, little support from the media toward a correct framing of the hazard, or any help to coordinate and ease the population through appropriate hazard communication, at least in the case of Stromboli. In this context, it is particularly important to use an adequate language that can be understood by the great majority of the population with a minimum content of technical words that can be mis-translated or mis-defined. The high credibility of the scientific group in charge of the risk evaluation and recommendations is essential for a quick response to warning and for the success of an emergency plan. To prevent information mishaps, it is thus best to also keep scientific debate in-house, and seek out a one-voice spokesperson so as to give a single univocal message, while avoiding handing the media material to further exaggerate the catastrophe frame (e.g. Harris, 2015; Harris and Villeneuve, 2018a, b). This view is also shared in literature by, for example, Hincks et al. (2014) and has long been proposed as one of the pillars of risk communications for people in charge at Volcanological Observatories (IAVCEI Subcommittee for Crisis Protocols, 1999).

The media play an increasingly important, sometimes negative, role in hazard management, as there is a tendency to over-emphasize any discrepancy between scientists or between scientists and authorities. Therefore, the spokespeople of the scientific group and the authorities become crucial in conveying the best estimate of any dangers and existing countermeasures. In transmitting this information, spokespeople should take into account

that the attitude of the local media is generally different from those that have national scope, as highlighted in this study. In fact the regional newspapers described the events of 2002–2003 with more alarmist and negative tones, thus causing problems also for the economy of the Island. However, as indicated by Kitzinger and Reilly (1997), reporting risks and event responses to the mass media needs to be influenced by what journalists perceive to be relevant to themselves, their audiences and their editors (Kitzinger, 1999).

Appendix

Note added in correction

While this paper was in review/correction, two paroxysms occurred on Stromboli on 3 July and 28 August 2019, respectively. Both fed plumes to several kilometers in height and generated pyroclastic density currents that advanced 1 km from the coastline, while the subsquent fallout of incandescent pyroclastic material rapidly igniting vegetation on the flanks of the volcano, resulting in one fatality. On the day of each event, we made a cursory analysis of the on-line stream of news from Il Corriere della Sera, La Repubblica, and La Gazzetta del Sud, as well as the website hosted by the Italian television news channel, RaiNews (http://www.rainews.it/). We found many improvements in the presentation of the news. The changes were particularly evident in La Gazzetta del Sud and on the Rai-News site, in which the news was reported in a more objective, correct and technical way, with less alarmist tones and sensationalist frames. For example, on 03/07/2019, Rai-News posted a factual piece entitled "Stromboli, explosions from the crater: one dead and one injured. Some tourists escape to the sea." (esplosioni dal cratere: un morto e un ferito. Alcuni turisti scappano in mare). On 28/07/2019, a posting was made under the equally objective heading: "Strong explosion at Stromboli, lots of fear but no one injured" (Forte esplosione a Stromboli, tanta paura ma nessuno ferito).

Most news sources also appeared to know where to go for appropriate, well-informed quotes (including Università di Firenze-LGS, INGV, Università di Roma, and Civil Protection). For example, on 03/07/2019 Rai-News posted a technical piece entitled "Stromboli, INGV: explosions among the strongest ever registered" (explosion tra più forte mai registrate). Likewise, Il Corriere della Sera website led with "Stromboli trembles, explosions from the crater: excursionist dead, another injured. Tourists in the sea" (Trema Stromboli, esplosioni dal cratere: escursionista muore, un altro è ferito. Turisti in mare, downloaded 03/07/2019). Associated images were of the on-going phenomena (the plume, pyroclastic density currents, lava flows and fires), and those of the island were actual, i.e., showing Stromboli under shrouded in smoke and gray/brown fume, with the plume towering above the island and pyroclastic flows running away from it. Follow-up on 04/07/2019 involved report of a small (magnitude 2) earthquake during the night, a suitably respectful obituary for the lost hiker, and situation reports regarding the fires and response (including dispatch of a large coastguard cutter and fire-fighting planes (Canadair fire bomber CL-415).

It has to be noted, though, that these events were very different from those accompanying the 2002–2003 eruption. The events were major explosions with high (> 4 km) eruption plumes and far-reaching (for an island just 5 km wide) pyroclastic density currents with sudden onset which, as in the headline of Il Corriere della Sera of 29 August 2019: "Stromboli, fear and anger", genuinely and naturally did instill fear (and an element of anger and frustration, as this was the height of the lucrative tourist season). Measures regarding restrictions were well, clearly, consistently and correctly communicated. Interviews reported with residents during these two paroxysms also underlined that the greatest fear was the tsunami (rather than the volcano). However, expert quotes (following the reaction of tourists on the beach on 03/07, who ran into the water to escape) pointing out that, as hard as it is to do given the ongoing eruptive event, one should run towards the volcano and uphill; as the biggest threat is the tsunami that will arrive from the sea (RaiNews, 03/07/2019). Especially in regards to the tsunami hazard. It has to be noted that, after the events of 2002–2003, there was a major effort to improve the monitoring array, especially in regards to the tsunami hazard, and to improve communication, signage and education. This, along with the memory of the 2002–03 (as well as the 2007) events, appears to have led to a more informed approach by journalists, as well as the sources, to result in the media outlets analyzed evolving into a much-improved information source.

Supplementary information

Supplementary information accompanies this paper at https://doi.org/10.1186/s13617-020-00094-0.

Additional file 1. Frequency of word

Additional file 2. Inconsistencies that support credibility issues

Additional file 3. Features of Newspapers selected for content analysis

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Availability of data and materials

Additional file 1 Frequency of word.
Additional file 2 References and quotes from Newspapers.
Additional file 3 Features of Newspapers selected for content analysis.

Competing interests

The authors declare that they have no competing interests.

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