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Impact of the Eyjafjallajökull ash cloud: A newspaper perspective

Andrew J. L. Harris,[1] Lucia Gurioli,[1] Elizabeth E. Hughes,[1] and Sandra Lagreulet[1]

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[1] We carried out a content analysis of eight national newspapers published during a 10-day period spanning Eyjafjallajökull's 2010 air space closure. Our intent was to understand the amount and type of material published, and the contribution of volcanologists and emergency responders to this material. We selected the best selling broadsheets and tabloids from the UK, France, Italy and USA. A total area of 135,000 cm^2 was devoted to Eyjafjallajökull. Of this, 33% dealt with social themes, followed by volcanological (24%), economic (17%), response (13%) and airline (8%) issues. If, however, we examine the sources providing information we find a very different situation. Altogether, 669 sources were cited as giving quotes, of which 33% were credited to the air industry, followed by public (22%), politicians (12%), volcanologists (9%), responders (8%) and economists (2%). We also recorded all word descriptors for the ash cloud and its effects, with a total of 5380 words being logged. Negative words were the most common, with *stranded* having the highest frequency (180); *chaos* appearing 57 times. Coverage, thus, tended to feature quotes from the air industry, and carry a negative air; at times being confusing and contradictory. This, coupled with the fact that volcanological pieces tended to be placed well down the reporting order, meant that the message was of a *chaotic* situation and response, the performance of those who could be ascribed blame, i.e., responsible government agencies, thus likely being perceived in a negative light.

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1. Introduction

[2] On 14 April 2010 a relatively small explosive eruption from Eyjafjallajökull, an ice-covered volcano in southern Iceland, released an ash cloud that drifted into transatlantic and European air routes [*Gudmundsson et al.*, 2010]. Due to the proven and detrimental effects of volcanic ash to aircraft operations [e.g., *Bernard and Rose*, 1990; *Kienle et al.*, 1990; *Casadevall*, 1994; *Grindle and Burcham*, 2002], the spread of Eyjafjallajökull's ash into some of the most heavily used air lanes in the world prompted large scale closure of European and Trans-Atlantic air space, along with many European airports, between 15 and 20 April [*Gudmundsson et al.*, 2010]. Scientific communications and advances using data for this event were numerous (as witnessed by this special issue), and also immediate [e.g., *Showstack*, 2010]. These communications in the scientific literature will influence the thoughts of practicing researchers, hazard managers, university professors and their students. However, the widespread disruption that this event caused to air travelers and society, along with the associated business and economic losses, prompted a massive media reaction. The event and its consequences dominated newspaper front pages across Europe and the United States for several days following the first day of the air space closure. A cursory analysis of the best selling newspapers in the UK, France, Italy and USA shows that the potential for dissemination of information about volcanoes (including eruptions, their effects, hazards, hazard assessment and response capabilities) caused by the Eyjafjallajökull eruption was enormous. For example, Note 1 of Text S1 of the auxiliary material shows that between 10 and 30% of front page space was devoted to Eyjafjallajökull on 16 April 2010 alone.[1] The resulting public knowledge regarding the volcano, its eruption and the impact of the ash cloud was subsequently high; with the newspaper content immediately influencing the thoughts and opinions of millions of people beyond the scientific community.

[3] Television-, radio-, newspaper- and web-based media will be the primary source of information that determines the view of an ongoing natural, political, social or economic event for millions of people [e.g., *Galli and Nigro*, 1987; *Gamson and Modigliani*, 1989; *Robinson et al.*, 2009; *Aday*, 2010; *Dixon*, 2008a, 2008b; *Bennett et al.*, 2006; *Porpora et al.*, 2010]. It will also influence the perception of the same population to the way in which the event was handled by those perceived as *responsible* for understanding, monitoring, tracking and managing the effects (we define this

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[1]Auxiliary materials are available in the HTML. doi:10.1029/2011JB008735.

group later, upon completion of the content analysis – see section 4.4). Thus, the media response cannot just be used as a measure of the societal importance of an event to an enormous population, but it can also be used to determine who those perceived as *responsible* were, and whether the *responders*, their actions and results were cast in a negative or positive light. Alongside this, we can determine whether there was *content bias* [e.g., *Entman*, 2007]. That is, was there dissemination of news favoring the opinion of a particular group when more than one opinion or argument was raised? In our case we can assess reporting of the opinion, or argument, of the *responders* versus those of any opponents.

[4] We can use content analysis of the popular information sources to examine the amount, type, quality and source of information that the *population* received; so allowing us to search for potential content bias in framing the event. To achieve this we carried out a content analysis of the most well known and widely read newspapers across Europe and USA, our aim being to provide a quantitative measure of (1) the amount, type and consistency of information provided, (2) those people (and their affiliations) linked to the information, and (3) the status of the volcanologist and responder in the dissemination process.

[5] We also compiled a series of dictionaries to allow us, using the words contained within each dictionary, to assess the content and weight (positive or negative) of descriptive statements made in each newspaper. Our results show that, although the event was possibly one of the most extensively covered volcanic events of the 20th and 21st centuries, volcanologists played a rather minor role in shaping the reporting process; so that framing and content bias supported of other interests.

2. Content Analysis

[6] Content analysis is a methodology commonly applied in the social sciences to extract information from written or oral communication. The earliest content analyses focused on newspapers, and later spread to analysis of books, comic strips, speeches and advertising [*Krippendorff*, 1980]. This included content analyses of broadcasts in Nazi Germany, by various groups in the United States, with results being used to understand and predict events in Germany during the Second World War, as well as to estimate the effects of military actions on war mood [*Krippendorff*, 1980]. Early content analysis of newspapers included their use to examine trends in the type of information given through time [*Speed*, 1893], and emerging levels of circulation and types of subject matter covered [*Willey*, 1926]. These initial studies had, in effect, the same as aims as ours, these being to (1) examine the levels of coverage and type of subject matter being reported, (2) to examine reporting trends in space (i.e., between newspapers and countries) and time, and (3) to determine the likely impact of the newspaper content on the reader.

[7] *Holsti* [1969] pointed out that definitions of content analysis have changed through time depending on the nature of the problem addressed and the type of material used, listing six definitions. Our approach is closest to the definitions of *Berelson* [1952] and *Holsti* [1969]. *Berelson* [1952, p. 18] defines content analysis as "*a research technique for the objective, systematic, and quantitative description of the manifest content of communication*." *Holsti* [1969, p. 3] adds that "*content analysis is a phase of information-processing in which communication content is transformed, through objective and systematic application of categorization rules, into data that can be summarized and compared*." Our methodology obeys both of these definitions, where we apply a series of rules to extract information from newspaper content to allow an examination of the amount and type of subject matter covered.

[8] By building and examining dictionaries (i.e., lists of key descriptive and factual words [*Weber*, 1990]) for each newspaper, as well as lists for cited information sources, we can objectively assess the type, weight and source of information given without reporter bias. The focus and tone of the report as reflected by the words used will, in turn, be influenced by the information sources used by the reporter. Different sources will have different perspectives depending on their area of expertise and interest. As a result, inclusion of statements and information provided by sources with one expertise type may force a different bias into the reporting than if a second expertise grouping is used. For example, a report dominated by quotes from the airline industry will have a very different content, theme and message to one dominated by quotes from volcanologists, passengers or economists.

[9] Thus, by determining the type information contained within each report and the relative contribution of various groups to the content of the report, as well as the strength of the statements issued by each group and positioning of those statements within the newspaper (front page or inner pages), we can determine the relative influence of the report content. Hence, we can make appraisals as to the likely impact of that material on the readership. In this way, as suggested by *Krippendorff* [1980], we move beyond basic column space measurements, and instead code the information content contained within the text to "*make replicable and valid inferences from the data*" [*Krippendorff*, 1980, p. 21].

2.1. Methodology

[10] There are a number of classic textbooks that cover methodologies in content analysis, including *Holsti* [1969], *Krippendorff* [1980] and *Weber* [1990]. Though now old, the basic principles and methodologies laid out in these texts remain valid, and we largely follow those given by *Weber* [1990]. Guidelines provided by these texts recommend three basic methodological steps: (1) target a data set capable of (and suitable for) providing the required information, (2) code the content of the selected communication in a way that allows extraction of the required information, and (3) analyze the results to draw inferences regarding the communication and its impact, this being *Krippendorff*'s [1980, p.26] "*basic intellectual task*" of content analysis, while (4) testing the data for validity.

2.1.1. Target Data Sets

[11] To complete our content analysis we selected newspapers from three European countries spanning the proximal, medial and distal air-space closure. These countries were, along an approximately NW-SE trending line extending from the ash cloud source in Iceland to the Mediterranean: the United Kingdom (UK), France and Italy. Because transatlantic aircraft operations were also effected, we also selected one newspaper from the United States. For

Table 1. Circulation, Format and Publication Details for Newspapers Selected for This Content Analysis

Country	Newspaper	Circulation (newspapers per day)	Country Population[a]	Number of Pages[b]	Page Area[c] (cm^2)	Eyjafjallajökull Area[d] (cm^2)	Publication Notes
USA	USA Today	1,900,000[e]	312,589,685 (0.6%)	31[f] (26 to 44)[f]	58 × 30.5 (1769)	7803 (14%)	Not published on Saturday or Sunday
UK	The Sun	3,007,000[g]	62,300,000 (4.8%)	77 (56 to 92)	28.5 × 37 (1055)	30,799 (38%)	Not published on Sunday
UK	The Daily Telegraph	690,000[g]	62,300,000 (1.1%)	33 (32 to 36)	57.4 × 37 (2124)	18,688 (27%)	Different Sunday format
UK	The Times	510,000[g]	62,300,000 (0.8%)	86 (68 to 112)	29 × 36.6 (1061)	28,352 (31%)	Different Sunday format
France	Le Figaro	320,000[h]	65,026,885 (0.49%)	18	47.3 × 31.6 (1495)	13,058 (49%)	Not published on Sunday; not available 21–22 April 2010[i]
France	Le Monde	314,000[h]	65,026,885 (0.48%)	26	46.8 × 31.9 (1493)	1766 (5%)	Not published on Sunday; not available 22–25 April 2010[i]
Italy	La Repubblica	586,000[j]	60,340,328 (0.97%)	66 (56 to 72)	48 × 35.2 (1690)	15,220 (14%)	
Italy	Corriere della Sera	515,000[j]	60,340,328 (0.85%)	62 (55 to 71)	44 × 31.5 (1386)	19,113 (22%)	Not available 21 April 2010[i]

[a]Values in parentheses are the percentage of population reached. Population sources: USA, US Census Bureau (http://www.census.gov/population/www/popclockus.html, downloaded 11-11-11 at 09:43 UT); UK, Office for National Statistics (Statistical Bulletin: Annual Mid-year Population Estimates, 2010, released 30-06-11); France, Population totale par sexe et âge au 1er janvier 2011, France, Institut national de la statistique et des études économiques; Italy, Istat.it (http://demo.istat.it/index_e.html, downloaded 11-11-11 at 10:15 UT).
[b]Average value for study period, with range in parentheses.
[c]Value given for daily (Monday-to-Friday) edition.
[d]Also given is the total area devoted to Eyjafjallajökull during the 10 days spanning 15 April 2010 to 24 April 2010. Values in parentheses are the percentage of each paper this area would comprise if appearing in a single issue (of average page length).
[e]Average circulation for September 2009.
[f]Value for Sections A (News), B (Money) and C (Sports).
[g]Average circulation for January 2010.
[h]Average circulation for 2006.
[i]Not printed on these dates due to strikes.
[j]Average circulation for 2004.

each country, we analyzed the most popular national newspapers (by circulation), so as to assess the information received by the largest readership in each of the selected countries. The key attributes of each selected newspaper are given in Table 1. Many of the UK newspapers typically have different and longer formats on a Sunday. In addition, many of the newspapers selected were not published on a Sunday (see Table 1). We thus excluded Sunday publications from our analysis. For each newspaper, all newspapers spanning a 10-day period beginning on the first day of air space closure (15 April 2010) through 24 April were examined (all dates hereafter are 2010, unless otherwise indicated). We note that, because a newspaper will report the news of the previous day, there will be a one day lag between event and report. Thus we did not expect reports of Eyjafjallajökull's eruption to appear at-least until 16 April (i.e., the second day of our analysis period and the day after the air space closure). However, we examined the 15 April newspapers so as to obtain control on the provision of news regarding Eyjafjallajökull's eruption before the air space closure began. This allows us to determine if there was any media interest in the eruption, which had begun around 01:15 UT on 14 April [*Gudmundsson et al.*, 2010], prior to air space closure on 15 April.

2.1.2. Newspapers Selected

[12] Although, as of September 2009, the United States most widely circulated national newspaper was the *Wall Street Journal*, with a circulation of ~2 million, we selected *USA Today* for our analysis. *USA Today* is the second most popular newspaper in the United States, but has a similar circulation, reaching 0.6% of USA's 312 million population (see Table 1). *USA Today* also has a broader scope than the *Wall Street Journal* which, like the UK's *Financial Times*, has a strong business orientation.

[13] As of January 2010, *The Sun* was the UK's most widely circulated national newspaper, selling one million copies more than the top five broadsheets combined: *The Daily Telegraph* (690,000), *The Times* (510,000), *The Financial Times* (390,000), *The Guardian* (300,000) and *The Independent* (190,000) have a combined circulation of ~2.1 million, compared with *The Sun*'s ~3 million. Because *The Sun* is a tabloid, we also selected the most widely circulated broadsheet, *The Daily Telegraph*, to allow comparison between the two forms of newspaper communication. Probably the most internationally recognized of the UK's newspapers is *The Times*. Although only the 7th best selling newspaper in the UK (as of January 2010), it is also one of the UK's most established broadsheets, and is the second best selling broadsheet behind *The Daily Telegraph*. We thus also selected *The Times*. Together these three newspapers reach around 4 million, or 7%, of the UK population (see Table 1).

[14] As of 2006, Rennes-based (Brittany, France) *Ouest-France* was the most widely circulated French newspaper, with a circulation of ~0.8 million. However, it is a regional newspaper being impossible to buy, for example, in the French towns of Ceyrat or Beaumont in France's Auvergne region. We thus selected the most widely circulated French national newspaper, this being *Le Figaro*. Established in 1826, *Le Figaro*'s circulation (320,000) is not that much greater than that of *Le Monde* (314,000). We thus also selected *Le Figaro*'s younger (established in 1944) rival for analysis. These two newspapers reach around 0.63 million, or around 1%, of France's population of 65 million (Table 1). Unfortunately, during our study period, four days of publication by *Le Monde* were lost due to strike action, as were two days of *Le Figaro* (see Table 1).

[15] Although only established in 1976, *La Repubblica* was (as of 2004) Italy's most widely read newspaper, with a circulation of ~0.6 million. Not far behind was the older (established in 1876) *Corriere della Sera* with a circulation of ~0.5 million (see Table 1). Thus, for Italy, we selected

these two newspapers which together reach ~1.1 million, or 2%, of Italy's population every day. We note that one copy of *Corriere della Sera* was unavailable during our study period due to strike action (see Table 1).

[16] Together our seven selected European newspapers reach, and thereby potentially influence the thoughts, views and opinions of, approximately six million Europeans, with the *USA Today* influencing a further two million Americans. This is about one percent of the total (750 million) population of all the countries sampled (see Table 1). All newspapers were purchased in-country or ordered direct from the publishers, except for the UK newspapers which, if not purchased in-country, were ordered from http://www.backissuenewspapers.co.uk/. Newspapers for each country were then examined and coded by a native speaker, so as to obtain and retain the full meaning and strength of all words and phrases appearing in each newspaper.

2.1.3. Coding: Rules and Definitions

[17] Each paper was examined for coverage of the Eyjafjallajökull eruption, its effects and response. Four levels of information were extracted and recorded.

2.1.3.1. Level 1: Basic Quantitative Information

[18] Each communication was assigned a number reflecting the sequence of the article within the newspaper (starting at one for the first communication found). Next the page number on which the article appeared and article area (in cm^2) were recorded. For articles containing photographs, maps and diagrams, these were measured separately to allow the proportion of pictures and text that comprised the communication to be assessed. For each communication the report title, or caption if the communication was a photo, was recorded as part of the level 1 data. To allow numeric data to be converted to percent of the paper devoted to coverage of Eyjafjallajökull the total number of pages in the newspaper and total page area were recorded. These statistics, and sections of the paper considered, are given in Table 1. For example, the *USA Today* consists of four sections. We considered the first three of these sections (i.e., the news, money and sports sections). These comprise sections A, B and C of the paper (section D being the life section). It was important to examine all three of these sections because while on 16 April, for example, the main report relating to Eyjafjallajökull appeared on page 3 of the money section (section B), disruption and impacts also extended to sporting fixtures such as the Boston marathon (i.e., section C). To maintain consistency, the same sections were considered for every edition of every paper.

2.1.3.2. Level 2: Communication Type, Content and Information Provider

[19] Next the type and content of the communication were entered, along with cited sources of information. This involved coding, whereby the recording units (these being, in our case, words, phrases and/or pictures) were placed into categories on the basis of the sense, meaning or symbolism of the word or phrase used, as well as the context of that word or phrase within the text. We first placed each communication or article into one of six types, defined as follows:

1. Front page flag: A bullet (and/or photo) appearing on the front page and referring to the existence of a main article deeper within the newspaper relating to Eyjafjallajökull.

2. Report: The main report containing coverage of Eyjafjallajökull. Reports could be split into two types: (1) news and (2) review. While a news report covered previous events relating the Eyjafjallajökull eruption, a review was written as a general synopsis of volcanic activity to help the readership in understanding the type, mechanics and global/historical context of Eyjafjallajökull's eruption.

3. Photo: Any picture, diagram or map relating to the eruption and its cloud.

4. Editorial: A discussion or opinion piece relating to the eruption.

5. Letter: Letters written by the readers regarding the eruption.

6. Advert: Advert for a product or service that used the eruption to sell or promote that product or service.

[20] The content of each communication was next placed into one of six categories depending on the dominant theme of the text or picture. For the text, we chose to code each sentence on the basis of key descriptive and factual words or phrases contained within the sentence, so that our coding unit was the sentence. However, we found that sentences coded into a given category tended to cluster into paragraphs of uniform category. Thus, after an initial analysis, coding was carried out on a paragraph-by-paragraph basis so that each paragraph was assigned a category. The area of the paragraph was then measured so that the column-space assigned to each category could be quantified. Coding of whole text, such as entire reports, can be unreliable, unless the text is short, as with a newspaper headline [*Weber*, 1990]. We found, for example, that entire reports typically contained information on a mixture of at-least two, and typically all, categories. Thus, we selected to code on a paragraph-by-paragraph basis.

[21] Six categories were selected prior to analysis, and required no post-analysis adjustment, all categories allowing placement of all sentences into a unique category, with no overlap; thereby allowing us to code all of the text relating to Eyjafjallajökull. Thus our categories fitted the two requirements of *Weber* [1990], their being mutually exclusive, so that no recording unit could be classified simultaneously in two or more categories, but sufficiently narrow so as to include all of the main themes of the Eyjafjallajökull eruption and its impact. These six categories were defined as follows:

1. Volcanic: This category included geological, location and/or volcanological information regarding Eyjafjallajökull (and other volcanoes), as well as information regarding volcanic activity and eruptive processes, including plume and cloud dynamics. It included pictures of the volcano and its products.

2. Technical: This category covered information regarding detrimental ash impacts to an aircraft's ability to fly, especially engine performance.

