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"RISK MANAGEMENT ISSUES IN TOURIST REGIONS WITH EXPLOSIVE VOLCANISM: THE TEIDE'S 2004 UNREST, CANARY ISLANDS"

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ABSTRACT

Volcanic crisis management in small and densely populated islands is extremely complex. Preparedness is critical to give an adequate response to volcanic unrest and reduce economic losses. However, such preparedness takes time, and involves a variety of groups of people and institutions, sometimes not only because of the requirements of knowledge with respect to self-protection but also because people must be made to change their understanding of the environment. Experience is vital if preparedness is to be improved meaning that the society at risk and the institutions involved in the management sometimes have to face eruptive process. A key factor here is the magnitude and behavior of eruptive events, how these are understood by people and decision-makers, plus the ability to use them as real-life drills. Lower-medium magnitude eruptive events may help to better understand how these natural processes work but may give the impression that such events are easy to manage. Large eruptive events without preparedness can be catastrophic, and may be arduous to recover from as a result. The idiosyncrasy of the society at risk plays a significant role here, thus improvements vary worldwide.

In the present study, we address the initial situation in Tenerife (The Canary Islands) in 2004 and the local people's resulting response, while addressing other situations such as the pressure exerted by international tour-operators or the tourist industry in general, the conflicting views of the scientists and how these affected the people, together with an overview of the management of the seismic catalog in the Canary Islands as a key factor in volcanic crisis management. Current achievements will be compared to the situation given in 2004.

1. INTRODUCTION

Communication is one of the key factors in volcanic crisis management [Scanlon, 2011; Owolabi and Ekechi 2014]. However, there is no single solution to crisis management in volcanic situations. The approach usually varies from country to country depending upon the national legal framework and the duties of the research groups, the level of risk, the idiosyncratic nature of the society, and various other socio-cultural aspects [Marrero et al., 2015]. Communication systems are more efficient in areas where there is frequent volcanic activity while in those with long repose periods, the scarcity of activity makes it more difficult to evaluate this aspect [Solana et al., 2017]. From the scientific perspective, concern must be raised with respect to which tools should be employed to afford the possibility of communicating with thousands of people in real-time. There are high concern when scientists within the Communication Department or momentarily assuming the role of communicators decide which volcanic information to issue and how to deliver the facts. In high-risk areas where communication roles are undefined or where there are irregularities in the communication network,

people will normally seek out information from unofficial sources, mainly on the Internet. Although these new tools allow for greater access to information, conflicts may occasionally arise when Internet contents do not align with official data.

Tourism is an important industry in some places where volcanic activity is significant (the case of, for example, the Stromboli volcano in Italy, Dragulanescu and Drutu, 2012] as well as in others where volcanic landscapes and the remains of past eruptions are an attraction as a landscape complement to beaches and other tourist draws [such as is the case in the Canary Islands, Scherrer et al., 2009]. However, in both the short and long-term volcanic areas, the tourist industry is affected when decisions are made to prohibit access to potentially dangerous areas when a new volcanic unrest is detected. In such conditions, national or regional emergency plans should not only consider strategies to mitigate the potential economic losses incurred as a result of the perceived danger to tourism activities [Marrero et al., 2015] but also plan for the long-term resilience of the tourist destination through adequate management of the perceived risk [Clayton et al., 2009]. If these measures are not adopted, both the economy of the region and the people living there may be adversely affected.

The present paper analyses the initial situation in Tenerife (The Canary Islands) in 2004 when there was a volcanic unrest at the Teide-Pico Viejo Volcanic System Complex (TP-VSC) and the response of the local people. This situation is an example of what may occur when there is sudden volcanic unrest in a high-risk area, long in repose, due to the lack of preparation of the population and authorities, and a relatively poor or non-existent historical memory of past eruptive activity. Some important lessons can be learned even although there are still conflicting opinions with respect to volcanic crisis management in the Islands that will be discussed. Present achievements will be compared to the initial situation in 2004.

2. THE SITUATION BEFORE THE VOLCANIC UNREST IN 2004

2.1 A LIMITED VOLCANO MONITORING NETWORK

The Teide volcano (Tenerife, 28.271°N; 16.641°W), was identified by the IAVCEI as one of the Decade Volcanoes (16) due to its history of large destructive eruptions and its proximity to densely populated areas. The Teide was also included among the European laboratory volcanoes (ESF). Both these initiatives have enhanced our knowledge with respect to the Teide-Pico Viejo Volcanic System Complex (TP-VSC) allowing the internal structure of the Teide to be defined [Ablay and Martí, 2000], together with its past eruptive history [Martí et al., 2008b], possible outcomes [Martí et al., 2008a; 2012] and the level of volcanic activity [Almendros et al., 1994; Pérez et al., 1996].

In 2004, the volcanic monitoring network was relatively limited in comparison to the proportionate threat posed by the TP-VSC [Marrero et al., 2012; Martí et al., 2012]. However, it was sufficient to detect changes in the volcanic system. At that time, the main ground deformation and seismic monitoring networks were managed by the Instituto Geográfico Nacional (IGN), together with a seismic network managed by the Estación Volcanológica de Canarias (CSIC) and the geochemical monitoring network controlled by the ITER-INVOLCAN [Pérez et al., 2008], all supported by temporary research programs conducted by national and international research groups. Here, it is important to highlight that there was neither a specific legal framework nor funding for the scientific management of a possible volcanic crisis nor for the maintenance of a long-term monitoring network. Thus, the resources devoted to studying the volcanic activity focused mainly on research activities and short-term monitoring networks.

