The Mitigation Effort Index (MEI). A new concept to asses the social and political factors in establishing risk levels.

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ABSTRACT

The traditional definition of risk is is the multiplication of hazard and vulnerability aspects, where the hazard is the probability of the impact of natural phenomena (in time and space) and vulnerability (includes exposure) refers to the expected losses, including lives. In general, risk is valued economically, but for the purposes of political decision-making, it is the number of expected deaths. In this definition, it is accepted that the only actions taken are physical ones, from the point of view of natural phenomenon (i.e. strong winds, ash fall, pyroclastic density current), actions are taken to reduce vulnerability (i.e. increase soundness of buildings), but this does not take into account the mitigation efforts related to risk management. Some recent disasters have highlighted the need to assess the risk management, especially regarding the loss of lives (i.e. El Chichon, Nevado del Ruiz, Katrina)

The Mitigation Effort Index (MEI) evaluates preventative measures taken by a community to protect itself from a natural phenomenon. Analysed factors are organized into three response groups; scientific response; political and civil defence response and social response. Knowledge of this index can help design corrective measures to improve the response of the community in the face of a threat. The factors selection process is complex due to the wide variety of social, political, legal and even religious organizations that affect the management of a crisis. We have chosen the ones which should be present in any management of an emergency. To assess the reliability of the MEI, we applied it to several volcanoes.

Some characteristics of the Mitigation Effort Index (MEI): **1)** The minimum and maximum value of MEI is from 0 to 36. **2)** Most of MEI's questions are answered using 0 or 1 (yes or no) and a few using a qualitative measure (0, 1 or 2). In this case, the meaning is (bad/poor, medium/normal or good). **3)** The MEI is a subjective index, so it should be calculated by several researchers for the same volcano. To evaluate the weight of each researcher, an elicitation methodology can be used (Aspinall et al., 2006). Finally, an average value is obtained. **4) The main objective of MEI is the characterization of volcanic crisis management in a homogeneous ranking**. As there is no relation between the number of causalities and the VEI of eruptions (Witham, 2005) we have to take into account both the mitigation actions and the volcanic threat to better understand the volcanic crisis management efforts. We propose to use the MEI in combination with the National Volcano Early Warning System (NVEWS) threat index elaborated by USGS (Ewert et al., 2005). The NVEWS threat is an easy and fast way to assess the volcanic threat based on hazard and exposure factors.

SC_1. In Ewert et al., (2005) the monitoring network must be adapted to the level of threat and the volcanic activity. So we consider a 0 value when there is no monitoring network or when the monitoring network is very poor related to threat and volcanic activity levels.
SC_2. The warning system has different components (Mileti and Sorensen, 1990). One of them is referred to as the pre-established communication protocol between the scientific committee (or the institution) responsible for giving the eruption forecast and authorities that must receive it. For example, are the people who must receive the forecast known to the scientific committee? What kind of information should be delivered?
SC_3. The Event Tree (Newhall and Hoblitt, 2002) helps us to define the Most Likely Scenario and the Worst Possible Scenario and all the situations that can lead to either. Are these scenarios defined in the Event Tree ? Has the Event Tree been used to elaborate the Emergency Plan?
SC_4. Many volcanoes lack an official Volcano Hazard Map but that does not mean that local or non-local research groups do not have this information available. Are there research groups making hazard maps? Are the hazard maps well made? Have hazard maps been incorporated in the Emergency Plan?
SC_5. Risk assessment is complicated in densely populated areas. Large amounts of data are needed and not all the data can be obtained or have the adequate level of detail, as well as there being difficulties to get information in some urban areas. However, it is extremely important to understand how natural hazards could affect us and therefore the design of mitigation strategies.
SC_6. To find out and understand future volcanic activity, it is important to study the volcano using new techniques and methodologies. Research programs help to improve the knowledge about volcanoes.
SC_7. In UNESCO, (1974) the importance of a Scientific committee as a an interlocutor between scientific groups and the authorities is pointed out to avoid the same problems as those generated by the volcano crisis of Guadalupe in 1974. These problems are addressed in UNDRO & UNESCO, 1985. On this point, we have to take into account if there is an official Scientific Committee or a scientific group doing these tasks, regardless of the quality of guidance or mediation efforts.
SC_8. One of the problems in volcanic crises is the lack of cooperation due to personal discrepancies between researchers (IAVCEI, 1999). These discrepancies are particularly serious when made public. So, have these differences been made public? Have they affected the credibility of research groups or institutions responsible for monitoring?
SC_9. During a volcanic crisis, continuous communication between the Scientific Committee (or institution) and authorities from local, state/regional and national/federal level is very important. So are there meetings or information exchange between researchers and authorities?