3. Response: The response category was complicated in that there were three levels of response, as drawn in Figure 1. In this classification the volcano and the ash cloud was the effect, or cause, of the primary response, which was air space and air port closure. However, this primary response was also a secondary effect which triggered a secondary response, this being flight cancellation. This, in turn, caused a final level of effect, this being passenger delay

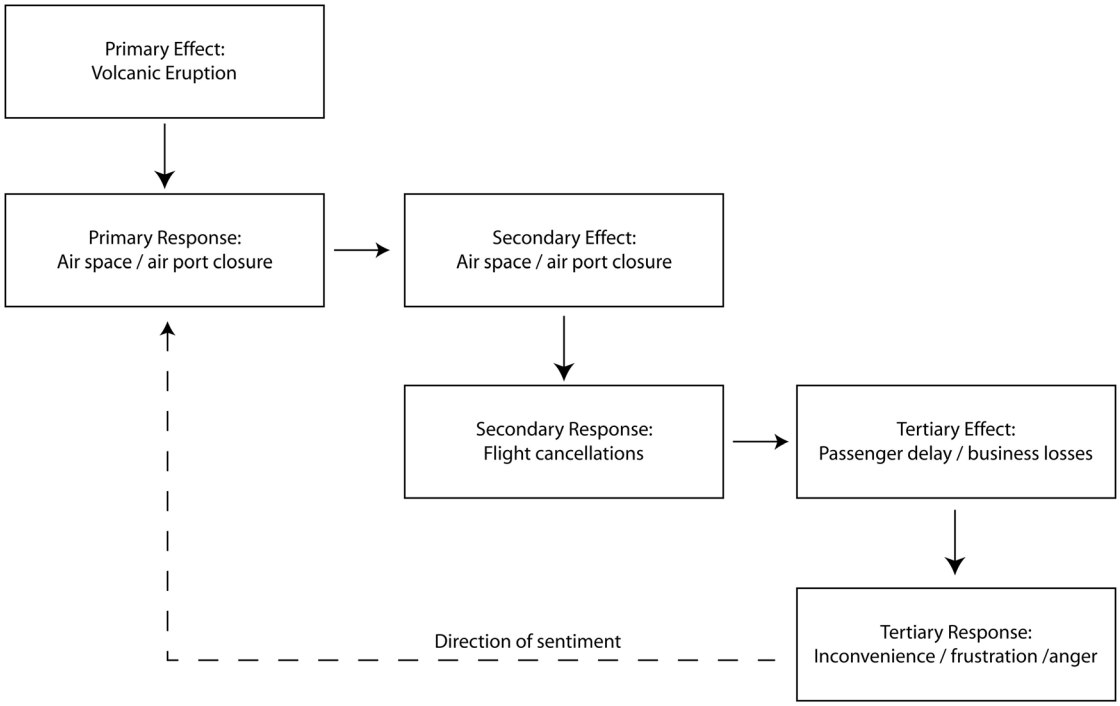

Figure 1. Effect and response cascade to airline and airport operations during the Eyjafjallajökull eruption.

and inconvenience, as well as economic problems and business losses. While this final level of effects were coded as social and business and economic, the second level was coded as airports and airlines, so that this category covered the response in terms of air space closure and the closure decision making process.

4. Airports and airlines: This category included any information regarding the operations of individual, specifically named, airlines, and mostly involved listings of flight cancellations or operational problems by airline.

5. Economic and business: Impacts on local, regional, national and global economies were included in this category, as well as impacts on business operations, including financial losses (or in some cases gains – for near-airport hotels, car rental companies, rail travel providers, etc.). It also included problems with exports and imports, demand and supply and business problems experienced by individual (named) companies, including airlines.

6. Social (including hazard): Problems, inconveniences and hardships (both logistical and financial) experienced by the general public (mostly air travelers) were included in this category, as well as the local hazard and impact (due to ashfall) to the local (Icelandic) as well as regional (European) population, where details regarding possible public health effects were published in all of the newspapers analyzed.

[22] The six themes were coded on the basis of the presence of keywords or phrases that could be used to link each paragraph to a specific category (see Note 2 of Text S1 for examples). Many single words were ambiguous and so had to be classified on the basis of their context within a sentence or phrase. The word "*cloud*," for example, could be associated with any of the six categories. By way of illustration, take the following headlines or picture captions from *USA Today* (see Note 3 of Text S1 for full citation and article type from which each phrase is taken): (1) "*Ash cloud thins as eruption loses fizz, reverts to lava*"; (2) "*Perilous cloud*"; (3) "*Volcanic ash cloud disrupts travel*"; (4) "*For air travel, signs of hope as cloud lets up*"; (5) "*Delta, the world's largest airline, said it lost only about $20 million as a result of the cloud of ash from Iceland that forced most airports in Northern and Central EU to shut down*"; (6) "*Lost in the ash cloud(s)*." In first two examples, the word *cloud* is used in a volcanological context, thus allowing the text to be coded as *volcanic*. This classification is not so clear for the second example, but the caption is associated with a picture of the ash plume rising above the vent so that the picture and caption are coded as *volcanic*. The third and fourth examples are set in the context of airport closure, flight cancellation and travel disruption. They are thus coded as *airports and airlines*. The fifth example is not a headline, but a sentence from within a report, but illustrates the use of the word *cloud* in a business context (the report actually appeared in the Money section of *USA Today*). The final string is another ambiguous piece of text, but was a caption relating to a picture of an Icelandic dairy farmer sitting in his car wearing mask and goggles for protection. It was thus coded "*social*." Likewise the widely used word "*cancelled*" could be linked to any one of the six categories. Take, for example, the following three phrases: (1) "*due to the detrimental effects of ash ingestion to aircraft engine operation, flight operations have to be cancelled when ash drifts into air lanes*"; (2) "*all flights out of Heathrow were cancelled today*"; (3) "*cancelled flights mean that flower exporters can no longer ship from Kenya to USA, meaning losses for Kenya*'s *flower exporters*." All three phrases contain the word "*cancelled*," but on the basis of the context of each sentence, the three

sentences will be respectively coded as technical, airports and airlines, and business.

[23] The names, affiliations and stated expertise of all cited information sources were also recorded. Where possible, these were classified into the same six categories as were used for the content classification, these being as follows:

1. Volcanologist: This category included those giving information with an expertise in volcanology, so that this class included geologists, physical geographers, remote sensors, geoscientists, and geophysicists with an interest or expertise in volcanic phenomena and processes, as well as other associated academic disciplines.

2. Air industry: This category mostly covered private and government agencies associated with air safety and operational issues, and include hardware (aircraft) manufacturers as well as engineers and air corridor/traffic control experts.

3. Responders: The responders were defined as those tasked with providing information for the decision makers, as well as those making the decisions regarding air space closures [i.e., Volcanic Ash Advisory Bureau's (VAAC's) and meteorological agencies], plus those responsible for civil protection.

4. Airlines: This category was assigned to any information cited as being given by a named airline.

5. Economic and business: This class comprised those working for agencies with interests in global markets, international funds, stocks and shares, imports and exports, shipping, and other economic issues.

6. Public: This class was assigned to statements from the general public (mostly air travelers), as well as the local residents impacted by the proximal fall deposits, plus personalities (e.g., film stars) and sports people.

[24] However, during analysis we added two other classes:

7. Politician, which included statements from elected local, regional, national and international representatives (i.e., members of local councils, municipalities or governments), as well as officials of the European Union Commission.

8. All other statements that we could not place were labeled "*miscellaneous*".

[25] A full listing of cited information sources, affiliations, declared expertise and their classification are given, by newspaper, in Text S2.

2.1.3.3. Level 3: Dictionary Generation

[26] Following *Weber* [1990, p. 24], in content analysis, dictionaries consist of "*category names, the definitions or rules for assigning words to categories and the actual assignment of specific words*." Once created, the dictionary provides a database for the words associated with each category, allowing cluster analysis [*Krippendorff*, 1980]. All words relating to Eyjafjallajökull were logged, counted and assigned a category. By way of example, the dictionary for *USA Today* is given in Text S3. Again, it was important to understand the context of individual words within a dictionary. Many words, for example, could be associated with a number of different categories. The word group *failed-failing-failure* in *The Times* dictionary, for example, had six different contexts and fell into five different categories depending on that context: (1) failed (to arrive), so that category = social (passenger); (2) failing (to explain blanket closure), so that category = responder; (3) failing (to organize transport for stranded passengers), so that category = airlines; (4) failure (to suffer engine failure), so that category = technical; (5) failure (of companies without sufficient cash reserves), so that category = economic and business; (6) failure (to meet responsibilities), so that category = airlines.

[27] Other positive words were negated, or made conditional, by the phrase around them. The word *open* for example could be turned negative by simply placing the word *not* in front of it. The act of opening could also be changed from a fact to a probability by association with words such as *expected* (e.g., *expected to open*) or *hopes* (e.g., *hopes to open*). Thus the context of all words were carefully checked for negative and positive connotations, as well as appropriate category placement.

2.1.3.4. Level 4: Qualitative Notes

[28] Detailed notes were made for each communication or article (report, picture, etc.). This included a summary of the written information contained within any article, detailing the main points covered, and recording any interesting, strong or potentially influential statements. In addition, descriptions of the content of any picture, map, schematic or graph were completed. As part of this, all numbers (regarding, for example, number of cancellations or stranded passengers, monetary losses, etc.) were recorded, and lists of closed (or open) airports and/or countries were compiled, along with the date and time of closure or reopening, if given. In this way, a qualitative and quantitative database regarding the impacts of Eyjafjallajökull, as recorded by the newspapers, could be complied, and information could be cross-checked across the newspapers. These results are given in Table 2 for the U.S. and British newspapers, and Table 3 for the French and Italian newspapers.

2.1.3.5. Level 5: Validity Tests

[29] To test the validity of the defined categories we used our dictionary data to perform a cluster analysis on all extracted keywords. As argued by *Krippendorff* [1980, p. 115] "*clustering seeks to group or lump together objects or variables that share some observed qualities or, alternatively, to partition or to divide a set of objects or variables into mutually exclusive classes whose boundaries reflect differences in the observed qualities of their members*." To do this we followed the method of *Krippendorff* [1980, p. 115] whereby, first, two words are found "*whose merger will have the smallest difference on the data as a whole*." Next, the initial two-word group is lumped into a larger (three-to-four word) cluster, with the process being repeated until there is "*nothing else to observe*" [*Krippendorff*, 1980, p. 115]. As part of this process, single words (which may not be grouped during steps 1, 2, 3 or 4) are fed into the cluster at an appropriate level so that, eventually, all words are lumped within one cluster (see Figure 2).

[30] The cluster analysis for the dictionary derived from the *USA Today* is given in Figure 2. This cluster analysis confirms the validity of our categories, with the information clustering into the six categories defined at the outset. Clustering also allows us to identify a number of sub-categories, as marked on Figure 2. It also allows us to examine the relations between each category and sub-category; as well as to examine the type of words associated with each category. Across the clusters, for example, we see the cascade effect predicted in Figure 1, this being from volcanic process

Table 2. Facts for Airspace Closure, Opening, Cancellations and Economic Impacts Given in the English Language Papers *USA Today, The Times* and *The Sun*

	USA Today		The Times		The Sun	
Date	Article Number[a]	Details	Article Number[a]	Details	Article Number[a]	Details
				Airspace Closure/Opening		
16 April	4(B3)	Countries experiencing closures (12 listed): Belgium, Denmark, Finland, France, Germany, Great Britain, Ireland, Norway, Poland, Sweden, Switzerland, The Netherlands	2a(3)	None formally listed, but closure of airports "*across Europe … …from Aberdeen to Charles De Gaulle and Dublin to northern Poland*"	2(4–5)	Countries experiencing closures (8 listed plus Scandinavia): Belgium, France, Germany, Great Britain, Holland, I reland, Russia, Scandinavia, Switzerland
17 April		Saturday: No publication	1(1)	Restrictions cited over Europe including Czech Republic, Latvia and Austria	2(4)	Countries experiencing closures (12 listed): Czech Republic, Denmark, Finland, France, Germany, Great Britain, Holland, Hungary, Russia, Poland, Slovakia, Switzerland Reopened: Norway and Sweden; Scotland (restrictions "*relaxed*")
19 April	1 + 3(A1)	Countries experiencing closures: 23 European countries (not listed); Germany allowed "*some flights*" to resume		None listed/reported		Only statement: UK airspace will remain closed until at least 7pm tonight; Spain quoted as reopening "*last night*"
	7(A4)	Countries listed as closed: France (northern), Germany, Great Britain, Ireland, Sweden (southern) Countries listed as open: Sweden (central), France (southern), Greece, Italy (southern), Portugal, Turkey, Spain (all other EU destinations "closed")				
20 April	1(A1)	Some airports would resume flights "this morning" in Germany, Netherlands, Scotland; Heathrow "hoping to open later in the day"	1(1)	Scottish airports due to reopen at 7am; London had hoped to reopen at 7am as well, but break unlikely to reach that far south; Manchester to reopen at 9am	2(4–5)	Scottish airspace hoped to reopen at 7am
			2(3)	Lufthansa authorized to fly to Germany from South America, Asia and Africa; Air France flying to regional airports at Toulouse and Pau, and are hoping for clearance to open an air corridor from the South of France to Paris		
			5(4–5)	Diagram showing British airports open or hoping to reopen today: Czech Republic, Bosnia, Bulgaria, Hungary, Lithuania, Montenegro, Romania, Russia, Serbia, Turkey; Aer Lingus operating transatlantic flights as normal and flights to Spain, Italy and Portugal; all Russian transatlantic flights open via North Pole		
21 April	1(A6)	Reopened airports: Amsterdam, Heathrow, Paris	1(1)	Flights are beginning to land in Britain again: Germany, the Netherlands	6(11)	(British) airports reopened at 10 pm (the previous day)
			2(3)	Countries that "*relaxed the ban earlier*": France		
22 April	1(A10)	Some restrictions over parts of Britain, France, Ireland		No details given		No details given

Table 2. (continued)

Date	USA Today Article Number[a]	USA Today Details	The Times Article Number[a]	The Times Details	The Sun Article Number[a]	The Sun Details
		Open airports: Frankfurt, London Heathrow, Paris Charles de Gaulle				
23 April	1(A5)	Some restrictions over Finland, Norway (southern), Scotland (northern), Sweden		No details given		No details given
24 April		Saturday: No publication		No details given		No details given
				Flights Cancelled/Operating		
16 April	4(B3)	"*US airlines canceled more than 100 flights to and from Britain by noon Thursday*"; American Airlines, 34; Delta, 65	2a(3)	"*5200 flights in and out of Britain each day but all had been cancelled by noon*"		No numbers given
			3a(4)	47 flights cancelled by Leeds Bradford International which affected 3500 people		
17 April		Saturday: No publication	1(1)	17,000 cancelled European flights	2(4)	35,000 UK flights cancelled since noon on Thursday (15 April); 16,000 of Europe's usual 28,000 daily flights cancelled yesterday
19 April	1 + 3(A1)	63,000 flights cancelled	4(7)	63,000 flights cancelled since last Thursday		No numbers given, but listings by main UK airlines as destinations to which flights had been cancelled
	7(A4)	24,000 (= normal no. flights on a Sunday); 4000 (= actual lights on Sunday 18 April)	1(1)	4000 flights expected over Europe compared to 24,000 normally (therefore 20,000 cancelled)		
20 April	1(A1)	70,000 flights cancelled so far	2(3)	80,000 flights	2(4–5)	"*fewer than 1/3 of usual 27000 European flights took off yesterday*": ~9000 completed, ~18000 cancelled
21 April	1(A6)	~13,000 flights completed Tuesday (46% of the normal daily total, 28,000); More than 95,000 flights grounded		None given	6(11)	28 long-haul flights landed at Heathrow
22 April	1(A10)	21,000 of 28,000 scheduled flights were going ahead Wednesday	4(7)	95,000	4(11)	102,000 flights axed worldwide
23 April	1(A5)	Nearly all of Europe's 28,000 scheduled flights, including more than 300 transatlantic routes, are going ahead; Frankfurt and Munich have ~90% of flights operating, all British airspace open, with Heathrow running a "nearly full" schedule. BA said all of its flights from Gatwick and City airports would take off, as well as the "vast majority" from Heathrow		None given		None given
24 April		Saturday: No publication		None given		None given
				Business Losses		
16 April		None Given	3a(4)	Title: Airlines set to lose more than £100 m if chaos continues (seems to be based on: 1989 Alaska eruption cost US airlines $100 m)	2(4–5)	Bill will run to many millions (£s)

Table 2. (continued)

	USA Today		The Times		The Sun	
Date	Article Number[a]	Details	Article Number[a]	Details	Article Number[a]	Details
17 April		Saturday: No publication	1(1)	Closures costing airlines £200 million per day	2(4)	Up to £28 million/day (for British and Irish airlines)
19 April	1 + 3(A1)	Total loss so far: $1 billion ($20 million/day, for US airlines that fly to EU)	1(1)	Airlines losing at least $200 m (£130 m) per day	3(4)	Airline industry will have lost around £650 million by tonight
	8(B1)	Total loss so far: $80 million ($22 million/day, for US airlines that fly to EU)	4(7)	$1billion lost by travel industry		Fallout from volcano wiped £1 billion from economy (£230 million/day)
20 April	7(B2)	Greater than $1 billion ($200 million/day, for the "airline industry") (US airlines have a revenue hit approaching $250 million)	1(1)	Airline loss: £630 m	2(4–5)	£1 billion (more than) means loss to British economy
			6(4–5)	Airline loss, £650 m; EU economy, £1.3 billion; Lost productivity of nearly 7 million people stranded abroad is more than £400 million/day: BA, £80 million (at £15–20 million/day); EasyJet, £40 million (at £5 million/day); Air France-KLM, €35 m/d (£31 million/day); 230 carriers, $200 m/day (£130 million)/day; TUI Travel, £20 million (£6 million/day); Thomas Cook, £7 m/day	5(39)	BA, up to £100 m (at £15–20 m/day); TUI Travel, £25 million (at-least); Thomas Cook, £7 m/day
21 April	1(A6)	Delta - the US carrier with the most EU flights - is losing about $5 million per day	2(3)	BAA (Heathrow owner), said losses were around £6 million per day; Airlines are considering total losses of $1 billion		None given
	2(B5)	Delta lost a total of $20 million; US travel Association estimated that the volcano cost the US economy $650 million in lost spending on airlines, hotels, food and other travel services	3(3)	Airspace closure is thought to be costing Europe £400 million/day in lost productivity		
22 April		None Given	2(2)	Airline losses: $1.7 billion to which business, economical & human costs need to be added	4(11)	Cost to airlines: £1 billion
			3(7)	Airlines thought to have lost a combined £1.1 billion		
			4(7)	$1.7 billion (total lost by airlines)		
23 April		None Given	2(20)	Total losses: Ryan Air, €30–€40 million (£26 m–£34 m); Airlines, $1.7b (£1.1 billion)		None given
24 April		Saturday: No publication		None given		None given

[a]Values in parentheses are page numbers.