2.2 A LACK OF EMERGENCY PLANS, COMMUNICATION AND EDUCATIONAL PROGRAMS

The scientific research of the TP-VSC and the volcanic activity on the island was extensive although little focused on the possible hazard and risk outcomes. Despite this research and the knowledge that the TP-VSC could produce VEI > 4 eruptions [Ablay and Martí, 2000], there were no emergency plans nor mitigation strategies in 2004. Neither were there any communication or educational programs relating to possible volcanic activity [Donovan, 2006]. Although Civil Protection existed, they knew little or nothing about volcanic activity and had no experience or training of what to do in case of an eruption. The community was also unaware of the volcanic risk as they had received no formal education on the subject nor had there been any communication of strategies of self-protection. Thus, there was, likewise, little or no memory of past

eruptions. Previous to the volcanic unrest on Tenerife in 2004, the closest historical reference was the eruption of Teneguía on La Palma in 1971 [Alfonso et al., 1974]. On the island of Tenerife itself, the last volcanic episode had been in 1909 at Chinyero [Mitchell-Thomé, 1981]. Thus, the events of 2004 occurred in the worst possible scenario for crisis management.

3. THE DETECTION OF THE VOLCANIC UNREST IN 2004 AND THE RESPONSE

A remarkable increase in seismicity, besides tremor episodes never previously observed (Almendros et al. 1994; 2007) were registered in 2000 and identified as the reactivation of the TP-VSC. These went on to become perceptible seismic events, tremors and fumaroles in 2004 [Garcia et al., 2006] (Figure 1). Various hypotheses were offered for the seismic activity observed in Tenerife. The first indicated the possibility of a basaltic eruption in the north-west rift of the island [Pérez et al., 2007]. A second argued for a possible reactivation of the TP-VSC [García et al., 2006; Martí et al., 2009] while a third refuted any possible eruption and argued that the increased seismic activity was mainly related to an improvement in the monitoring network [Carracedo et al., 2006; Carracedo and Troll, 2006]. This lack of agreement among the scientists was reflected in the media and affected not only the decision-making process but also the general public.

3.1 THE CITIZENS' RESPONSE

When the volcanic unrest started and after the first press release announcing a possible eruption (2004/05/10),