Table 3. Facts for Airspace Closure, Opening, Cancellations and Economic Impacts Given in *Le Figaro, Corriere della Sera* and *La Repubblica*

	Le Figaro		Corriere della Sera		La Repubblica	
Date	Article Number[a]	Details	Article Number[a]	Details	Article Number[a]	Details
				Airspace Closure/Opening		
16 April	2a(8)	Countries/airports experiencing closures (7 Listed): London-Heathrow, Schipol-Amsterdam, Ireland, Scandanavia, (Denmark, Finland, Sweden + Norway)	1(1)	Countries/airports experiencing closures (10 listed): Belgium, Denmark, Finland, France (north), Holland, Iceland, Ireland, Norway, UK, Sweden	2(12)	Countries/airports experiencing closures (13 listed): Belgium (*until 18:00*), Denmark, Finland (south), France (Paris + 23 cities), Holland (Amsterdam + Rotterdam), Iceland, Ireland, Italy, Poland, UK (Scotland + England), Norway, Sweden, Spain
	3c(9)	25 French airports closed, including North of France and it's airports (incl. Orly)				
17 April	2(2)	Countries/airports experiencing closures (14 listed): Austria, Belgium, Bulgaria, Czech Republic, Denmark, Estonia, Finland, Germany, Hungary, Kaliningrad, Lithuania, Netherlands, Poland, Slovenia Partial closures (5 listed): France, Italy, Romania, Russia, United Kingdom Reopened (or in the course of reopening): Iceland, Ireland, Norway, Sweden	2(2)	Countries/airports experiencing closures: (9 listed): Brussels (Belgium), Croatia, Frankfurt (Germany), Helsinki (Finland), Italy (north), Lithuania, Oslo (Norway), Paris (France), Stockholm (Sweden)	3(10)	Countries/airports experiencing closures (13 listed): Austria, Belgium, Czech Republic, Denmark, Estonia, Finland, Germany, Holland, Hungary, Lithuania, UK, Poland, Switzerland Partial closures (7 listed): Bulgaria, France, Germany[b], Ireland, Norway, Sweden, Romania
18 April		No Sunday Publication	5(5)	Countries experiencing closure (12 listed): Belgium (*until 20:00*), Croatia, Denmark, Ireland (*until 14:00*), Finland (*until 14:00*), France, N of Paris (*until 08:00 Monday*), Germany (*until 14:00*), Hungary, Sweden, Switzerland, UK (*until 08:00 Monday*) Italy: Torino, Milano, Bergamo, Venezia, Ancona, Pisa, Firenze, Bologna (*until 08:00 Monday*)	6(3)	Closed (Italian) airports (12 listed): Bolzano, Torino, Genova, Venezia, Bologna, Verona, Bergamo, Linate, Malpensa, Firenze, Pisa, Ancona
					7(4)	Countries experiencing closures (20 listed): Austria, Belgium, Bosnia-Montenegro, Croatia, Czech Republic, Denmark, Estonia, Finland, Holland, Hungary, France, Germany, Italy (north), Lithuania, UK, Ukraine, Serbia, Spain (north), Sweden, Switzerland Countries open: Italy (south), Spain (south), Turkey, Greece
19 April		None given	2(5)	Open: Berlin, Lisbon, Moscow, Madrid, Stockholm, Copenhagen (*open from 02:00*), Paris (*closed until Tuesday*), London (*open from 20:00*), Milan (*open from 07:00*), Rome (*open from 07:00*), Vienna (*open from 02:00*)	6(3)	Open: Belgium (*closed until 20:00 yesterday*), France, Germany, Spain, UK (*closed until 20:00 yesterday*), Austria (*closed until 06:00 today*), Bulgaria (*closed until 08:00 today*), Croatia (*closed until 08:00 today*), Denmark (*closed until 08:00 today*), Ireland (*closed until 14:00 today*), Switzerland (*closed until 14:00 today*), Czech Rep. (*closed until 08:00 today*)
					4(2)	Italian airports closed: Firenze Ancona Venezia
20 April		None given	4(2)	Open: Spain Reopening: Berlin (*from 01:00*), France (*direttrice Parigi-S*), Rome + Milan (*from 08:00*), UK (*today*)	7(3)	Closed: Germany, France-North (closed) Open or reopening: Austria (reopen since 05:00 yesterday, but limited), Croatia, Czech Rep. (reopen for overflights above 7450 m), Denmark (closed until 08:00, except above 11000 m), Belgium (gradual reopening from 08:00), Bulgaria (open for routes to S), Finland

Table 3. (continued)

Date	Le Figaro Article Number[a]	Le Figaro Details	Corriere della Sera Article Number[a]	Corriere della Sera Details	La Repubblica Article Number[a]	La Repubblica Details
						(temporarily open), France-south (open), Hungary, Ireland (closed until 14:00), Scotland (open 08:00 today), Sweden (partial reopening for flights to N and E), Switzerland (closed until 08:00 today), Spain (open), UK-north (12:00), UK-south (18:00)
21 April		Paper On Strike		Paper On Strike		None Given
22 April		Paper On Strike		None Given	2(20)	Restrictions for Finland and North of Scotland
23 April		None given	4(21)	Open: Denmark, Norway		None given
24 April		None Given		None Given		None Given
				Flights Cancelled/Operating		
16 April	2a(8)	Cancellations for flights to London, Scotland, Copenhagen and Oslo; 50% of flights for the USA cancelled; London Heathrow cancelled 1200 connections	2(12)	4000 flights (connections) cancelled	2(12)	8000 flights cancelled: 100 flights cancelled at Frankfurt, 44 flights cancelled at Dusseldorf, Hamburg + Berlin closed, Spain 466 flights cancelled, 49 flights cancelled at Fiumicino, also at Trieste, Venezia + Bologna, USA canceling or delaying flights
	3c(9)	Lyon: 29 flights cancelled, 16% of traffic arriving, 17% departing; Air France: cancelled all flights			4(13)	55 flights cancelled at Fiumicino
17 April	2(2)	17,000/28,000 flights cancelled		None Given	3(10)	17,000 flights cancelled: Linate + Malpensa, 200 cancelled; Bergamo, 53 cancelled; Venezia, −30%; Firenze + Pisa, 60 cancelled; Bologna, 64 cancelled; Fiumicino, 130 cancelled; Ciampino, 40 cancelled
18 April		No Sunday Publication	2(2)	34,600 flights cancelled (1117 in Italy); "*American airline companies have cancelled 83% of flights* (to/from Italy)"	1(1); 3(2)	17,000 flight cancelled (yesterday)
					6(3)	Flight cancellations in Italy: Malpensa (455), Linate (200), Torino (73), Genova (27), Fiumicino (403), Ciampino (59), Napoli (125), Lamezia Terme e Reggio Calabria (15), Palermo (67); Total = 1424
					7(4)	73% of flights cancelled (Saturday); 63% of flights cancelled (Friday); 73/300 transatlantic flights completed; New York, 80% flights cancelled; Hong Kong, 29 flights cancelled; Singapore, 22 flights cancelled; India, 70 flights cancelled
19 April	5(4)	63,000 flights cancelled since 15 April	9(9)	Flights cancelled in 3 days in Italy: 25-50-300	4(2)	20,000 flights cancelled (yesterday); In Italy: Torino (105), Fiumicino (446), Ciampino (100), Napoli (113), Catania (53), Malpensa (538), Linate (211), Bologna (176)
20 April		None given	5(2/3)	63,000 flights cancelled in 5 days in Europe; 8700 effected out of 28,000	4(2)	63,000 flights cancelled
			4(2)	Spain: yesterday cancelled 1600 flights out of 5000	6(2)	Flights cancelled in Italy: Malpensa (529), Linate (285); Torino (105), Fiumicino (360),

Table 3. (continued)

Date	Le Figaro Article Number[a]	Le Figaro Details	Corriere della Sera Article Number[a]	Corriere della Sera Details	La Repubblica Article Number[a]	La Repubblica Details
						Ciampino (73), Napoli (114), Palermo (53), Trapani (18), Catania (84), Verona (110), Venezia (184), Bologna (171), Bari (34)
21 April		Paper On Strike		Paper On Strike	1(12)	95,000 flights stopped in total
22 April		Paper On Strike		None Given	2(20)	80% (22,500 out of 28,000) flights operating yesterday; 100,000 flights cancelled in total; 29% of global aviation effected
23 April		None given	4(21)	29,000 flights operated yesterday		None given
24 April		None given		None given		None given
				Business Losses		
16 April		None given		None given		None given
17 April		None given		None given	3(10)	200 million € lost
					4(10)	1.13 million € lost per day
18 April		No Sunday Publication	3(2)	Airlines losing 1 billion euro per day	8(4)	3 billion € lost per day
19 April	2(2)	150 million €/day	9(9)	100 million €/day (Europe); 50 million €/day (USA); 5–10 million €/day (Italy)		None Given
20 April	7 + 8(3)	35 million €/day (AirFrance); 15 to 20 million £/day (British Airways); 5 to 9 million €/day (SAS); 250 million $/day (230 airlines); Total loss: 7 billion euro	6(3)	375 million € lost in # days by European airports: London, 57 million; Paris, 37 million; Frankfurt, 25 million; Amsterdam, 20 million; Lombardi, 15 million	4(2)	375 million € lost by tourist industry in 3 days; 15 million € lost; 250 million $/day lost by airlines
					7(3)	1 billion $ lost in 4 days; 200–250 million lost by airlines
21 April		Paper On Strike		Paper On Strike	2(12)	200 million € lost by airports; 10 million € lost by passengers
					6(13)	Lufthansa, 31 million €/day (after 5 days = 154 million €); AirFrance, 27 million €/day (after 5 days = 134 million €); British Airways, 12.5 million €/day (after 5 days = 127 million €); Ryanair, 5 million €/day (after 5 days = 5 million €); EasyJet, 4 million €/day (after 5 days = 18 million €)
22 April		Paper On Strike	2(27)	1.7 billion $ lost	2(20)	Airline losses = 1.26 billion €; 10,000 tons of merchandise lost
23 April	2(12)	>35 million €/day (AirFrance)	4(21)	2 billion $ lost by airlines		None given
24 April		None given		None given		None given

[a]Values in parentheses are page numbers.
[b]17 April: Germany listed in 3(10) of La Repubblica on as both *closed* and *partially closed*.

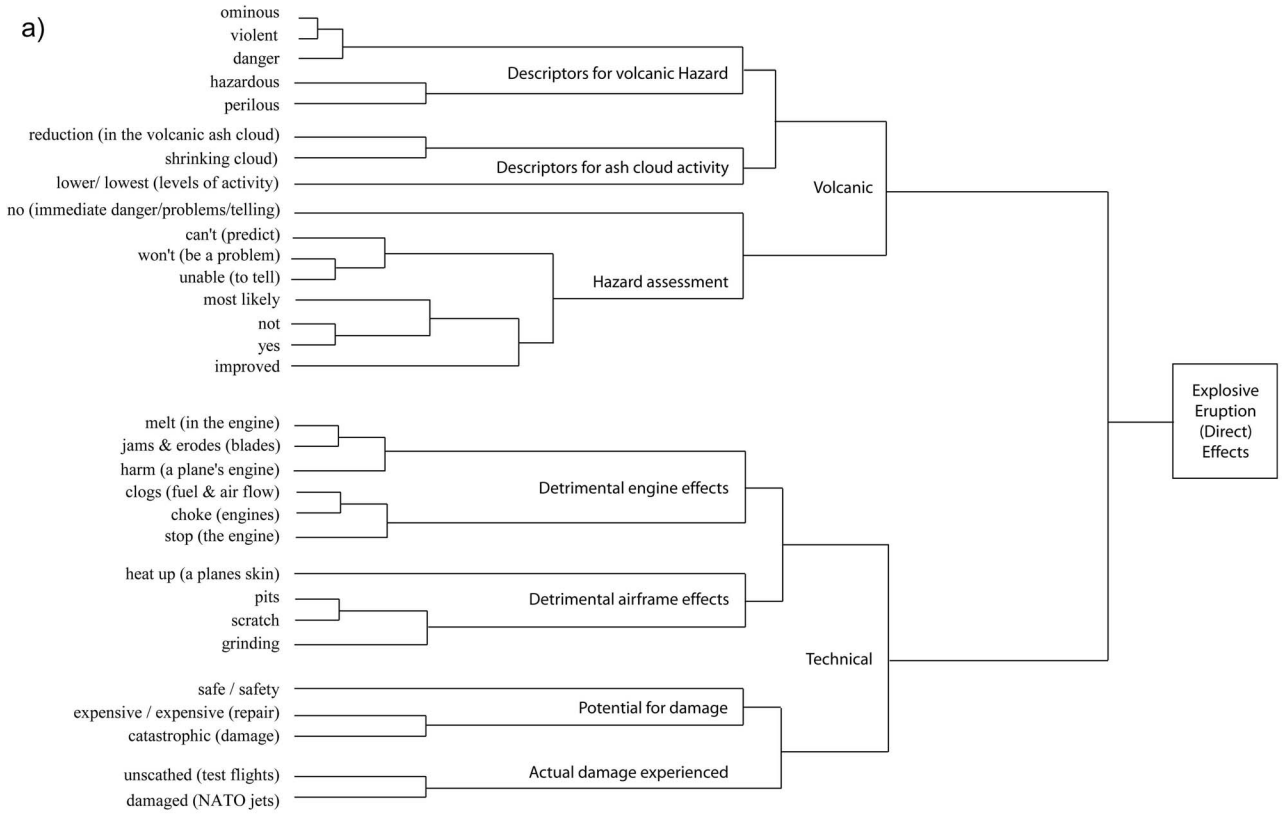

Figure 2. Dendogram for words in the *USA Today* dictionary within (a) the volcanic and technical categories, (b) the response and airports-airlines categories, and (c) the economic-business and social categories.

to predicted (and real) technical concerns (Figure 2a), through air space closure and effects on airline operations (Figure 2b), to economic, business and social impacts (Figure 2c). Such a treatment also allows us to see further (sub-cluster) cascades within each cluster. For example, within the social category of Figure 2c we see a sub-cluster cascade from the passenger-impact sub-cluster, through the passenger-sentiments-reactions-and-feelings sub-clusters, to the ultimate passenger-solutions and problem-resolution sub-cluster.

2.1.4. Media Frames

[31] By using the paragraph as our unit of analysis, and by analyzing the selection, placement, and structure of words and phrases within each paragraph, we mainly use a *linguistic approach* to identify *frames* or *framing* [*Matthes and Kohring*, 2008]. Framing occurs when the text is organized in such a way that it promotes a particular interpretation. That is, we can identify text elements that serve to raise the apparent importance of certain ideas, thereby encouraging the readership *to think, feel or decide in a particular way* [*Entman*, 2007]. In effect, the text frames, i.e., shapes, directs or disposes, the thoughts of the readers.

3. Analysis

[32] Over the 10 day period spanning 15–24 April 2010 coverage of Eyjafjallajökull occupied a total column area of ~135,000 cm^2, equivalent to 2.5 whole copies of *USA Today*, between 1.5 and 2.0 copies of *The Times, Telegraph or Sun*, 11 copies of *Le Figaro*, 3.5 copies of *Le Monde*, ~1 copy of *Corriere delle Sera* or ~1.5 copies of *La Repubblica*. Newspaper space devoted to Eyjafjallajökull did show some systematic variation by country (Figure 3), with the cumulative space being greatest in the country most proximal to the volcano, the UK, where total column area averaged between the three papers analyzed was 22,300 cm^2. This was followed by the country most distal (in a European-sense), Italy, where the total column space (averaged between the two papers analyzed) was 17,200 cm^2. Next was the medial country, France, where coverage amounted to 13,000 cm^2. Finally in the *USA Today* coverage summed to 7800 cm^2. In all countries, peak coverage occurred between the 18 and 21 April, waning after this point (Figure 4). In *The Times*, *The Sun, Le Figaro* and *Corriere della Sera* coverage reached an initial peak on 16 April, followed by a second peak between 18 and 21 April, with the second peak being higher than the first (Figure 4).

[33] While the column area devoted to each reporting category is given, by newspaper, in Figure 5, the relative contribution of each cited-information-source category is given in Figure 6. The highest frequency words contained in each dictionary are given, by newspaper, in Tables 4–9. In addition, all published air space and airport closure listings, plus quantitative information regarding cancellations and financial losses are collated in Tables 2 and 3. We next present these data. Our analysis also allows us to describe

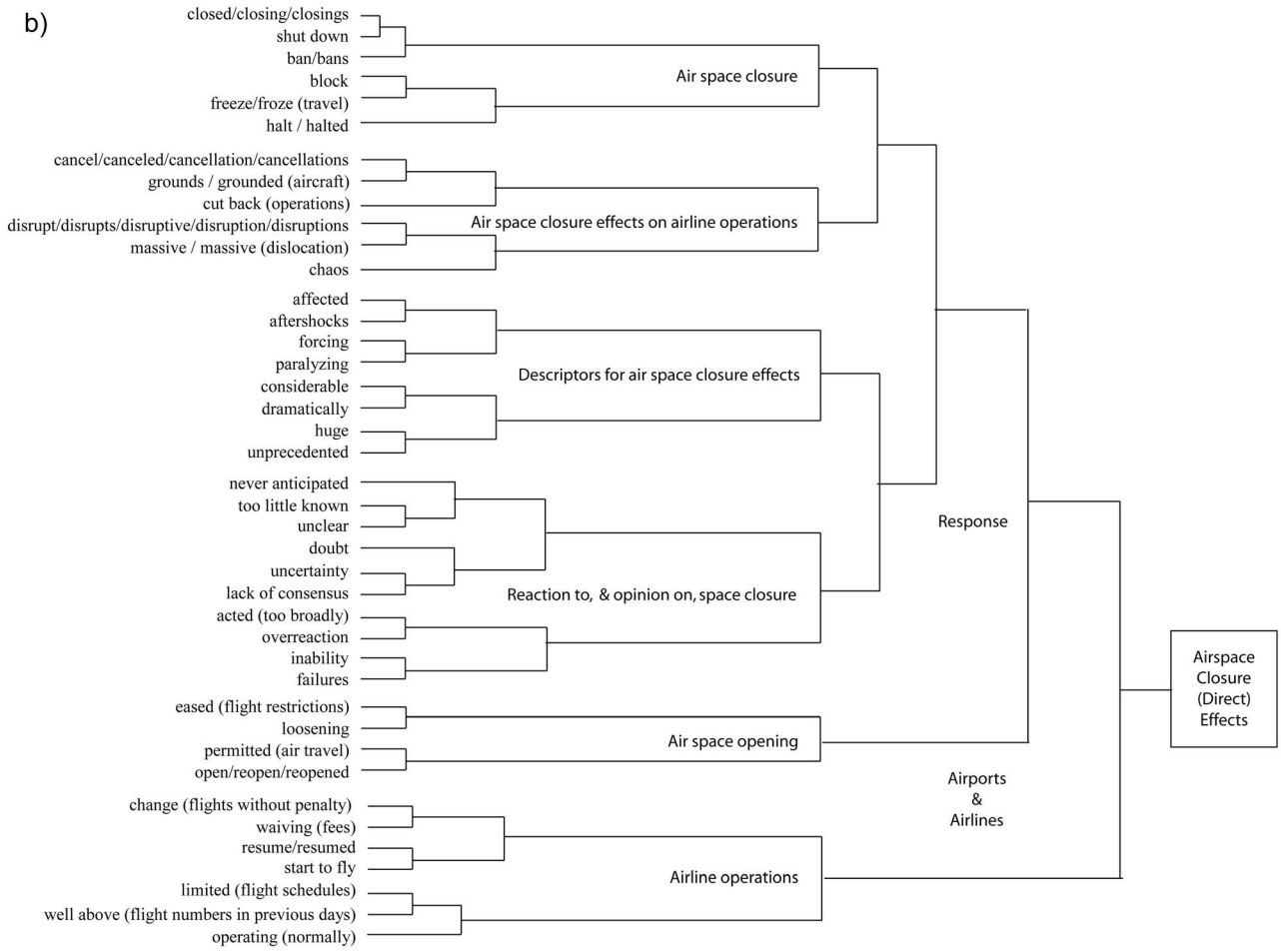

Figure 2. (continued)

each data set (i.e., to detail the information given in each newspaper) in some detail. This, however, is a somewhat lengthy and distracting task. Thus, by way of example, we describe the data for the *USA Today*. This sets the tone for most content analyzed, with the content descriptions for all other newspapers being given in Text S4. Text S4, along with Text S1, contains a great deal of data that support the points we raise in the discussion and conclusions.

3.1. USA Today

[34] The air space closure began on 15 April [*Gudmundsson et al.*, 2010], so that main newspaper coverage of the Eyjafjallajökull eruption, the airspace closure and its effects would be expected the following day (16 April). However, *USA Today* published a short report about Eyjafjallajökull's eruption on 15 April. Appearing on page 8 of section A, the report was entitled "*Icelanders flee volcano's* 2nd *eruption*" and explained that "*a volcano under a glacier in Iceland erupted for a second time in less than a month, melting ice, spewing smoke and steam, closing a major road and forcing hundreds of people to flee rising flood waters*" (*USA Today*, 15/4, 1(A8)). The report added that 70 trapped tourists had been rescued and that "*no lives or properties were in immediate danger*" (*USA Today*, 15/4, 1(A8)). The report was thus volcanic and social in content, and provided the readership with a reasonable summary of the volcanic, and local, situation.

[35] The following day (Friday 16 April) Eyjafjallajökull had moved to page 1, where two front page flags and a picture linked the reader to a page 3 report in section B (the business section) entitled "*Iceland volcano stops travel in its tracks*" (*USA Today*, 16/4, 4(B3)). The attention had of course switched to the air space closure and it's effects (i.e., flight cancellations) with statistics (as given in Table 2) focusing on cancellations effecting U.S. carriers and air traffic. Problems were predicted to affect "*global travel into the weekend, and possibly into next week*" (*USA Today*, 16/4, 4(B3)).