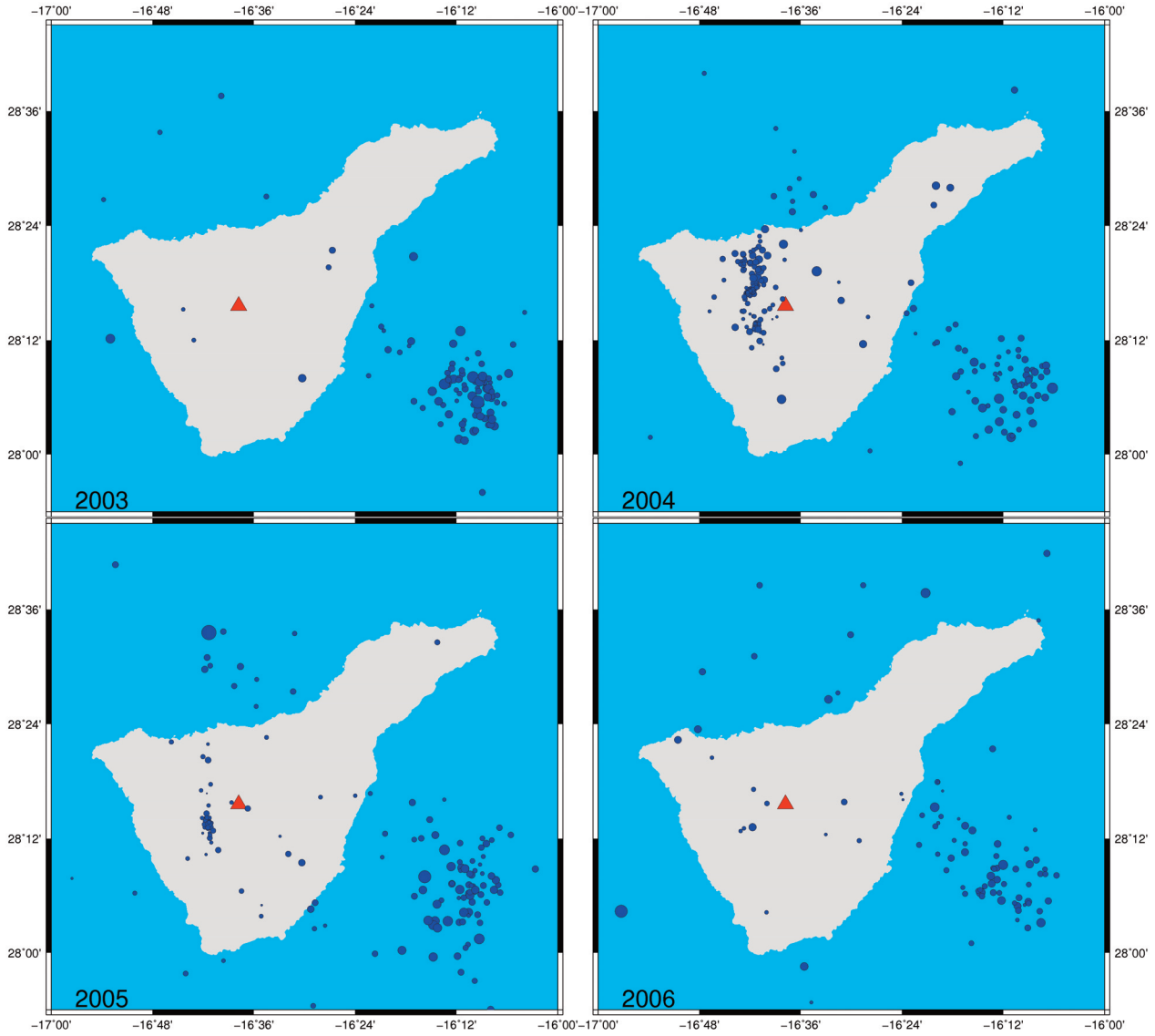

FIGURE 1. Seismic activity on the island of Tenerife from 2003 to 2006 (data from Instituto Geografico Nacional seismic catalog).

people in Tenerife sought out information on the respect on the Internet, though unsuccessfully. In the absence of such information, two volcano enthusiasts decided to open a topic on a specialist forum (www.todogeología.com) that ran under the title of "*¿Es posible una erupción en Tenerife?*" (Is there a possibility of an eruption on Tenerife?) on the 11th May 2004. Initially, this forum was modest in size, only visited by Spanish-speaking amateur and professional geologists. Soon however, the forum grew in popularity, with thousands of people visiting each day although the active participants were only a small group. The forum gradually became a reference not only for the general public but also for decision-makers, emergency and security professionals, journalists and other professional groups. No specific profile could be attached to the visitors who ranged broadly in educational level, income, type of job, age and all other significant parameters. Moreover, as a result of the capacity of the forum facilitators to establish contact with scientists and obtain technical advice, the forum generated comprehensible and accessible scientific information. The existence of "volunteer workers" for the forum was another key success factor. The volunteers worked monitoring continuously the volcanic activity and uploading information onto the forum. This allowed a more immediate flow of information than was available on the authorities' webpage, in terms of speed, clarity and proximity to the population. The forum evolved fast with some of the most important key factors resumed here:

1. **Lack of knowledge:** The first problem faced by the forum was the general lack of knowledge with respect to volcanic activity in the Canary Islands, that produced a situation where many people asked basic questions about how volcanic systems work, the hazards they pose, and how to interpret the scarce available public monitoring data (available at that time without informative explanations). There was a small group of people (volcano scientists included) that helped to answer these questions, while others compiled and uploaded the information available (for example, maps of location of seismic events).
2. **Growth in popularity:** Some of the members of the forum experienced a significant growth in popularity thanks to the way they communicated the information available. This fact worked in their counter producing a difficult relationship with other contributors that meant that that "divorce proceedings" began between the various agents of the forum by the Summer of 2005.
3. **Lack of impartiality:** The members of the forum aligned separately with the various different scientific theories and groups which, added to the aforementioned growth in popularity of some, made open debate more complicated. A critical question related to reveal sources of information. It is not always easy to reveal sources when situations are highly tense and the authorities themselves do not communicate the whole truth or gloss over the danger to avoid possible negative impacts on tourism.
4. **Dealing with Rumors:** Due to the scarcity of official information, unfounded statements and theories abounded, leading to social alarm. Neither the authorities nor the media were capable of mitigating the effects of these rumors. It was the forum that confirmed or denied rumors, keeping people informed in critical periods, when seismic activity was felt.
5. **Level of trust:** Trust was built between the members of the forum and the groups of researchers (ourselves included) with unwritten protocols establishing a relationship that has endured through to the present day. The scientists transmitted the information and hypothesis available openly to small groups of active participants on the forum who then issued the most important information in a simple manner to others, in order to be accessible.

In the months after the unrest, the forum volunteers increased their commitment and improved their level of organization. They created the web page "Vulcania", the first devoted to monitoring volcanic activity in the Canary Islands. They also began to produce radio programs on the subject of volcanoes on the local radio stations. Later, in collaboration with the scientists, they organized conferences and informative sessions on volcanology.

3.2 THE TOURISM ECONOMY AND THE RESULTANT PRESSURE ON VOLCANIC CRISIS MANAGEMENT

The Canary Islands are significantly consolidated tourist resorts, highly popular within Europe thus making it difficult to hide anything as important as volcanic unrest. In 2004, local and international media picked up on the situation using sensationalist headlines such as "Terrorife" [Christie, 2004].

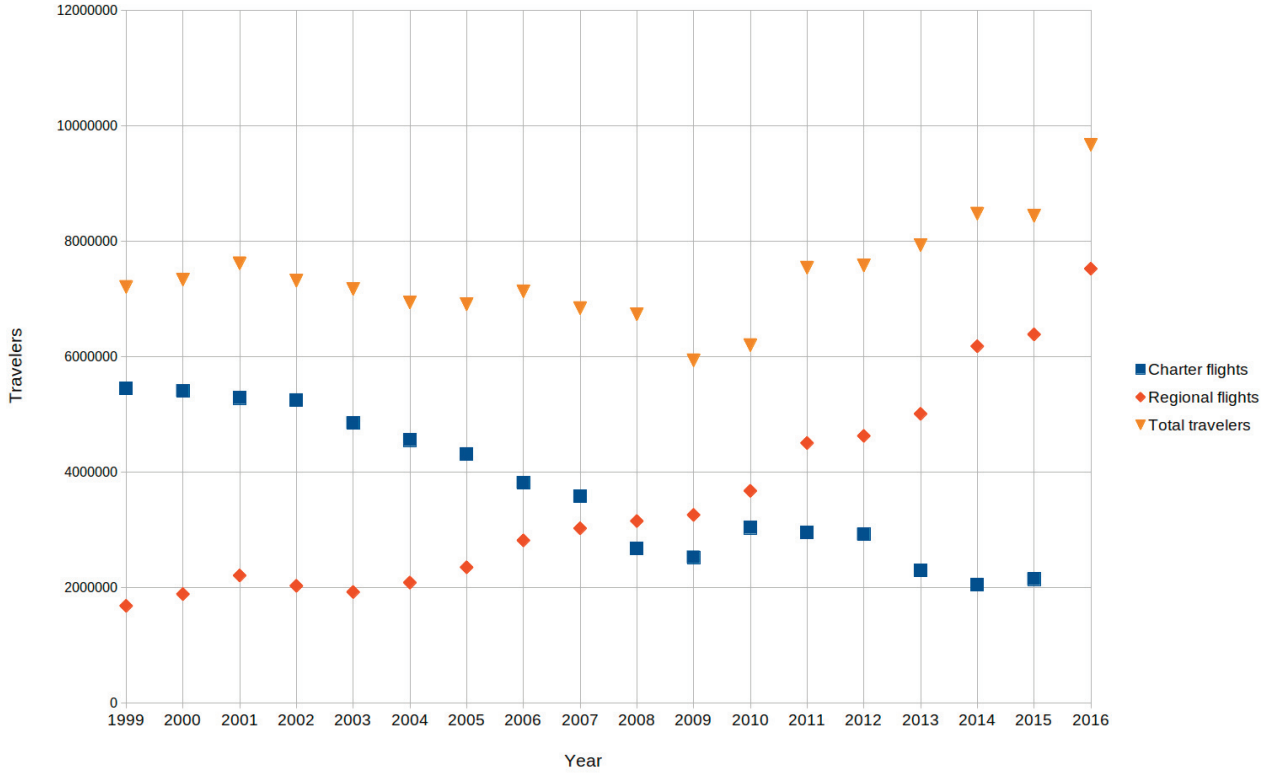

FIGURE 2. Total number of travelers to Tenerife (1999-2016) (ISTAC, 2016).

When the episode of unrest started, the authorities tried to divert the public attention from the volcanic activity related to the TP-VSC. However, they were simply unable to check the adverse flow of news, something they tried to rectify years later when they attempted to control all the communication protocols through the emergency plan [Marrero et al., 2015]. The scientific disagreement that evolved was by no means helpful to the general situation and gave rise to all kinds of alarming headlines. Several authors highlighted the inappropriate treatment of information during the volcanic crisis in the Canary Islands both by local and international mass media [Pérez Martínez, 2007; Ardèvol-Abreu et al., 2012].

One immediate result was that the tour-operators pressured politicians and the local tourist industry to ensure the security of the resorts or to face the consequences of a possible abandon supposedly in their clients' interests [Cavlek, 2002]. There was no specific emergency plan for tourists at the time [Donovan, 2006], and thus the economic losses were significant. Many reservations were canceled and increased pressure was placed on the crisis management process, all of which resulted in scientific information issued being much more critical. However, an analysis of the total number of travelers shows no clear reduction in 2004 [Bartolome et al., 2009] with the decrease in following years hypothetically related to environmental degradation, prices, and other competitive destinations being on the up. In fact, the significant reduction in tourism numbers took place years later as a result of the economic crisis (Figure 2).

4. COMPARISON BETWEEN THEN AND NOW

Since 2004, remarkable improvements have been achieved. The case of the recent eruption that occurred offshore of El Hierro Island [García et al., 2014] plus the two ultimate seismic swarms detected on La Palma (2017/10/07-14, and 2018/02/10-14) did not allow the authorities to lower their guard, with a better response in both organization and communication.

4.1 NEW EMERGENCY PLANS

There are two main emergency plans, one of which is general at the level of the Canary Islands [PEVOLCA; BOC, 2010], and the other that is national [BOE, 2013]. The former was recently updated, although significant problems still persist with relation to the understanding of volcanic processes and emergency response lev-

els [see Marrero et al., 2015]. Some drills relating to volcanic activity have also been carried out in various different areas of the Canary Islands. The municipality emergency plans, however, are still pending developments although some Cabildos (local island council authorities) have already elaborated their own emergency strategies.

4.2 THE LEGAL FRAMEWORK AND MONITORING NETWORKS

Conflicts between scientific groups are commonplace worldwide and several proposals have been made toward preventing them [Newhall, 1999; Bignami et al., 2012]. However, many substantial issues are still pending in Spain. In Marrero et al., [2015], special emphasis was placed on the severe pressure exerted on scientific decision-making during the El Hierro volcanic crisis. In this context, the limited resources, how they are distributed, and the official roles assigned to scientific groups have exacerbated the conflicts between them, especially in the case of volcanic surveillance. In the recently updated version of the PEVOLCA, some modifications were made to improve the management of the scientific committee, and most specifically with respect to how to exchange the data available during a volcanic unrest. However, these solutions are not directed at solving the problem of distribution of funds and official roles.