[36] By Monday 19 April the news had attained full front page status, 22% of section A's page 1 being devoted to Eyjafjallajökull. The main report, which was continued on page 4, again focused on cancellations and losses, but also began to report an absence of damage to test flights flown by airlines, including KLM, Air France and Lufthansa (*USA Today*, 19/4, 1(A1)). The optimistic tone of the headline "*Europe flights resume*" was in contrast to statements contained within the report that "*air traffic COULD return*

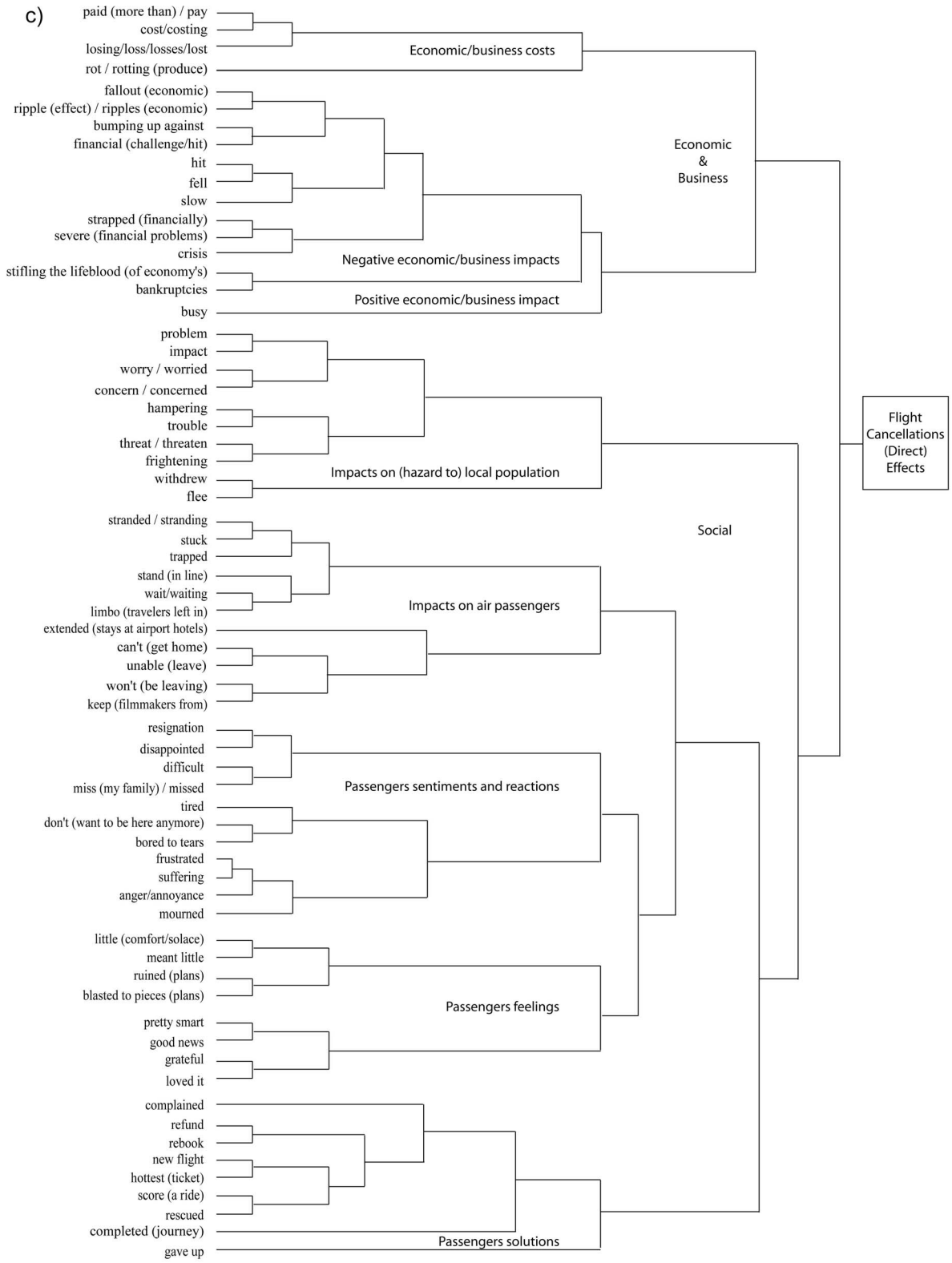

Figure 2. (continued)

to half its normal level this morning IF the dense cloud begins to dissipate" (*USA Today*, 19/4, 1(A1)). Although Germany was reported to have already allowed "*some flights*" to resume (*USA Today*, 19/4, 1(A1)), its airspace was listed as closed on page 4 (*USA Today*, 19/4, 4(A5)). Volcanological as well as social information was mostly given inside the paper, information describing the role and functioning of the Volcano Ash Advisory Centers, for

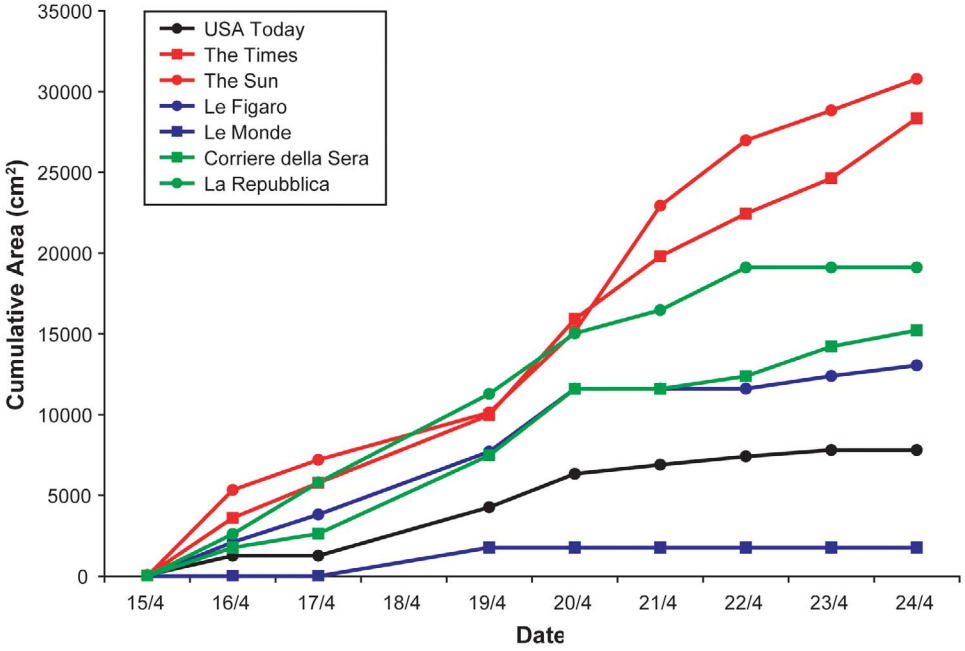

Figure 3. Cumulative area (in cm^2) devoted to Eyjafjallajökull in *USA Today* (black), *The Times* (red, squares), *The Sun* (red, circles), *Le Figaro* (blue, circles), *Le Monde* (blue, squares), *Corriere della Sera* (green, squares), and *La Repubblica* (green, circles) between 15 and 24 April 2020 (to allow comparison, Sunday column areas measured for *Corriere della Sera* and *La Repubblica* are excluded).

example, appearing on page 5 (*USA Today*, 19/4, 4(A5)). A social piece describing the problems facing travelers, alluding to problems of non-refundable costs and losses (e.g., for failed vacations due to cancellation of a connecting flight) also appeared on the same page (*USA Today*, 19/4, 6(A5)). Eyjafjallajökull also made page 1 of the business section, taking up 11% of section B's front page. Entitled "*Volcano casts shadow on air earning reports*" the report focused on losses experienced by the airline industry, suggesting that the closure COULD cost *U.S. airlines 10s of millions of dollars per day* (*USA Today*, 19/4, 8(B1)). The actual figure for losses was given as $22 million/day (*USA Today*, 19/4, 8(B1)), and compared with $20 million/day given on the page 1 report of section A (*USA Today*, 19/4, 1(A1)). The stating and quantifying of business losses on both the front pages of sections A and B, and relegation of social issues to latter pages, raises the question: was journalistic preference given to the losses suffered by airlines rather than the passengers?

[37] The air space closure continued to be front page news on Tuesday 20 April, comprising 26% of page 1 (section A). The front page report continued to promote optimism with the title "*For air travel, signs of hope as cloud lets up*" (*USA Today*, 20/4, 1(A1)). However, although the report began with the statement that there will be a "'*reduction in volcanic ash*" the following line read "*but uncertainty remains over when the aviation system will return to normal*" (*USA Today*, 20/4, 1(A1)). The listings of airports opening was also pitched in terms of "*hoping to open*" and "*would open*" (see Table 2). Such probabilistic optimism was summed up in the statement "*we SHOULD see progressively more planes start to fly*" (*USA Today*, 20/4, 1(A1)). Airlines were also remarked as arguing the shutdown was an overreaction. In spite of damage reported to F-16 fighter jets, with "*several NATO jets*" being recorded as having "*crystallized deposits in their engines after patrolling the region*" (*USA Today*, 20/4, 1(A1)). In contrast, British Airways were reported as having done (unspecified) tests, with the results being used to "*demonstrate that flying over Europe is safe*" (*USA Today*, 20/4, 1(A1)). Thus, conflicting information was beginning to creep in, with airlines leading the call for lifting of the flight ban. Again, reports describing the problems facing passengers, as well as addressing volcanological issues supported by expert statement, appeared inside the paper on page 6 (*USA Today*, 20/4, 2(A6)). The social report gave examples of individual losses (one passenger was cited as having to take a $2425 one-way car rental followed by a train), and reported that online booking systems had crashed, long-lines were forming for buses and trains, and phones were busy all the time (*USA Today*, 20/4, 1(A6)). It added that 150,000 British were estimated as stranded, with another 40,000 Americans being stranded in Britain (*USA Today*, 20/4, 1(A6)). An editorial pointing out that a lack of hard data meant that a decision regarding engine tolerances to ash ingestion was difficult to make, and encouraging a cautious approach in the meantime, also appeared on page 8 (*USA Today*, 20/4, 5(A8)). Again, Eyjafjallajökull featured prominently in the business section, taking up 14% of section B's second page. It pointed out that air companies were seeking financial aid as losses "*surge(d) past*" $1 billion, with British Airways claiming the impact to be worse than post-9/11 when compensation was paid (*USA Today*, 20/4, 6(B1)). Reported losses were an order of magnitude greater than those reported the previous day (Table 2), raising questions regarding clarity and consistency of information. The reason for this inflation, as discussed in

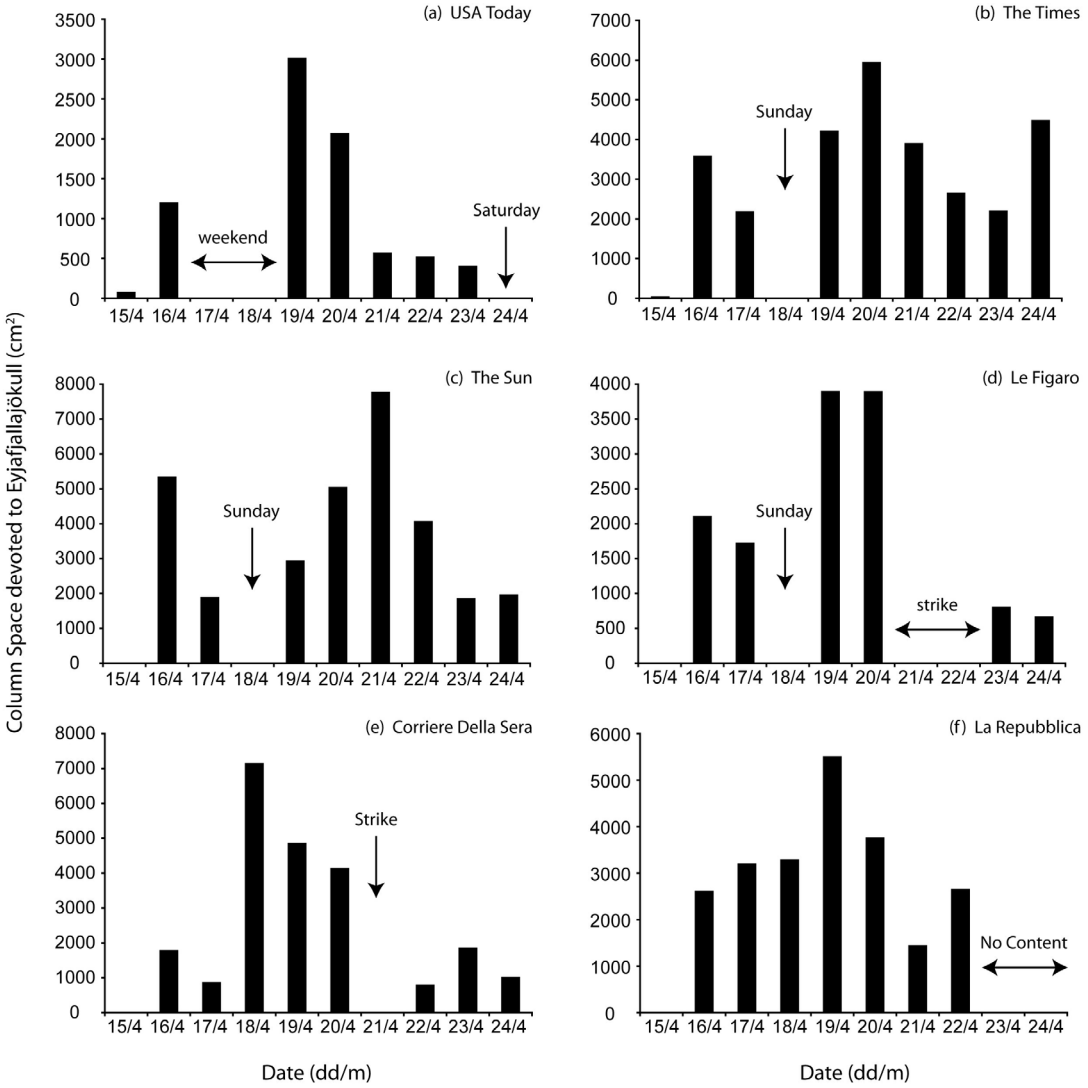

Figure 4. Daily newspaper area (in cm^2) devoted to Eyjafjallajökull in (a) *USA Today*, (b) *The Times*, (c) *The Sun*, (d) *Le Figaro*, (e) *Corriere della Sera*, and (f) *La Repubblica* between 15 and 24 April 2020.

the next section, was likely the use of global, rather than USA-only, figures, although this was not clarified in the report text.

[38] By Wednesday 21 April the main Eyjafjallajökull report had been relegated to page 6 of section A, where it took up 28% of the page space. The report, entitled "*Flights back to 46% of normal after volcano*," covered airport, airline and social issues together, reporting reopening of European airports with "*limited*" flight schedules (*USA Today*, 21/4, 1(A6)). However, many people were reported as stranded because "*financially strapped airlines try to keep as few empty seats as possible*" so that it could "*take more than a week to accommodate fliers*" with 300 being stranded at JFK, and 200 at Newark (*USA Today*, 21/4, 1(A6)). It also reported that Europe's airlines were suffering severe financial problems due to the shutdown, which was reported to have grounded more than 95,000 flights (*USA Today*, 21/4, 1(A6)). It went on to argue that larger airlines have cash reserves to make it through the "*crisis*," but smaller airlines face "*financial challenges*" speculating that the impact of the shut down will LIKELY exceed the short-term impact of September 11, when U.S. airlines canceled nearly 100,000 flights and "*which led to several bankruptcies*" (*USA Today*, 21/4, 1(A6)). Thus, the report began with a positive theme, but then focused on the problems of the stranded and airline financial losses, using the word "*bankruptcy*," although no air lines were listed as bankrupt, and giving the daily monetary loss suffered by Delta on the final line. It also contrasted with the previous days statement that the impact was worse than post-9/11. The only other report was on page 5 of section B. This painted an opposing picture. Entitled "*Delta posts optimistic outlook - expects profit in* 2nd *quarter despite volcano*," the report began by stating that "*Delta Airlines said Tuesday that canceling 400 flights across the Atlantic the last few days because of volcanic ash won't keep it from earning a solid profit in the second quarter*" (*USA Today*, 21/4, 2(B5)). It went on to report that "*Delta, the world's largest airline, said it lost only about $20 million as a result of the cloud of ash from Iceland*" and that "*Delta's experience suggests other U.S airlines could see smaller*

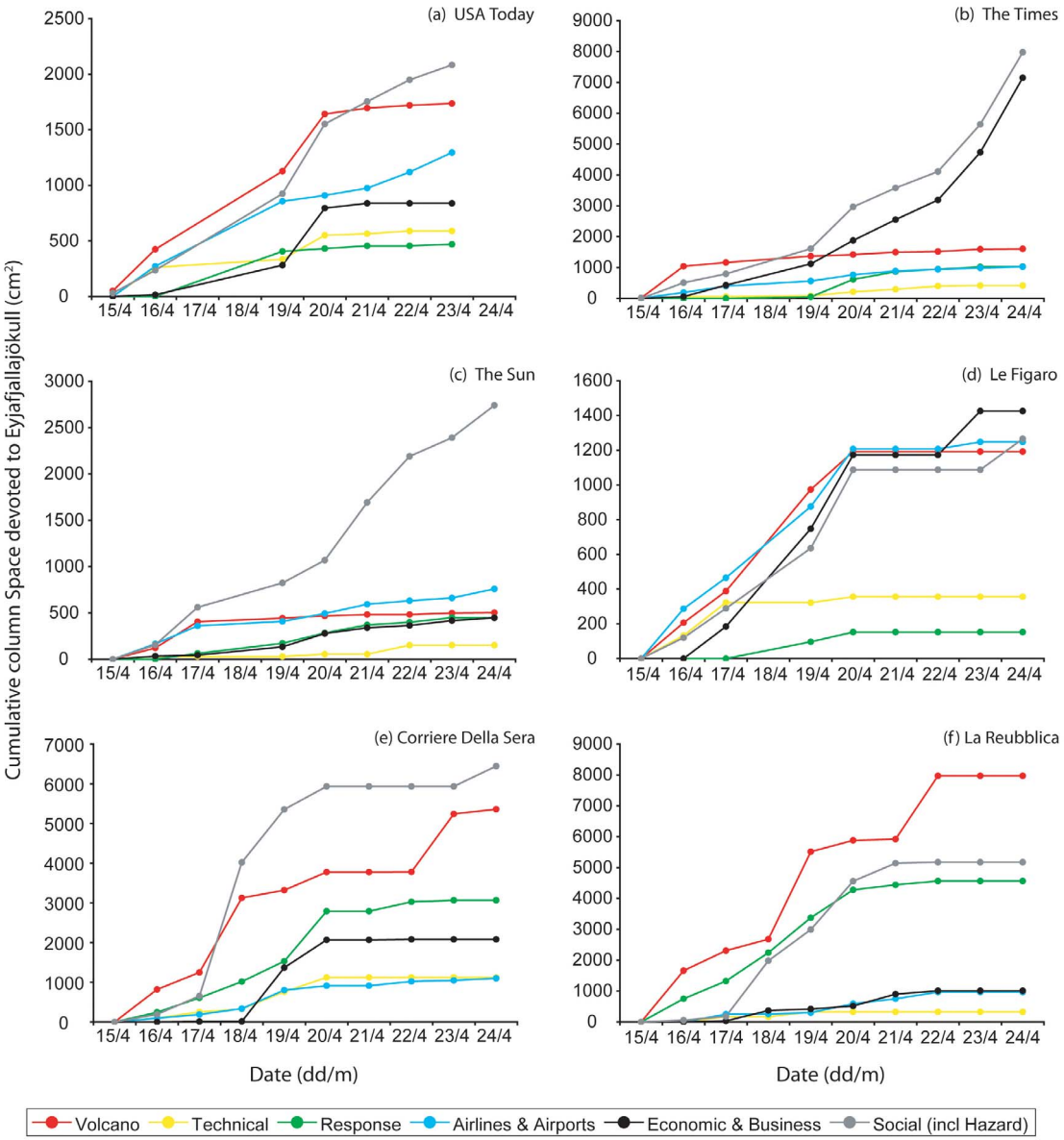

Figure 5. Cumulative area (in cm^2) covered by each information category in (a) *USA Today*, (b) *The Times*, (c) *The Sun*, (d) *Le Figaro*, (e) *Corriere della Sera*, and (f) *La Repubblica* between 15 and 24 April 2020.

losses than expected from the travel disruption" (*USA Today*, 21/4, 2(B5)). It also pointed out that Delta's loss (due to the volcano) was less than a third the size of that incurred during winter storms in 2010, when more than 7000 flights were canceled and $65 million was lost (*USA Today*, 21/4, 2(B5)).