From the volcano monitoring point of view, better and broader monitoring networks are available with their own specific funding and allotted staff at both the IGN (http://www.ign.es/resources/volcanologia/estaciones_red/estaciones.html) and the ITER-INVOLCAN, covering, among others ground deformation plus seismic and geochemical observables. In general, the recent volcanic crises have served as an incentive to improve research and volcanic monitoring networks, more in line with the level of risk present in Tenerife.

4.3 THE SOCIETAL RESPONSE

Society at large is probably more aware at present than ever. There are volcanological associations and brand names of products use volcanic elements or the same are incorporated into the product design itself (names of energy bars, chocolates, food in general and even shopping centers, among others). These volcanological associations use Internet tools (Facebook, Twitter, web-pages) and organize multiple activities (excursions, photo contests, training courses, and open conferences among others). Some of the forum members have gone on to create "Volcanesdecanarias.com" a few years later and the Association under the same name. "Volcanes de Canarias" was the first Spanish association to monitor volcanic activity and other natural risks (see supplementary material 1).

The UNESCO Global Geopark Network has also been proposed and accepted: the case of first El Hierro (http://www.unesco.org/new/en/natural-sciences/environment/earth-sciences/unesco-global-geoparks/list-of-unesco-global-geoparks/spain/el-hierro/) and then the Archipiélago Chinijo on Lanzarote, (http://www.unesco.org/new/en/natural-sciences/environment/earth-sciences/unesco-global-geoparks/list-of-unesco-global-geoparks/spain/lanzarote-and-chinijo-islands/) plus the subsequent international publicity received by the Canary Islands, as a result, has enhanced tourism with greater emphasis on volcanism.

4.4 SCIENTIFIC COMMUNICATION

There are still two issues, however, that are critical in volcanic crisis management in Canary Islands. The first is the pending issue of communication of scientific information, partially also affected by the "competition" between scientific groups for funding and responsibilities [Pérez and Hernández, 2008]. A grammatical analysis of the official statements (OS) released by the authorities during the El Hierro volcanic crisis is an example of what we mean here by way of issues. The classification was manual given the broad heterogeneity and grammatical difficulties presented in the OS texts. Category labels were defined to fully classify the contents of the information provided by the OS texts, amounting to a total of 18 for the 40,863 words analyses (Table 1 and Figure 4). The OS texts were written in the form of press releases and suffered multiple grammatical deficiencies, besides using ambiguous or even contradictory terms. No effort was made to translate the OS texts into any other language despite the fact that the islands are devoted to tourism and that many residents are foreigners and non-Spanish speaking. Only on limited occasions do they provide information with respect to forecasts and anticipated scenarios.

The OS texts themselves are available at http://www.gobiernodecanarias.org/dgse/noticias_sismo_hierro.html. The OS texts continue to present the same deficiencies as outlined previously, with no improvement made over time.

Category	Description
NgenEvalua	General assessment of the situation.
NactEvalua	Assessment exclusively of the volcanic activity
NdscripPassAct	Description of the past or recent volcanic activity, without assessment
NhowtoMeasure	Description of instrumental techniques, without interpretation, closely linked to the category of 'propaganda'
Nsanitary	Decisions made and recommendations given by Pubic Health Authorities and Institutions
Nforecast	Establishment of predictions / future evolution of the activity. This category has two aspects: 1. if a forecast has been established; and 2. if an indication can be given of how the activity could evolve
NforePass	Reminders of forecasts published in a previous official communication
Ndecission	Decisions and explanations. Decisions taken now (despatching of resources, changes of 'traffic light' colour, evacuations, etc...)
NdecisPass	Reminders of decisions taking in previous days, with-explanations
Nadvice	Recommendations. There are two types: specific and reminders of actions
Nimpacts	Description. Effects of the volcanic or associated activity (seismicity, eruption, etc)
NoperaInfo	Description. Actions in accordance with the Emergency Response Level (activation of committees, etc...) or with operating decisions (Website information, capacity and functions of shelters, etc)
Nnews	Announcement. Something is announced, a normal meeting, or the arrival of some resource (this topic must be handled carefully because many of the decisions are made in the form of an announcement)
Nwhois	Persons or institutions that attend the meetings
NphoneCall	Communications from the population. Phone calls made by the population to 112, in order to communicate information or ask questions
Npropagan	Publicity and propaganda. Showcasing (self-publicising by politicians or scientific groups)
Npromises	Promises. Solution of economic problems or other types of problem
Nbelie	Denials correction of information transmitted by unofficial channels that does not correspond with the reality

TABLE 1. Categories identified in the official statements.

4.4.1 A SPECIFIC CASE: THE SEISMIC CATALOG AS A TOOL FOR COMMUNICATING THE LEVEL OF VOLCANIC ACTIVITY

Many people monitor volcanic activity on the net (with new improved web-pages and app tools). Some of them also read and interpret the monitoring data, the most important source of information given the low level of superficial activity. In the Canary Islands, the official monitoring information is available on http://www.ign.es/web/ign/portal/sis-catalogo-terremotos. One of the elements most frequently used here is the seismic catalog which, in this case, corresponds to the national seismic network of the IGN. This catalog uses the standard international format, including only

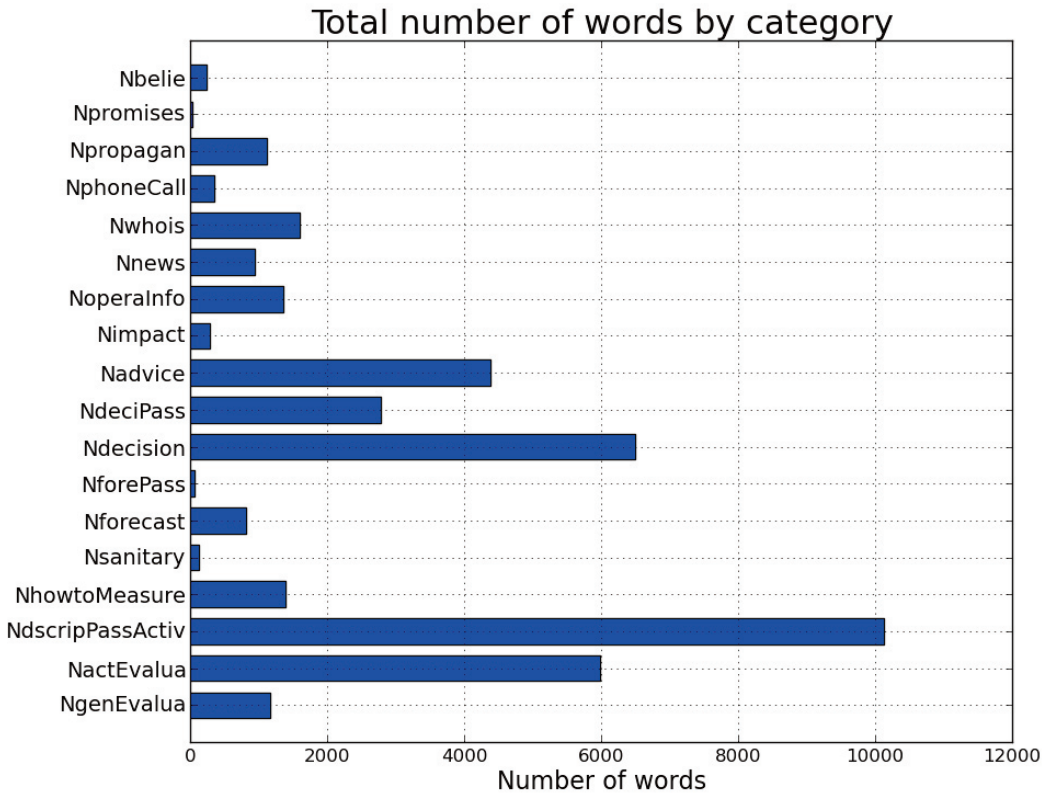

FIGURE 3. Percentage of words by category in the OS issued by PEVOLCA. The three most important categories are the forecast (Nforecast), interpretations (NactEvalua) and observation (NdscriptPassActiv).

those events detected over more than three seismic stations and with minimum uncertainty with respect to location. Therefore, the seismic catalog does not usually include low or very low magnitude events, with the cutting magnitude usually higher than 1. Moreover, there have been some significant changes in the criteria used when managing the seismic catalog that have been subject to criticism [Ibañez et al., 2012; García et al., 2014]. For example, in Figure 5, variations can be seen in the cutting magnitude, and Figure 6 shows the seismic activity in 2010 but with a catalog downloaded at that time compared to a more recent file downloaded in 2015. Another recent example was the shallow seismic swarm detected on the island of Tenerife on the 2nd October 2016 with over 800 events in only five hours, all of magnitudes under 1 [Luengo-Oroz et al., 2017]. The uncertainty in the location of said events was extremely high, not only on account of the low magnitude but also as a result of the high level of anthropic noise on the island so, initially, they were not included in the catalog. This situation was used by other research groups to publicly accuse the IGN of covering up on volcanic activity [Pérez and Schmincke, 2016]. Although significant, the activity was not initially reported, leaving people to think that everything was normal. Therefore, when it eventually filtered into local and international media, it caused widespread alarm. An important issue here is that the PEVOLCA does not address this type of sparse activity, because it is disabled when there is no volcanic unrest, and there is no specific protocol as to how and when to communicate said events. So the question remains as to how to keep people updated about a volcanic system with very low surface activity, in order to avoid the ensuing alarm when any anomaly is subsequently detected by the monitoring network.

One option would be to manage a non-standard seismic catalog where low magnitude events could be included in order to avoid confusion or false accusations (the IGN actually has two seismic catalogs, but with they still have the same data in both only using a different format; the standard seismic catalog http://www.ign.es/web/ign/portal/sis-catalogo-terremotos; and the volcanic seismic catalog http://www.ign.es/web/ign/portal/vlc-catalogo). This solution would also allow for the cutting magnitude to be controlled more precisely and would be of greater significance for scientific work and for the population, by considering sparse activity as normal.