[39] By Thursday 22 April Eyjafjallajökull had been reduced to a single report on page 10. Entitled "*Major European hubs reopen skies to air traffic*," the quoted statistics showed recovery with the number of cancellations decreasing (Table 2), but the report pointed out that it "*could take more than a week to clear the backlog of stranded passengers*" (*USA Today*, 22/4, 1(A10)). It was also reported that Spain had remained mostly open during the crisis and was arranging for special flights to move more than 40,000 stranded people (*USA Today*, 22/4, 1(A10)). Some of the report contained industry backlash, with British Airways stating that the shutdown was "*overkill*" and Ryan Air being quoted as saying "*it might have made sense to ground flights for a day or two. But there should have been a much faster response by the governments, the transport ministers and the regulators*" (*USA Today*, 22/4, 1(A10)). The stance of the editorial staff of the newspaper was, though, communicated through a cartoon showing a man reading paper and saying "*the volcanic ash is financially hurting airlines*," with the wife responding "*you know what that means*" (*USA Today*, 22/4, 2(A19)). The main report also gave information that, while test flights over Germany picked up various ash levels, there was no damage to the planes that completed the test flights (*USA Today*, 22/4, 1(A10)). The Finish Air Force was also reported to have found ash in the engine of an F-18

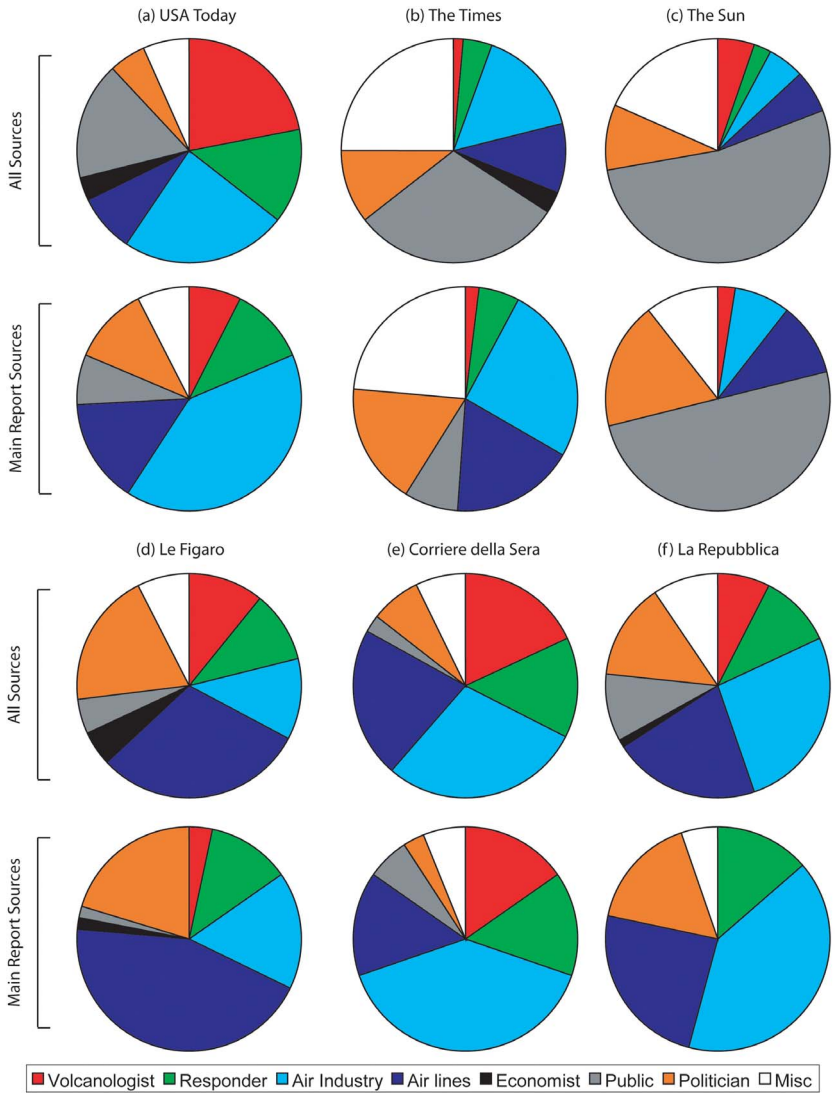

Figure 6. Pie charts showing the relative contributions of each group to all quotes given in the newspaper, as well as those for just the main report, in (a) *USA Today*, (b) *The Times*, (c) *The Sun*, (d) *Le Figaro*, (e) *Corriere della Sera*, and (f) *La Repubblica* between 15 and 24 April 2020.

Hornet jet, which caused no significant damage (*USA Today*, 22/4, 1(A10)).

[40] A single report on page 5 also appeared on Friday 23 April, by which time the focus was on efforts to get stranded passengers home with the Association of European Airlines being quoted as saying "*we don't know where they are and in what numbers, so we would expect it to go on into the early part of next week*" (*USA Today*, 23/4, 1(A5)). Although nearly all of Europe's 28,000 scheduled flights, including more than 300 transatlantic routes, were reported as going ahead (*USA Today*, 23/4, 1(A5)), extracted cancellation information as given in Table 2 still shows some uncertainty and inconsistency over the actual level of cancellations.

3.1.1. USA Today: Quantity and Type and Information Provided

[41] If we examine Figure 4a we see that *USA Today* coverage rose to a peak on 19 April, and then quite rapidly waned. However, the amount of coverage on individual days was impressive. On 19 April, for example, 28% of the first page was devoted to Eyjafjallajökull, with coverage occupying a total of 1.6 pages, out of section A's 10 pages of news on that day. Figure 5a shows that content was dominated by the volcanic and social information categories. The airlines and airports category received similar amounts of column space until 19 April, thereafter space devoted to this category began to diminish, with that devoted to economic and business impacts increasing (Figure 5a).

[42] Table 2 shows regular listings of closed airspace, as well as reopening. However, some contradiction is evident, such as on 19 April when a page A1 report stated that while Germany allowed "*some flights*" to resume, a page A4 report listed German airspace as closed. Also on 20 April, reopenings were listed in terms of airports that *would* resume flights or were *hoping* to open, rather than actual openings. However, we assume that opening did occur because Amsterdam, Heathrow and Paris were listed as open the following day. Table 2 also shows daily updates as to the

Table 4. Top 27 Words by Frequency in the *USA Today* Dictionary[a]

Rank	Word	Frequency	Percent	Classification
1	cancel/canceled/cancellation/ cancellations	25	9.29	Response
2	disrupt/disrupts/disruptive/ disruption/disruptions	12	4.46	Response
3	closed/closing/closings	9	3.35	Response
4	stranded/stranding	8	2.97	Social
5	grounds/grounded	6	2.23	Response
6	losing/loss/losses/lost	6	2.23	Economic and Business
7	open/reopen/reopened	6	2.23	Response
8	impact	5	1.86	Airports and Airlines
9	not	5	1.86	All
10	affected	4	1.49	All
11	frustrated	4	1.49	Social
12	shut down	4	1.49	Response
13	ban/bans	3	1.12	Response
14	can't	3	1.12	All
15	chaos	3	1.12	Response
16	cost/costing	3	1.12	Economic and Business
17	dramatically	3	1.12	Response
18	fallout	3	1.12	Economic and Business
19	flee	3	1.12	Social
20	miss (my family)/missed	3	1.12	Social
21	no (immediate danger/ problems/telling)	3	1.12	Volcanic
22	resume/resumed	3	1.12	Airports and Airlines
23	ripple (effect)/ripples (economic)	3	1.12	Economic and Business
24	rot/rotting	3	1.12	Economic and Business
25	stuck	3	1.12	Social
26	unable	3	1.12	Social
27	wait/waiting	3	1.12	Social
Sum		139	52	

[a]The cut off is the frequency of two; a cut off that includes 52% of all words in the dictionary.

Table 5. Top 29 Words by Frequency in *The Times* Dictionary[a]

Rank	Word	Frequency	Percent	Classification
1	stranded	85	5.34	Social
2	cancel/canceling/cancellation/ cancelled/cancelling	50	3.14	Response
3	cost/costing/costs	40	2.51	Economic and Business
4	close/close/closed/closing/closure	32	2.01	Response
5	disrupt/disrupted/disruption	30	1.88	Airports and Airlines
6	lose/losers/loses/losing/loss/losses/lost	26	1.63	Economic & Business
7	ground/grounded/grounding	24	1.51	Airports and Airlines
8	refund/refunded/refunds	20	1.26	Social
9	hope/hoped/hopeful/hopes/hoping	19	1.19	All
10	open/opened/opening	19	1.19	Airports and Airlines
11	crisis	17	1.07	Volcanic
12	pay/paying/pay out	15	0.94	Economic and Business
13	suspend/suspended/suspension	15	0.94	Response
14	restricted/restrictions	14	0.88	Response
15	shut down/shuts down/shutting down	14	0.88	Response
16	rescue/rescued	13	0.82	Social
17	return/returned/returning	13	0.82	Social
18	home	12	0.75	Social
19	miss/missed/missing	12	0.75	Social
20	resume/resumed/resuming/resumption	12	0.75	Airports and Airlines
21	stuck	12	0.75	Social
22	problem/problem	11	0.69	Airports and Airlines
23	risk	11	0.69	Volcanic
24	unable	11	0.69	All
25	alter/alternative/alternatively	10	0.63	All
26	arrive/arrived/arriving	10	0.63	Social
27	chaos/chaotic	10	0.63	Response
28	extra	10	0.63	Response
29	struggle/struggled/struggling	10	0.63	Social
Sum		577	36	

[a]The cut off is the frequency of 10; a cut off that includes 36% of all words in the dictionary.

Table 6. Top 32 Words by Frequency in *The Sun* Dictionary[a]

Rank	Word	Frequency	Percent	Classification
1	stranded/stranding	54	4.63	Social
2	home	37	3.17	Social
3	crisis	22	1.89	Volcanic
4	stuck	22	1.89	Social
5	chaos/chaotic	20	1.72	Airports and Airlines
6	rescue/rescued/rescues	16	1.37	Social
7	cancel/cancellation/cancelled	15	1.29	Response
8	ban/banning/bans/barred	14	1.20	Response
9	cost/costing/costly/costs	13	1.11	Economic and Business
10	grounded/grounding	13	1.11	Airports and Airlines
11	reopen/reopened/reopening	13	1.11	Response
12	return/returned/returning	13	1.11	Social
13	close/closed/closing/closure	12	1.03	Response
14	back	11	0.94	Social
15	compensated/compensation	10	0.86	Social
16	delay/delayed/delays	9	0.77	Airports and Airlines
17	fear/feared/fearing/fears	9	0.77	All
18	help/helped/helping	9	0.77	Social
19	hit	9	0.77	All
20	pay/paying/payouts	9	0.77	Economic and Business
21	refund/reimburse/repay	9	0.77	Social
22	trapped	9	0.77	Social
23	disruption/disrupts	8	0.69	Airports and Airlines
24	hope/hoped/hoping	8	0.69	All
25	losing/losses/lost	8	0.69	Economic and Business
26	plan/planned/plans	8	0.69	All
27	wait/waiting	8	0.69	Social
28	warned	8	0.69	Response
29	arrive/arrived/arriving	7	0.60	Social
30	problem/problems	7	0.60	All
31	safe/safely/safety	7	0.60	Airports and Airlines
32	shut/shut down	7	0.60	Airports and Airlines
Sum		424	36	

[a]The cut off is the frequency of seven; a cut off that includes 36% of all words in the dictionary.

Table 7. Top 23 Words by Frequency in *Le Figaro* Dictionary[a]

Rank	Word	Frequency	Percent	Classification
1	fermé/fermeture	23	5.11	Response
2	annulait/annulation/annulé	20	4.44	Response
3	bloqué	20	4.44	Social
4	crise	15	3.33	All
5	perd/perdait/perdre/perdus/perte	13	2.89	Economic and Business
6	paralyse/paralyserait/paralysie	12	2.67	Airports and Airlines
7	pertuberait/perturbation/ perturbations/perturbé	12	2.67	Airports and Airlines
8	difficile/difficilement prévisible/difficultés	8	1.78	Social
9	menaçant/menace	8	1.78	Volcanic
10	cloués	7	1.56	Airports and Airlines
11	danger/dangereux/dangerosité	7	1.56	Technical
12	impact	6	1.33	Volcanic
13	riques/risquent/risques	6	1.33	Volcanic
14	aide	5	1.11	Social
15	éviter	5	1.11	Response
16	ouverture/réouverture	5	1.11	Response
17	urgence/urgents	5	1.11	Response
18	mal	4	0.89	Airports and Airlines
19	malade	4	0.89	Airports and Airlines
20	problème	4	0.89	Airports and Airlines
21	provoqué	4	0.89	Response
22	rapatriement/rapatrier	4	0.89	Social
23	reprise	4	0.89	Airports and Airlines
Sum		201	53	

[a]The cut off is the frequency of three, a cut off that includes 53% of all words in the dictionary.

Table 8. Top 31 Words by Frequency in *Corriere della Sera* Dictionary[a]

Rank	Word	Frequency	Percent	Classification
1	chiudere/chiusa/chiusi/chiuso/chiusura	30	3.44	Response
2	blocca/bloccano/bloccate/bloccati/ bloccato/blocco	24	2.75	Response
3	cancellare/cancellata/cancellate/ cancellati/cancellato/cancellazione/ cancellazioni	22	2.52	Response
4	rimborsa/rimborsate/rimborsato/rimborserà/ rimborsi/rimborso	17	1.95	Social
5	riaperto/riapertura/riapre/riaprono	14	1.60	Response
6	a terra	13	1.49	Airports and Airlines
7	perdita/perdite/perdono	12	1.37	Economic and Business
8	sicurezza/sicuri	11	1.26	Response
9	caos	10	1.15	All
10	annullano/annullare/annullate/annullati/annullato	9	1.03	Airports and Airlines
11	modelli/modellizazioni/modellizzazione/modello	9	1.03	Technical
12	paralisi/paralizzare/paralizzato	8	0.92	Airports and Airlines
13	problema/problemi	8	0.92	All
14	brandine	7	0.80	Social
15	danni/danno	7	0.80	All
16	pericoli/pericolisità/pericolo/pericolosa/pericolose	7	0.80	Volcanic
17	rimanere/rimaste	7	0.80	Social
18	rischi/rischio	7	0.80	Volcanic
19	esaurire/esaurita/esaurito	6	0.69	Social
20	gigante/gigantesca	6	0.69	Volcanic
21	niente	6	0.69	All
22	normale/normalita	6	0.69	Response
23	abrasiva	5	0.57	Technical
25	costretti/costretto	5	0.57	Social
26	diritti/diritto	5	0.57	Social
27	disagi	5	0.57	Social
28	eccessive/eccesso	5	0.57	Response
29	impossibile/impossibilitati	5	0.57	All
30	mancanza/mancata/mancati	5	0.57	Social
31	previsione/previsioni	5	0.57	Response
Sum		283	33	

[a]The cut off is the frequency of five, a cut off that includes 33% of all words in the dictionary.

number of flights canceled, which shifts to listings of number of flights allowed or completed on 21 April. Again there are some inconsistencies, as on 21 April when a page A6 report reported that ~13,000 flights, or 46% of the normal daily total of 28,000, had been completed the previous day. The means that 15,000 flights must have been canceled. If we add this number of new cancellations to the previous day's cumulative total of 70,000 canceled flights we arrive at a new total of 85,000. However, later in the same report we find the statement that the shutdown had grounded more than 95,000 flights so far.

[43] The level of financial loss was updated daily after 16 April, although losses were typically only given in regard to the losses suffered by airlines, as listed in Table 2. It was not until 21 April that a figure for total economic losses was given, and then only for losses suffered by the U.S. economy ($650 million). There appears to be a disparity between the airline daily losses encountered on 19 April ($20–22 million/day) and 20 April ($200 million/day). As already discussed, this likely results from mixing of losses experienced solely by U.S. airlines (the former figure) and all airlines (the latter figure). There are also some apparent inconsistencies on 19 April, where we assume that the figure for total losses of $1 billion given on page A1 is for losses suffered by all airlines, whereas the total loss of $80 million given on page B1 is just for U.S. airlines. However, we cannot explain why the figure of $1 billion did not increase between 19 and 20 April (Table 2), nor can we mathematically square these numbers. The total loss for U.S. airlines on 19 April (presumably for the first four days of airspace closure) is given as $80 million, but the daily loss ($22 million/day) multiples to $88 million. Likewise the assumed total global loss of $1 billion only works if the daily average ($200 million/day) is multiplied by five days rather than four; explaining why the figure remained the same the following day.

3.1.2. USA Today: Dictionary

[44] A total of 136 different words were entered into the *USA Today* dictionary. They show a logarithmic decay in their frequency of usage (Figure 7a), so that just 27 of all words made up ~50% of the total used. These 27 words, all of which have a frequency of greater than two, are given in Table 4 and are dominated by words associated with the response, social and economic/business categories. These categories contribute nine, six and five words to the top 27 word listing, for a total of 20, with words associated with the response taking up the top three places; contributing almost 20% of all words used. The top 27 (most used) words, as given in Table 4, also show a negative tendency, with only two of the words (*open* and *resume*) having positive connotations. *Canceled* was the most used word, appearing 25 times, with its opposite, *resume*, only appearing three times. Likewise, while the word *closed* was used nine times, *open* appeared six times; while *stranded* and *stuck* were used 11 times, *rescued* and *going home* were used just twice.

Table 9. Top 34 Words by Frequency in *La Repubblica* Dictionary[a]

Rank	Word	Frequency	Percent	Classification
1	chiudere/chiusi/chiuso/chiusura	56	5.44	Response
2	bloccando/bloccare/bloccata/bloccati/bloccato/blocco	54	5.24	Response
3	cancellare/cancellati/cancellato/cancellazione/cancellazioni	31	3.01	Response
4	riaperti/riaperto/riapertura/riaprirà/riaprono	23	2.23	Response
5	danni/danno	15	1.46	All
6	rischi/rischia/rischio/rischioso	15	1.46	Volcanic
7	sicurezza	14	1.36	Response
8	a terra	12	1.17	Airports and Airlines
9	costa/costare/costata/costerà/costi/costo/costose/costoso	12	1.17	Economic and Business
10	emergenza	12	1.17	Response
11	caos	11	1.07	All
12	pericoli/pericolo/pericolosa/pericolose/pericolosità	11	1.07	Volcanic
13	normale/normali/normalità	10	0.97	Response
14	aperti/aperto/apertura/aprirà/aprire	9	0.87	Response
15	disagi	9	0.87	Social
16	fermare/fermato/fermi	9	0.87	Response
17	paralisi/paralizzare/paralizzata/paralizzati	9	0.87	Airports and Airlines
18	problema/problemi	9	0.87	All
19	crisi	8	0.78	All
20	perde/perdere/perdita/perdite	8	0.78	Economic and Business
21	stop	8	0.78	Response
22	tornare/tornata/tornato	8	0.78	All
23	impatto	7	0.68	All
24	presi d'assalto	7	0.68	Social
25	prevedere/previsioni/previsti	7	0.68	Response
26	coda/code	6	0.58	Social
27	persi/perso	6	0.58	Economic and Business
28	rimaner/rimasti	6	0.58	Airports and Airlines
29	rinuncia/rinunciare	6	0.58	Social
30	colpire/colpite/colpiti/colpito	5	0.49	Social
31	costratta/costretti	5	0.49	Social
32	decollano/decollato/decolleranno/decolli/decollo	5	0.49	Airports and Airlines
33	pesante/pesanti	5	0.49	All
34	preoccupante/preoccupati/preoccupazione	5	0.49	Social
Sum		423	41	

[a]The cut off is the frequency of five, a cut off that includes 41% of all words in the dictionary.

Interestingly the word *crash* was only used once, and then in regard to a computer system. Also some positive words were actually used in a negative sense. *Good news*, for example, was used in the context, "*good news, we can go back home: many people can't*" and *pretty smart*" in the context "*it would have been pretty smart to do some research regarding safe levels before hand*." This points to a content bias toward negative/bad news, as opposed to positive/good news.

[45] The cluster analysis of Figure 2 indicates a reasonable level of information provision regarding the detrimental impacts of volcanic ash to aircraft operations (see the words associated with the *detrimental engine effects* sub-category of Figure 2a). The same cluster analysis also reveals some interesting reactions and interrelations. For example, resolution of problems facing passengers (due to canceled flights) included "*giving up*" and going home, as well as being *rescued*. The word "*rescued*" has connotations linked, no doubt, to feelings of being "*stranded,*" "*stuck*" and "*trapped*" far from home and "*family*", as indicated by the words listed in the sub-categories above the passengers solutions sub-category, in which the word *rescue* resides (Figure 2c). Indeed, examining the words associated with each cluster and sub-cluster allows us to quickly understand the nature of the problem, response, effects and reactions. Note, for example, the words used within the passenger sentiments and feelings category (Figure 2c). These indicate a high degree of fatigue evolving into anger. The words associated with the *reaction to, and opinion on, air space closure* sub-category of Figure 2b are also telling, and include *doubt*, *lack of consensus*, *overreaction*, *inability* and *failure*.

3.1.3. USA Today: Information Sources

[46] The high degree of volcanic information provided by *USA Today* seems to be linked with their use of volcanologists (and scientists working in associated disciplines) as sources, with this group providing 22% of the quoted information (see Text S2 for full listing of sources used by *USA Today*). Six of the 13 volcanological sources were from U.S.-based institutes. This level of information provision was second only to that provided by the air industry, who provided 24% of all quotes (Figure 6a). If we combine volcanologists and responders into one group, and air industry and airlines into a second, we find that the former provided 36% of the quotable information and the latter 32%.

[47] The apparently high contribution of the volcanologists is, however, heavily influenced by a single report appearing on page 5 of section A on 19 April. This report contained five (or nearly 40%) of all quotations given by volcanologists in *USA Today* during the analysis period Although continued from a page 1 report, the page 8 report was very much a Type II review, as opposed to the Type I (news) content of the page 1 segment. A comparison of the two segments comprising this report is given in Note 4 of Text S1. The comparison is extremely interesting in terms of

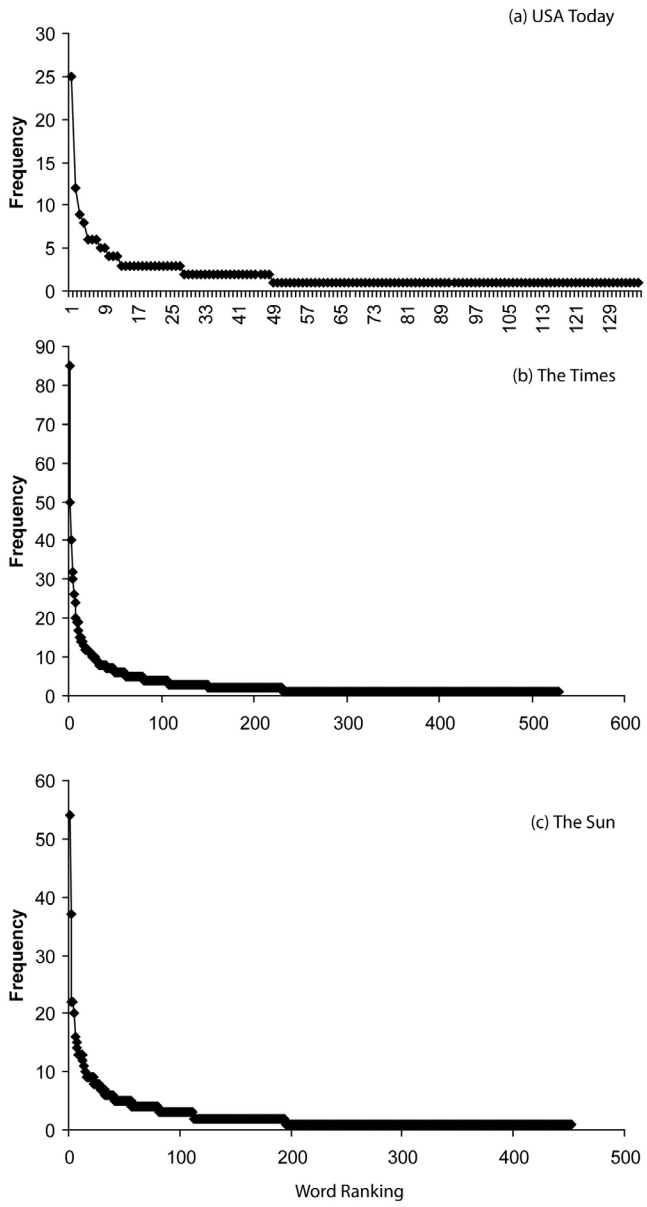

Figure 7. Frequency of word usage by rank for (a) *USA Today*, (b) *The Times*, and (c) *The Sun*.

the differences in strength and type of information given in each segment, as well as the sources associated with each. Whereas the page 1 segment gives current information about the ash cloud and its impact, with a dominance of facts and quotes from the airlines and air industry, the page 5 segment gives more measured facts and explanations about Eyjafjallajökull's eruptive history and ash cloud impacts on air routes, with the latter half of the segment covering gas effects on local populations and global climate.

[48] If we examine the information sources cited on just page 1, the situation changes further. Now the air industry and air lines become responsible for 43% and 15% of the quotable information, respectively; volcanologists fall to 7% and responders to 11% (Figure 6a). While the relative contribution of quotes from politicians increases from 5% (if we consider all quotes) to 11%, those from the public decreases from 17% to 7%. This seems to support the supposition that, if we consider the main (first) report appearing in *USA Today* during the period of air space closure, news associated with airlines, their losses and reactions were given prominent (page 1) space, causing a front page dominance of the opinion and views of the air industry, air lines and politicians. We return to these issues in the discussion.

3.2. The Times, The Telegraph, and The Sun

[49] After *USA Today*, *The Times* was the only other newspaper considered in this study that covered Eyjafjallajökull on 15 April. However, the space set aside on that day was small and, thereafter, space devoted to Eyjafjallajökull was similar across all three of the English newspapers examined, with *The Times* and *The Telegraph* setting aside almost identical page area's on all days (Figure 8). The content of this coverage is detailed in Text S4.

3.2.1. The Times and The Sun: Quantity and Type and Information Provided

[50] If we examine Figure 4b we see that coverage in *The Times* and *The Sun* rose to a peak on the 20 and 21 April. It then waned but remained at a relatively high level through the end of the study period as the trials and tribulations of, and reimbursement issues facing, returning passengers were reported. As in the *USA Today*, the amount of coverage was impressive. On 20 April, for example, almost 8% of the 72 page long edition of *The Times* was devoted to Eyjafjallajökull; on 21 April 13% of *The Sun's* 56 pages were devoted to Eyjafjallajökull. While Figure 5b shows that content in *The Times* was dominated by social and economic/business information, Figure 5c shows that *The Sun* was completely dominated by the social category which, by the end of the study period, had accounted for 54% of all material reported. In both newspapers, content regarding volcanological issues ceased to increase after 17 April, with all other categories not increasing much after 21 April, in contrast to the steady and steep increase in the cumulative space devoted to social issues (Figure 5b).

[51] Table 2 shows listings of closed airspace, as well as reopening, given in *The Times* and *The Sun*. While *The Sun* provided detailed listings for closure, there were few details (beyond Britain) regarding re-opening. The inverse was true for *The Times*, with poor coverage of closure, but detailed listings of re-opening. After 21 April, no details were given in either paper for air space limitations or relaxations. Listings of flight cancellations continued in both newspapers until 22 April. There is some inconstancy between *The Times* and *The Sun* on 17 April when 17,000 flights were listed as canceled by the former, and 16,000 by the latter. There is, though, good agreement between cancellation figures given in *The Times* and *USA Today* on 19 April, but then disagreement on 20 April (Table 2). *The Times* and *USA Today* also agree over the final total for cancellations (95,000), with *The Sun* giving 102,000 (Table 2).

[52] For financial losses, there are several contradictions and sources of confusion (Table 2). While *The Times* gives losses experienced by airlines as £200 million per day on 17 April, this switches to $200 million (£130 million) per day on 19 April. Again, there could be a currency problem in *The Times*' assessment on 19 April that $1 billion had been lost by the travel industry, compared with *The Sun's* estimate of £1 billion losses to the economy in general. The

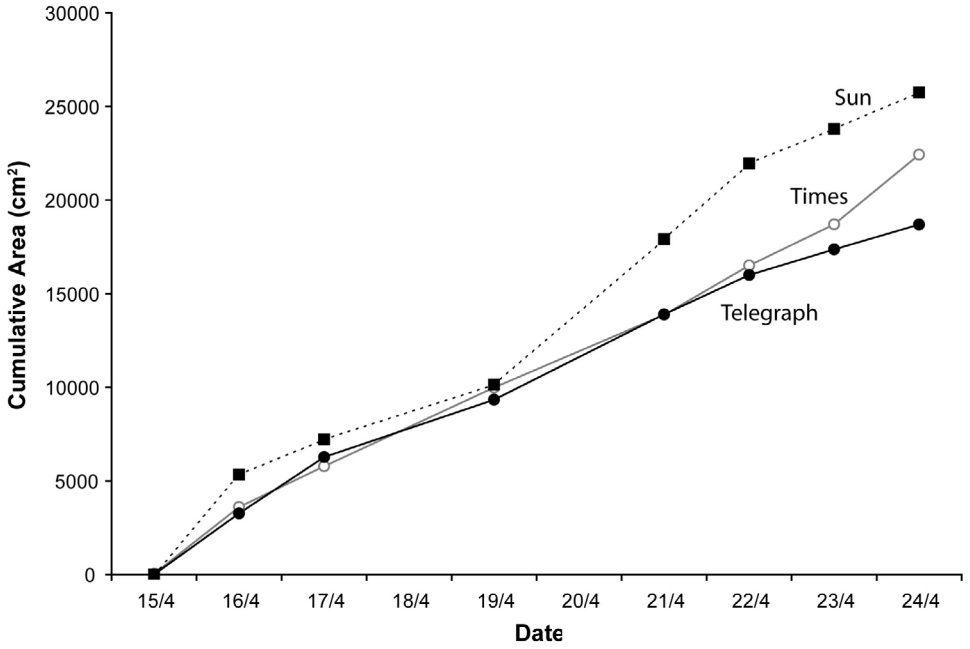

Figure 8. Cumulative area (in cm^2) devoted to Eyjafjallajökull in *The Daily Telegraph*, *The Times* and *The Sun* between 15 and 24 April 2020.

situation becomes more confused the following day, when *The Times* switches to £1.3 billion for losses suffered by the European economy, with *The Sun* giving £1 billion loss for just the UK economy. On 20 April, there were also inconsistencies in the total airline loss given by *The Times* on page 1 (£630 million) and page 4–5 (£650 million), as well as losses for individual airlines quoted by the two newspapers. British Airways, for example, was quoted as having suffered losses £80 million in *The Times*, but £100 million in *The Sun*. Both papers, though, closed in on total airline losses of $1.7 billion or £1 billion as of 22 and 23 April (Table 2).

3.2.2. The Times and The Sun: Dictionaries

[53] While a total of 529 different words were entered into the dictionary for *The Times*, 452 words were entered into *The Sun* dictionary. The greater number of words entered into these two dictionaries when compared with those entered into that compiled for *USA Today* reflect the greater amount of column space devoted to Eyjafjallajökull by the two British papers. Between three and four times more words were entered into the dictionaries for the two British papers, whose coverage by column space also exceeded that of *USA Today* by a factor of ~4. Again, the words show a logarithmic decay in their frequency of usage (Figures 7b and 7c) so that, while in *The Times* 29 words made up 36% of the total used, in *The Sun* 32 words comprised 36% of the total. The top-ranked word listings are given in Table 5 for *The Times* and in Table 6 for *The Sun*. Despite the former being a broadsheet and the latter being a tabloid, there is a high degree of similarity in the words used between the two papers, with *stranded* topping both listings and 18 of the most frequently used words in *The Times* also appearing in the top-ranked words used by *The Sun*. Further down the listings there are differences, for example while *The Sun* used fumed/furious/fury four times, *The Times* did not use these words at-all.

[54] Both listings are dominated by words associated with the social category, which contribute seven words to *The Times* listing and ten to *The Sun* listing, followed by words associated with the response and airlines/airports categories. As with the *USA Today*, both Tables 5 and 6 show a negative tendency, with only three of the words having positive connotations in both listings, these being the same three words in both cases: *open* (or *reopen), return* and *arrive*. The words *chaos* and *crisis* also appear in both listings, as do the words *rescue*, *return*, *home*, and *stuck*, with *stranded* being by far the most frequently used word in both lists. The word *chaos*, by definition, indicates a feeling of utter confusion where, in this case, both the travel and volcanic effects were deemed *chaotic*, with *The Sun* also using the words *havoc*, *pandemonium* and *mayhem* in place of *chaos* on occasion. Many of these words result from a focus on repatriation issues in both papers; no doubt a result of UK being an island which increases the difficulties for those wanting to return home and forcing a strong feeling of being *stranded*, with both papers also using the word *marooned* re-enforcing the British island mentality. The common use of the word *home,* which was the 2nd most frequent word in *The Sun* dictionary and the 18th ranked word in *The Times* dictionary (with a total of 49 occurrences) also stresses a strong sense of place in the reporting of both papers.

3.2.3. The Times and The Sun: Information Sources

[55] The high degree of socially focused reporting is reflected in the information sources used by *The Times* and *The Sun*, as listed in Text S2. In *The Times*, the public provide 29% of all quoted information, followed by the air industry (16%), politicians (11%), airlines (10%); with the miscellaneous category accounting for 25% (Figure 6b). The miscellaneous category is largely composed by experts from other transport forms (30%), sports people (20%) and banks/insurance representatives (10%). Volcanologists represent just 2% of all sources (Figure 6b). Volcanologists provided

just three quotes, with only one coming from a UK-based volcanologist (Text S2). As with the *USA Today*, if we just consider the first or main report, the public become squeezed out by the air industry, politicians and airlines (Figure 6b). While the public contribution falls to 8%, that of the air industry increases to 24%, and politicians and airlines both increase to 18%.

[56] Likewise, in *The Sun* the public provide the majority (53%) of all quoted information, followed by politicians (10%), air lines (6%) and air industry (5%), with the miscellaneous category accounting for 18% (Figure 6c). In The Sun's case, the miscellaneous category is mostly comprised sports people (62%) and personalities (24%). The difference between *The Sun* and all other newspapers is that, if we consider just the main report, the dominance of the public category does not decline, maintaining a level of 49% (Figure 6c). Quoted information provided by the politicians does increase (to 18%), as does that for the air lines (11%) and air industry (8%), but this is at the expense of the miscellaneous category which declines to 11%. Again the contribution of the Volcanologists to information published in *The Sun* was small, providing just 5% of the total information, and 3% of the main report information (Figure 6c). None of these volcanological sources were associated with a UK-based institution (Text S2).

3.3. Le Monde and Le Figaro

[57] Although reports regarding Eyjafjallajökull appeared in *Le Monde* on 10, 11 and 13 May, during the study period reports only appeared once, on 19 April. Even on that day coverage was rather limited, totaling a column area of 1766 cm^2 or 4.5% of the paper, with most (60%) of the information appearing on page 4. The page 1 component was a flag for the page 4 reports, featuring a photo of Roissy airport with the title "*air transport a prisoner to a cloud*" (The original French text for all translated headlines and captions is given in Note 5 of Text S5) [Monde, 19/4, 1(1)]. The readers of *Le Monde* thus received little daily information regarding Eyjafjallajökull during the event. Reporting in *Le Figaro* was somewhat more regular, news regarding Eyjafjallajökull appearing on all days, except 21 and 22 April when *Le Figaro* was on strike. We thus concentrate our analysis of the French newspapers on *Le Figaro* from herein, as well as in the content notes of Text S4.

3.3.1. Le Figaro: Quantity and Type and Information Provided

[58] Our analysis shows that coverage in *Le Figaro* rose to a peak on 19–20 April, and then rapidly waned. The amount of coverage was once more impressive, with all of pages 8 and 9 being devoted to Eyjafjallajökull on 16 April, and most of pages 2, 3 and 4 being given over to Eyjafjallajökull on 19 and 20 April. However, the main report never made page 1 and was always relegated to inside pages. Figure 5d shows that content was fairly evenly distributed between all categories except the technical and response categories, which received by far the least attention. The technical category received similar amounts of column space to all other categories until 17 April, and thereafter received very little attention (Figure 5d).

[59] Table 3 shows that complete listings of closed, as well as open, airspace occurred on only one day (17 April). Table 3 also shows that statistics for flight cancellations and completed flights was mostly given for flights to and from French airports on 16 April. A daily number of all canceled flights was given on 17 April and a total number for all flights canceled since the beginning of the crisis on 19 April. Thereafter no new numbers were given. The level of financial loss was also given rather inconsistently, being 150 million euro/day on 19 April increasing to 250 million euro/day on 20 April. These were just losses for airlines, and the total loss of 7 billion euro given for 20 April must be the full economic cost, but is somewhat larger than total losses reported in the U.S. and British press. Thereafter just a single figure, the daily loss incurred by Air France, was given on 23 April.

[60] Further inconsistency was apparent in the number of French citizens stranded abroad. On 19 April, the main report of *Le Monde* stated, three times (once in the headline and again twice in the body of the article), that 150,000 French were blocked abroad (*sont bloqués à l'étranger*) and needed repatriation (*à rapatrier*) (*Monde*, 20/4, 2(2)). Instead, a report on page 4 gave a figure of 50,000 and stated that between 150 and 200 flights (*rotations*) would be required to bring them home (*Monde*, 20/4, 5(4)). The 50,000 figure for stranded French seems more likely, as repatriation of 150,000 would require planes with passenger capacities of between 750 and 1000, as opposed to the 250 to 350 passenger capacity required to bring home 50,000 French citizens. We note here that, as of July 2007, the Air France fleet comprised 253 passenger aircraft with an average capacity of 265 (see Note 5, Text S1). If flown at full capacity, the Airbus A380 can carry 853 passengers, but only six such aircraft were available, the most common aircraft in the fleet, the Airbus A319, having a maximum capacity of 156.

3.3.2. Le Figaro: Dictionary

[61] A total of 203 different words were entered into the *Le Figaro* dictionary. They show a logarithmic decay in their frequency of usage, so that just 23 of all words made up ~50% of the total used. These 23 words, all of which have a frequency of greater than three, are given in Table 7 and are dominated by words associated with the response and airports/airlines categories. These categories contribute six and seven words to the top 23 word listing, for a total of 13, with words associated with the response taking up the top two places; contributing almost 22% of all words used. The word *loss* (in terms of business and economic loss) was also well placed, being 5th with a frequency of 13.

[62] The most used words of Table 7 again show a negative tendency, with only three of the words (*open*, *repatriation*, and *resume*) having positive connotations. *Closed, canceled* and *block*ed were the most used words, *closed* appearing 23 times, and *canceled* and *block*ed both appearing 20 times. Their opposites, *open, resume and repatriate*, however, had frequencies of five, four and four, respectively. We note that, while the word *blocked* was used for people, *paralyzed* was reserved for effects to air traffic. Also some quite evocative and powerful words, such as *menace* and *nailed or pinned* (as in nailed or pinned to the ground) were among the most used words, as were *danger* and *risk*, as well as *sick* or *ill*.

3.3.3. Le Figaro: Information Sources

[63] A tabulation of the exact sources and affiliations used by *Le Figaro* is given in Text S2, and plotted in Figure 6d.

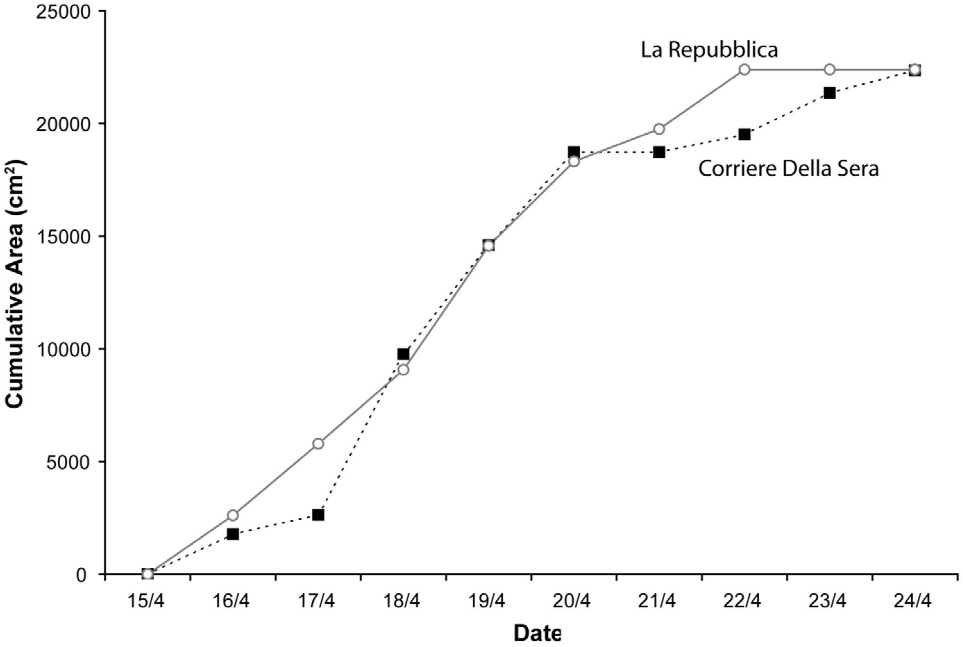

Figure 9. Cumulative area (in cm^2) devoted to Eyjafjallajökull in *Corriere della Sera* and *La Repubblica* between 15 and 24 April 2020.