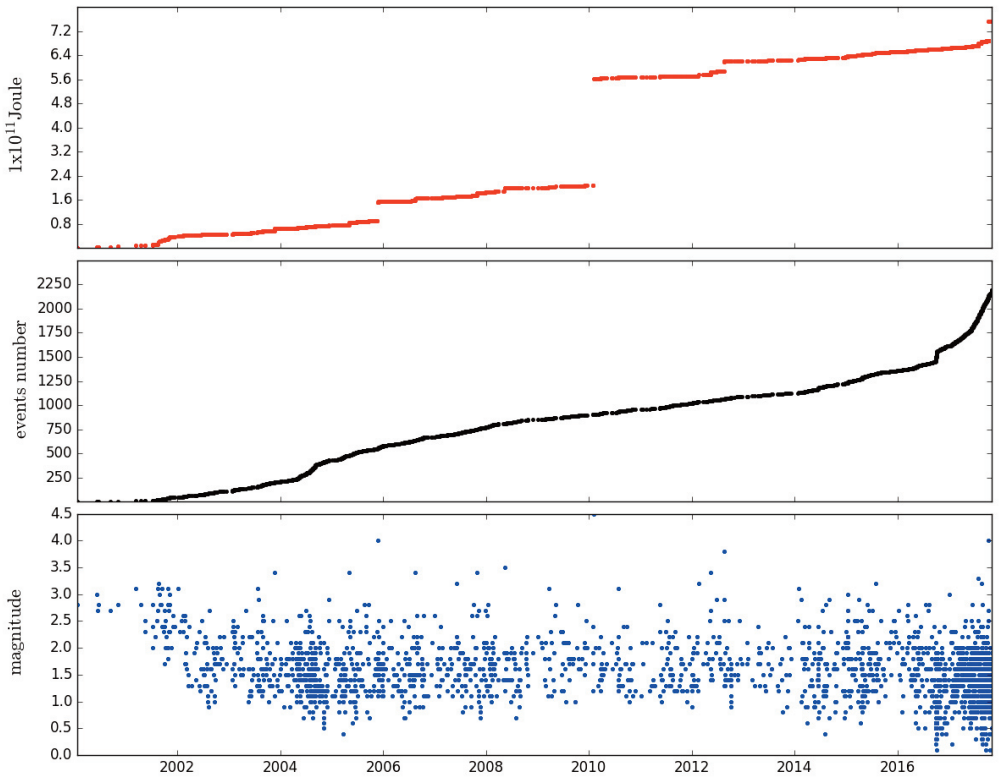

FIGURE 4. Cutting magnitude variation since 2001 in Tenerife Island (blue dots) compared with accumulative seismic energy and events (source http://www.ign.es/web/ign/portal/sis-catalogo-terremotos).

4.5 EDUCATIONAL PROGRAMS

The second issue is specific awareness and educational programs, a matter systematically avoided not only in schools but also in the tourist sector. The only initiatives that have prospered have been private and/or individual. Despite the fact that the first Volcanic Guidebook for teachers was issued back in 2004 [Llinares et al., 2004], most children have no idea of what to do in situations of natural risk and therefore no self-protection strategies. In fact, the most important educational and communication strategies are carried out nowadays by the volcanological associations.

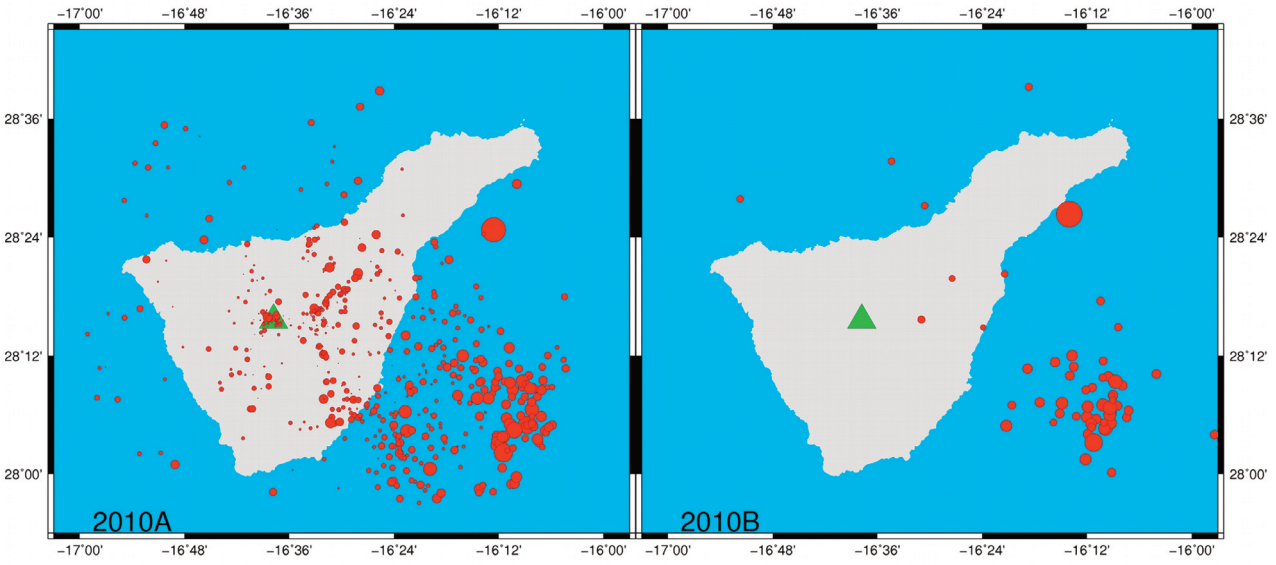

FIGURE 5. Earthquake locations and magnitudes for the same period 2010 but using IGN seismic catalog files downloaded in 2010 and 2015.

5. DISCUSSIONS AND CONCLUSIONS

The idea of assessing the management of a volcanic crisis in all its complexity gave rise to the proposal of a new index called the Mitigation Effort Index [Marrero et al., 2011]. In general, the factors used to construct the index and the values obtained in 2004 show the complicated situation in the Canary Islands. These factors were divided into three groups: by scientific response, by Civil Protection response and by community response. The proposed factors are key to an understanding of how difficult the management of a volcanic crisis can be. The results offer substantial improvements (2018) over 2004 (Table 2).