We see that air lines is by far the dominant sector providing 30% of all quotes, followed by politicians (19%) and air industry (12%), thereafter come volcanologists (11%) and responders (10%), with the public accounting for just 5%. If we consider only the main or first article appearing in each issue (Figure 6d), the disparity becomes wider. Now the contribution of airlines increases to 44% of all quotes, politicians to 20% and air-industry to 17%. This is at the expense of the volcanologist, who declines to 2% and public, who decline also to 2%. The responder category increases slightly to 12%; but clearly the most dominant opinions and views are those of the air industry, air lines and politicians.

3.4. Corriere della Sera and La Repubblica

[64] As in the United Kingdom, space devoted to coverage of Eyjafjallajökull was similar across the two Italian newspapers examined. The spatial coverage for *Corriere della Sera* and *La Repubblica* was, in fact, more or less identical (Figure 9). Coverage in both newspapers began on 16 April; that of *La Repubblica* ending in 22 April, but that of *Corriere della Sera* continuing through 24 April. The detail of this content is given in Text S4.

3.4.1. Corriere della Sera and La Repubblica: Quantity and Type and Information Provided

[65] If we examine Figure 4 we see that coverage in the *Corriere della Sera* and *La Repubblica* reached a peak on the 18 or 19 April. It then waned, reaching zero coverage in *La Repubblica* by 23 April. Both newspapers had high degrees of coverage for social, volcanological and response issues, *La Repubblica* being the only newspaper among those examined where the volcanological class was the primary category (Figure 5). On several days, near-full page volcanological pieces appeared in *Corriere della Sera* and *La Repubblica.* This focus may reflect Italy's close relation with volcanoes and volcanic activity.

[66] Table 3 gives listings of closed airspace, as well as reopening, given by *Corriere della Sera* and *La Repubblica*. Both newspapers gave daily, and detailed, listings of closures and openings, supported by maps and charts. Lists of flight cancellations were equally rigorous, *La Repubblica* itemizing the number of flights canceled by airport in Italy on at-least three days (see Table 3). There were, though, some inconsistencies. On 16 April, for example, 8000 flight cancellations were reported by *La Repubblica*, as opposed to 4000 reported by *Corriere della Sera*. In *La Repubblica*, the number of flights canceled from Rome Fiumicino on 15 April also differed between the page 12 report of 16 April, this number being 46 (*Repubblica*, 16/4, 2(12)) and the page 13 report of the same day, at which point it was 55 (*Repubblica*, 16/4, 4(13)). There also continued to be an inconsistency in the total number of cancellations. *La Repubblica* gave 95,000 on 21 April, agreeing with the final figure given in *USA Today* and *The Times*. However, by 22 April the figure had been increased to 100,000, closer to *The Sun's* final figure of 102,000.

[67] Financial losses concentrated on those suffered by airlines and airports (Table 3). However, *La Repubblica* was the only newspaper examined that attempted to set a financial loss suffered by the passengers, this being placed at 10 million euro, in comparison with 200 million lost by airport operators. Estimates for the final amount lost varied between \$1.26 billion (*La Repubblica*) and \$1.7 billion (*Corriere della Sera*) on 22 April, increasing to \$2 billion on 23 April (*Corriere della Sera*), comparing with losses of \$1.7 billion given by *The Times*, £1 billion given by *The Sun*, and €7 billion given by *Le Figaro*.

3.4.2. Corriere della Sera and La Repubblica: Dictionaries

[68] A total of 469 different words were entered into the dictionary for *Corriere della Sera*, and 451 words into that for *La Repubblica*. While in *Corriere della Sera* 31 words made up 32% of the total used, in *La Repubblica* 34 words comprised 41% of the total. The top-ranked word listings are given in Table 8 for *Corriere della Sera* and in Table 9 for *La Repubblica*. There was plenty of similarity in the words used between the two papers, with the same words making up the top three in both papers, with *closed*, *blocked* and *canceled* being the first, second and third most-used words in both newspapers.

[69] Both listings were dominated by words associated with the response category, with the *Corriere della Sera* having a much greater presence of words related to the social category than *La Repubblica*, the social category contributing eight words to *Corriere della Sera* listing, but just one to *La Repubblica* listing. Negative words such as *close*, *block*, *cancel* and *grounded* (*a terra*) dominated the top 10 words of both dictionaries, but the word *reopen* appeared high up (4th in *La Repubblica*; 5th in *Corriere della Sera*). This squares with the thorough listings that these two newspapers provided regarding airspace and airport openings, as well as closures (see Table 3).

[70] The frequent occurrence of words relating to the response category in both dictionaries may reflect Italy's position at the edge of the cloud, their air traffic being stopped from flying in apparently clear skies. The frustration that this caused appears to be reflected in the presence of words such as *excessive* and *chaos*. The word camp bed makes 14th place in the *Corriere della Sera* dictionary (also making 38th place, with a frequency of four, in *La Repubblica* dictionary). This, along with a high social content to the reporting (Figure 5) appears to reflect a country where the *stranded* of other countries had to be catered for. Several volcanic and technical words also enter the top word listings for *Corriere della Sera* and *La Repubblica*, including words such as abrasive and modeling, as well as *danger*, *security* and *risk*. This reflects the high degree of information and opinion provided for volcanic processes and technical problems related to air craft ash encounters by the two Italian newspapers (see Figure 5).

3.4.3. Corriere della Sera and La Repubblica: Information Sources

[71] The information sources used by *Corriere della Sera* and *La Repubblica* are listed in Text S2. As in most countries, the sources were dominated by air industry (30% in *Corriere della Sera*; 26% in *La Repubblica*) and airlines (22% in *Corriere della Sera*; 21% in *La Repubblica*). *Corriere della Sera* was the only newspaper studied for which the use of air lines and air industry sources did not increase if we considered just the sources used for the main report (Figure 6). The relative contribution of volcanologists and responders was maintained also between the total and first report plot for *Corriere della Sera*, and that from politicians actually decreased a little between the two (Figure 6e). Again, *Corriere della Sera* was the only newspaper for which this was the case. For *La Repubblica*, the comparison (Figure 6f) shows increased contribution from air line sources if we compare all quoted sources with those quoted in the main report, although contributions from the responder category increased a little between the two.

[72] The pie charts of Figure 6 show a higher presence of volcanological sources in *Corriere della Sera* (18%) as opposed to *La Repubblica* (7%). Instead, in *La Repubblica* politicians had a greater presence, providing 14% of all quoted material as opposed to 7% in *Corriere della Sera.* Of the 22 volcanologists and academics named as sources in *Corriere della Sera* and *La Repubblica*, 19 were from Italian institutions.

4. Discussion

[73] For a volcanic event, the newspaper space devoted to Eyjafjallajökull was enormous. If placed in a single issue of any one of the eight newspapers examined, the space devoted to Eyjafjallajökul during the 10 day period spanning the first day of air space closure (15 April) and 24 April would have accounted for between 8% and 49% of one 18-to-77-page-long newspaper (Table 1). By shutting down transatlantic and European flight operations for several days, Eyjafjallajökull caused tens-of-thousands of flights to be canceled; this, and the knock on effect, made Eyjafjallajökull newsworthy. But what was reported, how was it reported and how did it vary by country? Answering these questions allows us to determine whether there was content bias and, if so, how this was framed in relation to the scientific community.

4.1. Impact in Terms of Flight Cancellation and Monetary Loss

[74] For flight cancellations, a figure of 95,000 was that most consistently given by the newspapers considered here, although it may have been as high as 102,000 (see Tables 2 and 3). As a result, an enormous number of passengers became stranded and needed repatriation. However, exact figures for the numbers of stranded passengers given by the same press were not always given and were less consistent, one statement even admitting "*we don't know where they are and in what numbers*" (*USA Today*, 23/4, 1(A5)). Estimates for the numbers of stranded British varied between a million (*Sun*, 19/4, 3(4)), 150,000 (S*un*, 20/4, 2(4–5)), between 150,000 and 200,000 (*Repubblica*, 20/4, 9(4)), 130,000 (*Sun*, 21/4, 1(1)) and 140,000 (*Sun*, 22/4, 1(1)). For stranded French, it varied between 150,000 (*Figaro*, 19/4, 1(1)), 50,000 (*Monde*, 20/4, 5(4)) and 100,000 (*Repubblica*, 20/4, 9(4)). The total number of stranded for all nationalities was placed between 65,000 (*Corriere della Sera*, 19/4, 9(9)), 2 million (*Times*, 19/4, 1(1)), 5 million (*Times*, 21/4, 2(3)) and 7 million (*Repubblica*, 18/4, 4(2)), with the 7 million figure being that most consistently given by *Corriere della Sera* and *La Repubblica* (see Text S4).

[75] The cancellations also inflicted financial losses. Precise losses for airlines and the economy were regularly (if not always consistently) stated, with the most consistently stated estimate for airline losses being a total of $1.6 billion (or £1 billion). In addition, a sum of £400 million per day was attributed to economic losses, across Europe, due to reduced productivity due to stranded workforce. However, the cost to passengers was harder to find and, although costs accrued in individual cases were given (some of which are collated in Note 1 of Text S5), the losses to individuals were

Table 10. Usage of the Top Five Words From Each Newspaper Across All Newspapers, Ranked by Total Number[a]

Word	USA Today	Times	Sun	Figaro	Corriere della Sera	Repubblica	Total
Stranded (bloque, rimanere)	8 (4th)	85 (1st)	54 (1st)	20 (3rd)	7 (17th)	6 (28th)	180 (1st)
Cancel	25 (3rd)	50 (2nd)	15 (7th)	20 (2nd)	22 (3rd)	31 (3rd)	163 (2nd)
Closed	9 (1st)	32 (4th)	12 (13th)	23 (1st)	30 (1st)	56 (1st)	162 (3rd)
Disrupt (perturbation, bloccato)	12 (2nd)	30 (5th)	8 (23rd)	12 (7th)	22 (2nd)	54 (2nd)	138 (4th)
Open (riaprono)	6	19	13	5	14	23	80
	6 (7th)	19 (10th)	13 (11th)	5 (16th)	14 (5th)	23 (4th)	80 (5th)
Cost (facture)	3 (16th)	40 (3rd)	13 (9th)	3 (32nd)	4 (33rd)	12 (9th)	75 (6th)
Loss	6 (6th)	26 (6th)	8 (25th)	13 (5th)	12 (7th)	8 (20th)	73 (7th)
Stuck (cloue, a terra)	3 (25th)	12 (21st)	22 (4th)	7 (10th)	13 (6th)	12 (8th)	69 (8th)
Crisis	2 (30th)	17 (12th)	22 (3rd)	15 (4th)	2 (87th)	8 (19th)	66 (9th)
Chaos	3 (15th)	10 (27th)	20 (5th)	3 (29th)	10 (9th)	11 (11th)	57 (10th)
Total	77	321	187	121	136	221	1063
Rank (out of all newspapers)	6th	1st	3rd	5th	4th	2nd	——
Word contribution (%)	7	30	18	11	13	21	100

[a]Values in parentheses are rank of that word within the frequency distribution of each newspaper. The last column is the rank by total number.

never fully assessed, as they were for airlines. They were likely not trivial. If we take a total loss suffered by each of the 150,000 stranded British passengers of between £100 and £1000 per passenger, the loss to British passengers alone would have been between £15 million and £150 million. If we take a figure of between 2 million (*Times*, 19/4, 1(1)) and 5 million (*Times*, 21/4, 2(3)) for passengers of all nationalities stranded, this loss to individuals climbs to between £200 million and £5 billion.

[76] We identify, here, a theme which ran through all newspapers, except *The Sun*. That is, airline and air industry losses, as well as political issues, were ascribed much higher status and factual detail in the newspapers than those of the *stranded* passengers. We use the word *stranded* to label the passengers because this word (or its equivalent) was used to describe the passengers situation, and the passengers themselves (they were the *stranded*). The word was used a total of 180 times across *USA Today*, *The Times*, *The Sun*, *Le Figaro*, *Corriere della Sera* and *La Repubblica* (bloqué is the worded counted in *Le Figaro*; rimanere in *Corriere della Sera* and *La Repubblica*); being by far the most frequent word used (see Table 10). However, if we examine the cited information sources for the primary article, the airlines and air industry dominate quotes, opinions and information-sources given, these sources typically dominating front page news (see Figure 6).

4.2. Theme of the Coverage and Variation by Country

[77] The content of reports did vary from country-to-country. In the USA, although the country was not directly impacted by the ash cloud, the closure of transatlantic routes, coupled with the novelty of the situation, caused reporting to focus on the volcano, social and airline impacts, plus financial (business) losses (Figure 5a). In the UK, where a large population was stranded overseas, coverage was dominantly social in theme, covering the problems facing the *stranded* and efforts to *repatriate* them, with *The Times* also containing a significant amount of business information (Figures 5b and 5c). In France, while *Le Monde* lacked reports, *Le Figaro* distributed its reporting evenly between the themes economic/business, airlines/airports, volcano and social (Figure 5d). In Italy, where planes were grounded in spite of being at the edge of the impact zone, the main themes were related to social issues and the response.

[78] *Corriere della Sera* and *La Repubblica* devoted by far the greatest amount of space to volcanic issues, the total area covered by volcano-related articles being 13211 cm^2; 2.6 times more space than that set aside to volcanological aspects by all of the other newspapers combined (i.e., 5038 cm^2). The listings of closures, openings and cancellations were also particularly detailed in *Corriere della Sera* and *La Repubblica*; *The Sun* and *Le Figaro* in particular tending to focus on just the closing process rather than the opening process (cf. Tables 2 and 3).

4.3. Tone of the Coverage

[79] Because of these losses and problems the news was, of course, bad. This is reflected in negative words being the dominant words used in all countries, with the words *stranded* (bloqué = French equivalent; rimanere = Italian equivalent) (180), *canceled* (163), *closed* (162), *disrupt* (perturbation = French equivalent; bloccato = Italian equivalent) (138), *cost* (75), *loss* (73), *stuck* (cloue = French equivalent; a terra = Italian equivalent) (69), *crisis* (66), and *chaos* (57), along with *open* (80), being the most commonly used words. These words appear in all of the top five word listings derived here (Table 10). Of the other high frequency words, *grounded* was the 5th most common word in *USA Today*, *home* the 2nd most common in *The Sun*, *reimburse* the 4th most common in *Corriere dell Sera*, and *harm* the 5th most common in *La Repubblica*. Positive words were much less frequently used, *open* (or *reopen*) being the only positive word used in the top-five word collation of Table 10. Within this negative tone the closure was largely seen as a *crisis* rather than a necessary *response*, and *chaos* being the result (Other words also being used, *The Sun*, for example, adding words such as *havoc* (2), *pandemonium* (1) and *mayhem* (2)). Thus, the next question is: who was seen as responsible for, or associated with, this *crisis* and *chaos*?

4.4. Who Was Blamed?

[80] With such a severe impact and negative word usage, it was only natural for businesses and individuals to search for a source to blame. In the United Kingdom, where the closure caused 150,000 to be stranded over the English channel, the news focused on repatriation, with *The Sun* using words such as *Amada* and *Dunkirk* to describe repatriation efforts. In this atmosphere, the finger of blame was more often than not pointed at the government, this being the group

perceived as responsible for solving the primary problem: repatriation of the stranded.

[81] However, in all countries it was generally understood that it was the British meteorological office (the Met. Office) that was at the root of, what was perceived as, the *problem* or *disruption*; this agency was tied to the response of the *authorities*. It was thus they, and the theoretical and mathematical models and modelers that were associated with the perceived *excessive* response, who were blamed. This explains the high frequency of words such as *modeling* in the word listings in, for example, the Italian newspapers … … it is not a positive presence.

[82] By way of example, it was not infrequent to see letter writers, plus the airlines and air industry, point the finger directly at the responders in the British press. Letter writers tended to be members of the public, i.e., the newspaper readers (see Text S2 for named information sources, including letter writers). A letter written in *The Times* on 20 April demanded *better facts, proper science and solid risk analysis* (see Note 6a, Text S1); clearly singling out scientists. Likewise, in a report in *The Times* on 20 April, while the Met. Office were accused of "*only making a weather report*," the International Air Transport Association was reported to be demanding an overhaul of European no-fly zone laws, and criticizing "*reliance*" on "*theoretical modeling*" of ash. This, by implication, gave the responders and modelers negative press; likely instilling a feeling among the readership that the responders and scientists were *incompetent*.

[83] From our analysis of the dictionaries we can now add the sentiments and reactions of the final level in the response-effect graph of Figure 1, this being the response of passengers and businesses to the air space closure. The response at this level appears to have been one of *frustration* and *anger*, rather than *relief* and *gratefulness*. The direction of this sentiment is backward toward the primary response (air space and air port closure) and, by association, those responsible for that closure (Figure 1). The reason for this negative sentiment may be related to some of the other words found in the dictionaries associated with the response, and reaction to it. These included *unclear*, *doubt*, *lack of consensus* and *uncertainty*; words not likely to generate a positive reaction to the decisions and responses effecting hundreds of thousands, even millions, of people and businesses.

4.5. Sources of Confusion?

[84] The problem was reported as confused, with words such as *chaos* and *crisis* being common, with *doubt* and *lack of consensus* appearing well up in the *USA Today* dictionary. This did not help in casting a positive light on the ash cloud impact and air space closure response. Instead, it added to the negative feel. The *lack of consensus* feeling was accentuated by a common tendency to report two different perspectives. The first perspective was that air craft operations in an ashy atmosphere were risky. This perspective used examples of past, and current, aircraft encounters to illustrate the point. The second perspective was that the Eyjafjallajökull cloud presented no risk at low latitudes, and used reports of no problems encountered by airline-operated test flights during the closure to illustrate the point. Both perspectives were associated with words such as *problem*, *hazard* or *risk*, the placement of *no* in front of each word making them work in reporting associated with the second perspective. This mixing was apparent many times, as in the *Corriere della Sera* on 20 April, for example, when two reports appeared side-by-side, the first reporting ash encounters by NATO jets in Norway, the second recording no problems experienced by an Alitalia test flight between Rome and Milan. Likewise, *The Sun* on 19 April reported on a test flight by a British Airways Boeing 747 that landed undamaged after a three hour flight, followed by a report of a possible aircraft ash encounter on 22 April which forced a plane to return to its departure airport shortly after take off. This could well have caused confusion in the readership: was it safe or was it not?

[85] *Gamson and Modigliani* [1989] note a similar theme in media audio reports following the Three Mile Island and Chernobyl nuclear crises, this being one of official confusion. This, in our case, couples with a picture of *unnecessary* response that created what was perceived as a *mess* or *crisis*. This confusion is apparent from the collation of excerpts from letters and editorials of Note 6 in Text S1. A letter published in *The Sun* on 20 April, for example, did not agree with the air space closure, arguing that planes fly through *dust* storms all the time. A letter on the 22 April, however, applauded the government for *doing the right thing*. Plenty of sound fact to address this confusion was given, such as an excellent article that described the modeling and monitoring efforts in *The Times* on 21 April (see Note 7, Text S1). However, these explanations often appeared well down the newspaper, and after the main news article, the article of 21 April being the 7th in the paper on that day and appearing on page 5.

4.6. Which Sector Exerted the Greatest Influence?

[86] The analysis of Figure 6 shows that by far the most frequently quoted sources were from the air lines and air industry, their quotes being especially prominent in the main (front page or first) report. This prominent positioning of their statements would have made the opinions of this sector particularly influential and, because the industry was suffering huge financial loss and uncertainty, were understandably damning in regard to the response and closure. Take, for example, the following headline taken from *The Times*: "*The cloud lifts - but leaves airlines furious*" (*Times*, 20/4, 2(3)).

[87] An exception to this rule was *The Sun*, whose quoted opinions were dominated by those of the public. Volcanologists and responders were reasonably represented in the U.S., French and Italian newspapers examined here but, with the exception of *Corriere della Sera*, these contributions evaporated somewhat when the most influential (i.e., the front page or first) report was considered. This reduction in front page column space devoted to the opinions of volcanologists and responders was invariably balanced by increased contributions from politicians, the air lines and air industry. Economists were very rarely cited, in spite of a strong focus on financial losses, these being detailed on a near-daily basis in all newspapers considered (see Tables 2 and 3). An interesting fact is that, on 16 April, a picture or mention of the ash cloud makes the front pages of seven of the sampled newspapers (*USA Today*, *The Sun*, *The Times*, *The Daily Telegraph*, *Le Figaro*, *Corriere della Sera* and *La*

Repubblica); but so too does a picture, or head-line naming, of each of the country's respective Prime Ministers or Presidents, with even *The Sun* insetting a picture of the British Prime Minister into a near-full-page Eyjafjallajökull picture and report.

4.7. Quantity and Quality of Volcanological and Technical Information

[88] A considerable amount of volcanological information was given over the 10 day study period, volcano-related material covering a total area of 18,251 cm^2; representing 13.5% of the total Eyjafjallajökull information given across all papers by area (134,778 cm^2). The level of volcanic information given was particularly high in *USA Today*, *Le Figaro*, *Corriere della Sera* and *La Repubblica*. Information given included diagrams, maps and reports. Some were highly technical and covered volcanic eruptions and eruption processes, modeling and monitoring, as well as problems that ash causes to air line operations. *Corriere della Sera* and *La Repubblica* led the way, with several near-full-page articles dealing solely of volcanology-related issues. As a result, some of the most popular words in the dictionaries for these two papers included technical or volcanological words such as *abrasive*. The readership therefore had access to material allowing them to understand the cause and nature of the problem. However, such articles tended to appear well down the newspaper, and always after the main article(s); never on the front page. This is reflected, with the exception of *Corriere della Sera*, in a reduction in the number of quotes from volcanologists if we compare all quoted sources in the paper with those appearing in just the first report (Figure 6). In addition, in *The Times, The Sun* and *Le Figaro*, quoted contributions from named volcanologists were rare, to almost non-existant.

[89] Volcanological words tended to be used, but were mixed with more colloquial terms. For example, while *USA Today* used terms such as *ash*, it also used *grit* to describe the products of the cloud. Another commonly used word in both the British and Italian press was *dust* and, of course, *smoke*, although these words were usually mixed with words such as *ash* and even *tephra*. The word *fall out* was also used, but not in a volcanological context. Instead it tended to be used to describe knock on effects, especially *economic fall out*.

[90] High quality technical information was given regarding the effects of both ash, and acid gas, on air craft engines, exteriors and interiors, both in text, photo's and schematics. The main report in *USA Today* on 16 April, for example, detailed the damage ash could do to aircraft, including abrasion effects to both the body and wind screen (shield) of the aircraft, and commented that if the damage was not repaired it could lead to long-term safety issues [USA Today, 16/04, 4(3)]. We also see many related technical words in our dictionaries, including *abrasive* and *choke* (as in choke an engine). The hazard was thus well reported and understood. The problem was, seemingly straightforward solutions were given, such as defining clear-cut corridors within which flights would be safe; setting of a single, absolute ash density threshold for ashy air in which flights would be safe; sending up weather balloons to detect ash. The difficulty, impossibility or potential risk in making such black-and-white decisions were also stated. While the *USA Today* editorial of Note 6d (Text S1), for example, explored the problem of defining a density threshold, *The Times* article of Note 7 (Text S1) discussed the problem of defining safe corridors within the no-fly zone and pointed out that weather balloons were not designed to detect ash. However, again, such information was placed well inside the paper, and well after the more provocative points regarding these issues.

4.8. A Giant, Black Cloud … …

[91] The cloud was often described as *black*. *Nube nera* was used at-least three times by the *Corriere della Sera.* A headline in *The Times* on 20 April read "*Airlines and holiday firms count the cost of black cloud*," and *The Sun* labeled 19 April as *Black Monday*. Take also the opening phrase of the front page article in Britain's *The Daily Mail* on 16 April: "*dark and menacing, this is the giant cloud of volcanic ash that paralyzed air travel in Britain yesterday*"; or the lead sentence from *The Independent* on the same day, "*the last plane heads into darkening skies* …."

[92] Words implying that the cloud was rather large were likewise common. We see this, for example, in the headline of the *Daily Mail* report just cited: *giant cloud of volcanic ash*. We also see it in descriptions appearing on the 16 April front pages of *USA Today* (towering burst of ash), *The Sun* (huge plume of volcanic ash), *Corriere della Ser*a (nube gigante) and *Repubblica* (maxi nube).

[93] If we examine *The Sun*, *The Times*, *The Telegraph*, *Le Figaro* and *Corriere della Sera* on 16 April they all carry maps of the Eyjafjallajökull cloud extent. The cloud is always mapped as a black-gray and/or red-pink zone smothering large parts of Europe, and always placed next, or near, to a picture of a dense, well-culminated dense and dark plume billowing upwards from Eyjafjallajökull's vent.

[94] *Galli and Nigro* [1987] noted that Italian school children, sampled 14 days after the news of the Chernobyl disaster of 1986, tended to draw a picture of radioactivity that was dominated by a cloud. This was almost always dark gray and threatening. Some children even made the cloud pink, the color used by Italian television in computerized representations of Chernobyl's cloud [*Galli and Nigro*, 1987].

[95] In our studies could the framing of the volcanic cloud have encouraged a feeling, or reflected a belief, that Europe's population should have been seeing dark clouds of dense ash above them, and their absence meant that the skies were clear and safe?

4.9. Content-Bias and Framing

[96] A focus on negative news, prominent placement of airline and political views in primary articles, the general air of confusion and conflicting opinion, plus provision of volcanologist and responder views well within the newspapers, resulted in content bias in favor of airline views. Reader views were thus likely framed (for this use of the word frame, The Oxford English Dictionary defines frame as to *shape, direct, dispose, (thoughts, acts) to a purpose*) toward a point-of-view that the *scientist*s (in this case the volcanologists and responders – specifically the Met. Office and VAACs) did not perform well. This seems to have occurred to the extent that, as one letter writer put it, *better facts, proper science and solid risk analysis* were believed to be

required (see Note 6a, Text S1). This conclusion can be found in many headlines, letters and editorials that were published in newspapers beyond those surveyed here. Take, for example, the headline that appeared on the UK's *The Daily Mirror* front page on the 22 April: "Ash Test Dummies" or the title of a prominent editorial that appeared in the *Mail on Sunday* on 25 April: "A Natural Disaster … but a Man-Made Catastrophe."

[97] Readers thoughts were thus not at-all framed in favor of the *scientists*, and a confused and incompetent reaction was portrayed. Whether this was the scientific reality or not, it was the reality of the content-biased opinion of these newspapers. It led to questions being posed to the scientific community such as: *what were you doing?* (Question to lead author by passenger stranded in S. Africa and then (at some expense) in Dubai).

[98] Content bias and framing in such a way (i.e., against the volcanologists and responders) is not new, and probably not surprising. After all, volcanic eruptions are spectacular and newsworthy, especially if they have far-reaching social, economic and environmental impacts. They are also easy to sensationalize; as are disagreements with, and within, the scientific community [see, e.g., *Fiske*, 1984]. *Cardona* [1997, p. 320, 322] when remarking on the media response to volcanic crises at Galeras volcano (Colombia) noted that "*The media, mainly at the national level, contributed greatly in generating a situation of anxiety that rapidly aggravated the crisis … … sensationalist stories to attract local, regional and national audiences … … produced confusion and generated much anxiety*." *Cardona* [1997, p. 322] also pointed out that footage of more spectacular eruptions from other volcanoes were used to portray the actual, reported, eruption, adding "*A new situation was created when some members of the media … … began to question official silence with respect to the volcano … … this generated doubt and speculation … … and contributed to the confusion of the community*." The same themes of doubt, speculation and confusion comprise the primary framing of news during the Eyjafjallajökull air space closure.

[99] *Fiske* [1984] highlighted problems that arise if media relations are poorly constructed during a volcanic crisis, stressing the role of an "*information officer*." *Fiske* [1984] also explored the potential disconnect between the need for scientific discussion and debate, that has to use "*jargon*" with which scientists are familiar, and the expectations of journalists charged with reporting the event. Subsequently, *Peterson* [1988, p. 4166] emphasized the "*major*" role that journalists play in transmitting information during volcanic eruptions, stressing that "*being straightforward and lucid, avoiding jargon and detail*" can do much to ensure that information is "*clearly understood*." *Peterson* [1988, Table 1] provides a list of disconnects between the expectations of scientists and reporters that can be used as a common-sense guide for media interaction. Such communication protocols were emphasized by the *IAVCEI Subcommittee for Crisis Protocols* [*Newhall et al.*, 1999]. Successful communication procedures, and protocol failures, are detailed in many other documents such as the USGS Open File Report 87–229 [*Gori and Hayes*, 1987] in which *Sorensen and Mileti* [1987] and *Blair* [1987] appear. *Bertolaso et al.* [2009] iterated the need for a "*press office*" during volcanic crises to allow a continuous-feed of reliable information (containing simple, unequivocal terminology) to the media and public during Stromboli's 2007 eruptive crisis. In all cases, the aim is to minimize pressure on scientists responding to the emergency, while reducing the potential for exaggeration and sensationalism, to ensure appropriate framing of the volcanic hazard. Judging by the information credited to volcanologisits and responders during Eyjafjallajökull, these communication protocols were well-applied.

[100] Thus, problems of poor communication by *scientists* was not an issue during Eyjafjallajökull reporting analyzed here. Scientific communications in the studied media were clear and appropriate, and followed the protocols of *Fiske* [1984], *Sorensen and Mileti* [1987], *Peterson* [1988], *Newhall et al.* [1999] and *Bertolaso et al.* [2009]. The new problem facing the community was that of content bias and framing. When presented with a second, and politically potent, source of argument, opinion or statement regarding a hazardous event, the opinions of the *experts* (*scientists*) will not be as influential in framing the news. In this case the argument over the necessity of air space closure was between the proponents – the scientists (responders and volcanologists) and the opponents – the airline industry. Both groups have obviously conflicting interests and differing expertise and, it seems, differing status in the media when placed face-to-face. During Eyjafjallajökull, while strongly worded *opponent* statements were made on the front page, those of the proponents were buried deeper within the newspaper or report. The opponent grouping even influenced headline syntax. Take, for example, the headline report on page 3 of The Times on 20 April 2010: *The Cloud Lifts – but leaves airlines furious*. The perspective of a volcanologist was given two days later on 22 April, but in a short, untitled article on page 71 associated with weather reporting. The influence was also pervasive. Even an exclusive run by *The Sun* supporting a possible aircraft ash cloud encounter that caused a commercial flight to "*abort*" when the pilot "*smelt ash and reported an engine fault*" (see Note 3 Text S3) ended with the lines "*meanwhile, travel firms claimed that Britain's response to the ash crisis was* "*a shambles,*" *Transport Secretary Lord Adonis admitted:* "*It's fair to say we've been too cautious*"."

[101] The problem was, such framing coupled with the dominant negative content of the reporting, likely meant that the *scientists* were viewed negatively during Eyjafjallajökull. Recognition of the *framing* problem, and the search for potential solutions, has to be added to the check-list of effective media communication protocols during volcanic crises.

5. Conclusion

[102] Page space devoted to Eyjafjallajökull was enormous, occupying a total area of 13.48 m^2 across *USA Today, The Times, The Sun, Le Figaro, Corriere delle Sera* and *La Repubblica*. While the total space devoted by each of these newspapers to the themes defined here is given in Table 11, the numbers of individual sources contributing to each theme is given in Table 12 (Table 10 already having collated the words most frequently used to describe Eyjafjallajökull's ash cloud and its effects). Together, these tables summarize the newspaper perspective. We see from Table 11 that social issues received the greatest amount of column space,

Table 11. Absolute Space Devoted to Each Theme Defined by Each the Newspaper Studied[a]

	Social (cm^2)	Volcano (cm^2)	Economic (cm^2)	Response (cm^2)	Air Industry (cm^2)	Technical (cm^2)	Total (cm^2)
			All Newspapers				
USA Today	2084	1737	838	470	1295	589	7014
The Times	7973	1606	7151	1034	1027	417	19208
The Sun	2741	503	446	449	759	151	5049
Le Figaro	1265	1192	1426	152	1248	356	5639
Corriere della Sera	5934	5239	2081	3065	1047	1119	18485
La Repubblica	5174	7972	1008	4563	968	324	20009
Total (cm^2)	25171	18248	12950	9733	6344	2957	75403
Percent cover (%)	33	24	17	13	8	4	100
			Italian Newspapers Excluded				
USA Today	2084	838	1737	1295	470	589	7014
The Times	7973	7151	1606	1027	1034	417	19208
The Sun	2741	446	503	759	449	151	5049
Le Figaro	1265	1426	1192	1248	152	356	5639
Total (cm^2)	14063	9861	5037	4329	2104	1514	36909
Percent cover (%)	38	27	14	12	6	4	100

[a]While the first grouping includes all newspapers studied, while the second excludes the two Italian newspapers. In each case the categories are given in order of importance, as determined by the area of coverage.

followed by volcanic, economic, response, air industry and, finally, technical issues. However, the high ranking of the volcanic category is a result of extensive coverage in the Italian newspapers. If we exclude the two Italian newspapers, the volcanic theme drops to 4th place. The air industry theme, however, remains 5th, with economic and response issues moving up to 2nd and 3rd places, respectively (Table 11). This contrasts with the statistics for the sources used, as given in Table 11. In terms of sources-used, we see that the air industry is now the most prominent, followed by the public, politicians, volcanologists, responders and economists (Table 12). The high ranking of the public is a result of extensive coverage in the British newspapers. If we exclude the two British newspapers, the public drops to 5th place, volcanologists, politicians and responders rise to 2nd, 3rd and 4th, respectively, but economists remain 7th (Table 12). This seems strange given that economic news (i.e., news regarding financial losses and impacts) was second in the theme ranking of Table 11. However, the collation of Table 12 does show a strong contribution from volcanological (academic) sources. This, at first sight, appears encouraging. However, if we consider just the quoted sources given in the main (front page or first) report, the influence of the air industry strengthens, increasing from 33 to 55% (Table 13); politicians move up to 2nd place, public drop to 3rd and volcanologists to 6th. If we remove the influence of the British newspapers, the air industry now provides 60% of the quotable information, politicians 14%, responders 13%, volcanologists 6%, and the public and economists more or less disappear (Table 13).

[103] This numerical appraisal sums up a situation where column space devoted to volcano-related issues was high, as was the contribution of volcanologists and associated academic disciplines to this information. However, the placing of volcanological information, as well as of the quotes and opinions by those with expertise in this area, occurred down

Table 12. Number of Quotes, and/or Sourced Information, Given by Each Expertise Category[a]

	Air Industry	Public	Misc.	Politician	Volcanologist	Responder	Economist	Total
				All Newspapers				
USA Today	19	10	4	3	13	8	2	59
The Times	51	60	50	21	3	8	6	199
The Sun	13	61	21	11	6	3	0	115
Le Figaro	50	6	9	23	13	12	6	119
Corriere della Sera	42	2	6	6	15	12	0	83
La Repubblica	45	9	9	13	7	10	1	94
Total	220	148	99	77	57	53	15	669
Percent cover (%)	33	22	15	12	9	8	2	100
				UK Newspapers Excluded				
USA Today	19	13	3	8	10	4	2	59
Le Figaro	50	13	23	12	6	9	6	119
Corriere della Sera	42	15	6	12	2	6	0	83
La Repubblica	45	7	13	10	9	9	1	94
Total	156	48	45	42	27	28	9	355
Percent cover (%)	44	14	13	12	8	8	3	100

[a]While the first grouping includes all newspapers studied, while the second excludes the two UK newspapers. In each case the categories are given in order of importance, as determined by the area of coverage.

Table 13. Number of Quotes, and/or Sourced Information, Given by Each Expertise Category for Just the Main Front Page or First Report Appearing in Each Newspaper[a]

	Air Industry	Politician	Public	Responder	Misc.	Volcanologist	Economist	Total
				All Newspapers				
USA Today	15	3	2	3	2	2	0	27
The Times	22	9	4	3	12	1	0	51
The Sun	7	7	19	0	4	1	0	38
Le Figaro	36	12	1	7	0	2	1	59
Corriere della Sera	18	1	2	5	2	5	0	33
La Repubblica	24	6	0	5	2	0	0	37
Total	122	38	28	23	22	11	1	245
Percent cover (%)	50	16	11	9	9	4	0	100
				UK Newspapers Excluded				
USA Today	15	3	3	2	2	2	0	27
Le Figaro	36	12	7	2	0	1	1	59
Corriere della Sera	18	1	5	5	2	2	0	33
La Repubblica	24	6	5	0	2	0	0	37
Total	93	22	20	9	6	5	1	156
Percent cover (%)	60	14	13	6	4	3	1	100

[a]While the first grouping includes all newspapers studied, while the second excludes the two UK newspapers. In each case the categories are given in order of importance, as determined by the area of coverage.

the paper, i.e., after the first report. Instead, opinions of the air industry received prominent (first report) positioning. There was, thus, a *content bias* toward, or *framing* by, the argument of the air industry and political interests. This, along with the negative word types that dominated the reporting, must have influenced the view of the readership. It can only have left a feeling that the situation and response was indeed *chaotic*, this being the 10th most frequently used word (Table 10); that the situation was a *crisis* (the 9th most frequently used word). Meanwhile, the response was *excessive* (one of the most commonly used words in *Corriere della Sera*, Table 8), or an *overreaction* (as used by *USA Today*, see section 3.1.), and *paralyzed* or *disrupted* air traffic (as used on the front pages of *USA Today*, *The Sun*, *Le Figaro* and *Corriere della Sera* on 16 April). The use of such words in headlines and prominent text must have reflected badly on those associated with understanding the problem and implementing the response (i.e., the volcanologists and responders). Take, for example, the following three headlines: (1) "*The cloud lifts - but leaves airlines furious*" (*Times*, 20/4, 2(2)), (2) "*The Icelandic cloud: The cause of a big European mess*" (*Figaro*, 23/4, 1(1/12) (Nuage islandais: les raisons du grand cafouillage européen)), (3) "*Flights in chaos, hiccupping recovery. Airspace alarm: state of crisis*" (*Repubblica*, 21/4, 1(12) (Voli nel caos, ripresa a singhiozzo l'allarme degli scali: stato di crisi)). Or the following four phrases and/or quoted statements regarding the response, all of which are taken from a single report in *The Times* on 20 April (*Times*, 20/4, 2(3)): (1) "*lined up to criticize*"; (2) "*blanket ban was unnecessary*"; (3) "*no-one seems to take full responsibility*"; (4) "*only making a weather report*". We could find many more examples such as these spread across the headlines and text of the newspapers studied (see Text S4 and Text S5), but the wording of these seven examples speak for themselves.

[104] Because of the direct impact of Eyjafjallajökull's eruption on ~7 million people (who became stranded during the air space closure), plus the ~100,000 flight cancellations and $1.6 billion losses suffered by airlines, the April 2010 Eyjafjallajökull eruption and it's effects were widely reported. It is well-known that content bias serves to re-enforce stereotypes [e.g., *Dixon* 2008a, 2008b], shape opinion or event interpretation [e.g., *Bennett et al.*, 2006; *Aday*, 2010], or frame news so as to support, or oppose, a particular position [e.g., *Robinson et al.*, 2009; *Porpora et al.*, 2010]. During Eyjafjallajökull's eruption, newspapers were one source of many people's information, our sample set potentially reaching ~8 million Europeans and Americans every day. The information appearing in these newspapers would have influenced the way in which populations viewed scientists and hazard managers during this event, their response to the *crisis*, and the decision to close air space; it may also shape the way they view us now. The quantity of information available was thus high, but the content bias of that information probably meant that their opinion of the way the event was understood and handled by the experts was low. This will no doubt influence the way in which European populations view scientists and hazard managers during similar events in the future and is thus, for us a scientists, somewhat disturbing.

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