Number	Factors by category	Max Value	2004	2018
	Scientific Response			
1	Is there a Monitoring network?	0-1	1	1
2	Is there a Volcano Warning System?	0-1	0	1
3	Is there an Event Tree of expected volcanic activity	0-1	0	1
4	Is there a volcanic hazard map?	0-1	0	1
5	Is there a volcanic risk assessment?	0-1	0	1
6	Are there volcanic research programs?	0-1	1	1
7	Is there an Official Assessor Scientific Team or Institution?	0-1	1	1
8	Is there cooperation between the different volcano research groups?	0-1	1	1
9	Is there a communication channel between scientific team and authorities?	0-1	1	1
TOTAL		9	5	9
	Civil Protection Response			
1	Is there any public or private institution dedicated to managing emergencies?	0-1	1	1
2	Does such institution have experience in organizing preventive massive evacuations?	0-1	0	0
3	Have the personnel of said institution received training related to volcanic hazards?	0-1	0	1
4	Have volcano drill or exercises been carried out by said institution?	0-1	0	1
5	Is there any interaction between said institution and the community to elaborate the emergency plan?	0-1	0	0
6	Is there a National/Federal Volcano Emergency Plan?	0-1	0	1
7	Is there a State/Regional Volcano Emergency Plan?	0-1	0	1
8	Is there a Local Volcano Emergency Plan?	0-1	0	1
9	Is the Volcano Warning System public?	0-1	0	1
10	Is the Volcano Emergency Plan suited to the expected volcano activity?	0-1	0	1
TOTAL		10	1	8

	Community response			
1	Has the community got the capacity to self-evacuate?	1-0	1	1
2	Is there a volcanic hazard perception in the community?	0-2	0	2
3	Is there an official educational program of volcanic hazard in schools?	0-1	0	0
4	Is there a short-term educational program for community self-protection?	0-1	0	0
5	Is the volcanic Warning System known by the community?	0-2	0	1
6	Is the volcanic Warning System understood by the community?	0-2	0	1
7	Is there any official public statement about the volcanic activity?	0-1	0	1
8	Does the community trust on their emergency managers?	0-2	0	0
9	Does the community have a historical memory of eruption with VEI >3	0-1	0	0
10	Does the community have a historical memory of eruption with VEI <=3	0-1	1	1
11	Does the community remember casualties produced by the volcanic activity?	0-1	0	0
12	What knowledge people have about volcanic hazard?	0-2	0	1
TOTAL		**17**	**2**	**8**
MITIGATION EFFORT INDEX		**36**	**8**	**25**
MITIGATION EFFORT INDEX ESCALE **Very Low 0-7** **Low 7-14** **Moderate 14-21** **High 26-28** **Very high 28-36**				

TABLE 2. Mitigation Effort Index to assess the complexity of a volcanic crisis management could be.

The TP-VSC volcanic activity level is variable, with higher and lower periods of activity but there is still a problem of some magnitude relating to communication of the scientific information to the general public, influenced by the perception of the potential problem posed for tourism. However, geotourism is growing worldwide, and even in high-risk areas [Rucińska and Lechowicz, 2014], tourism is still on the up and contributing to economic development [Erfurt-Cooper, 2011; Sagala et al., 2015]. When an episode of unrest is declared, tour-operators want to know if the place is safe or not, so hiding potential volcanic activity is neither viable nor advisable. Sooner or later, the media will pick up on the story or bloggers will get the news out, allowing more influential media to highlight the action. On the contrary, the authorities should present the measures being taken to mitigate whatever outcome might arise as the result of the volcanic activity and apply an excellent Emergency Warning System, in order to keep economic losses to a minimum.

There was an initial lack of public information in 2004, with a social forum on a webpage used as the only source of data for information to the general public with respect to the volcanic nature of the island and what was happening. This initiative therefore was outside the control of the local authorities. If the authorities responsible for volcanic crisis management do not give a faster and/or more appropriate response, people will find one for themselves on the Internet. In the case of the Canary Islands in 2004, the recourse to non-of-

ficial sources was so important that these groups actually became the most important communication channels, proving to be efficiently organized and trustworthy. When there is seismic activity nowadays, visitor numbers jump as happen in other places [Bird et al., 2008].

During long-term volcanic crises, it is fundamental to keep the population constantly updated even when the level of volcanic activity is low [UNDRO, 1985; McGuire et al., 2009]. However, in the volcanic process of the island of El Hierro (2011-2015), the OS texts were infrequent. One of the arguments given by the decision-makers for this infrequency was that said information might spark social alarm and/or economic losses, an argument, unfortunately, still used in the present. Social alarm is one of the myths of emergency management [Mileti and Sorensen, 1990], but the fact of the matter is that the population reacts negatively when information is unavailable or when the information given is deficient, producing confusion [Haynes et al., 2008]. OS language is still ambiguous and confused, and does not provide adequate information with respect to forecasts and anticipated scenarios, in spite of the recommendations given, for example, in Bignami et al., [2012].

A good forecast does not mean the crisis will be managed correctly [Marrero, 2015]. Improving crisis management needs not only greater scientific development but also a better understanding of the community at risk [Twingg, 2003]. The Canary Archipelago is a complex environment at high volcanic risk, where great improvements have been achieved. However there are still important issues that must be improved in order to ensure better volcanic crisis management.

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