CP_1. The increase of population also increases the need of institutions involved in managing emergencies, especially in densely populated areas.
CP_2. Managing massive evacuations in densely populated volcanic areas is a complex problem. The political and socio-economic implications make it difficult to take an evacuation decision and the logistics needed exceed the normal resources required in most everyday emergencies. The lack of experience could be considered an important handicap to managing these situations. Massive evacuation should be undertaken from a preventive perspective as opposed to more conventional reactive one.
CP_3. To improve the lack of preparedness training in the natural phenomenon is one of the improvements that can be made by the INSTITUCION (i.e. Civil Protection). Obviously the training quality is really important so if courses transmit false information about the volcano activity, we can consider assessing this point as 0.
CP_4. Volcano drills or exercises are very important to assess the Emergency Plan quality. We can test the evacuation strategies designed to find problems they could have in real situations. If drills and exercises transmit a misconception of the volcanic hazard and the protective measures that should be taken, the value will be 0.
CP_5. In Paton et al., (2008) the interaction between Civil Protection and the community is considered an important task to improve the risk perception and preparedness, especially to elaborate the Emergency Plan.
CP_6. The volcano risk is managed in a different way in each country depending on laws, society, cultural history, etc. The volcano crisis can be managed by one administration or in collaboration with others (National/Federal, State/Regional and Local institutions). So depending on the situation CP_5, CP_6 and CP_7 could work as one point or three different points. In the first case, when one institution manages all the volcanic risk and has developed an Emergency Plan in which all aspects are addressed, we can add a value of 1 to the others.
CP_7. Same as above.
CP_8. Same as above.
CP_9. In this case, the components of a volcano warning system are related to those meant to inform the population (De la Cruz-Reyna and Tilling, 2008). The department or people that have to transmit the warning message, the warning message content, resources used to disseminate the warning message, etc. Have all these components been established?
CP_10. Sometimes Emergency Plans do not take into account the Worst Possible Scenario or expected situations that may arise during an eruption. In others, Emergency Plans could have serious deficiencies.

CR_1. Regardless of the evacuation strategies (self-evacuation or phased response) followed by Civil Protection (or the authorities), capacity to self-evacuation allows people to decide when they want to evacuate and where to go. Depending on the situation, the self-evacuation capacity could be understood as a positive factor or negative one especially in a densely populated areas. In this case and related to volcanic hazards, we consider the self-evacuation capacity as a positive task that should be taken into account in emergency plans with a correct planning. In a densely populated area without a well developed plan, self -evacuation should be given a zero value.
CR_2. It is very difficult to assess the community's volcanic hazard perception. When no data is available, we could use people's behaviour if they have experienced any volcano activity.
CR_3. In this point, we don't talk about periodic educational strategies like a school campaign or a public conference (meeting, workshop, etc). We consider a volcanic hazard educational program as a long-term educational strategy. The knowledge of volcano activity, volcano hazard, mitigation actions, etc. are taught every year at different school levels. Teachers are trained so they can teach the children.
CR_4. Unlike the previous point, in this case we highlight all short-term, periodic educational strategies.
CR_5. An important component of the warning system is whether it is known to the community or not (De la Cruz-Reyna and Tilling, 2008). We can have an excellent warning system but if it is unknown to people, it only partially fulfils its mission. So do people know the warning message? Do people know what they have to do in case of an emergency? Do people Know how the warning message is disseminated?
CR_6. As well as the above, the Volcano Warning System must be understood by the community ((De la Cruz-Reyna and Tilling, 2008).
CR_7. Public reports about volcano activity help people to familiarize themselves with volcano news. At the same time, authorities learn how to manage and understand the information provided by scientists. The dissemination of volcano activity reports should be done when there is not any sign of unrest or at the beginning of the unrest phase to avoid alarming the population. The dissemination of volcano reports could be done by the media or in institutional web pages and they must inform about daily (weekly or monthly) volcano activity.
CR_8. Due to the complexity of volcanic crisis management and problems detected during the course of several volcanic crises, the confidence of people in politicians and in all administrative and research groups that play an important role in any decision-making is a critical factor that may affect the evacuation decision. When these data are not available the conduct and performance of authorities and Civil Protection in past emergencies and the public opinion generated could be used to define this point.
CR_9. In the following three points, we assess the volcanic historical memory. In Paton et al., (2008) past experience of volcanic hazards does not mean that people will be better prepared. However, past experience should be considered due to both its positive and negative implications on people's behavioural. The VEI (Newhall and Self, 1982) and the number of causalities are taken into account to assess the MEI.
CR_10. Same as above
CR_11. Same as above
CR_12. Due to low frequency of volcanic activity in most places, volcanic historical memory can only be transmitted by educational programs or by family discussion. But the quality of information is very important to avoid misunderstandings. What people know or believe they know could modify their behaviour in a volcanic crisis.

DO YOU WANT TO EVALUATE THE VOLCANIC RISK MANAGEMENT IN YOUR COUNTRY?

NVEWS Threat scale	VERY LOW 0 - 6	LOW 7 - 30	MODERATE 31 - 63	HIGH 64 - 113	VERY HIGH + 113

	NVEWS threat		195	340	238
Nº	Scientist response	Max Value	Teide	Popo	Chichón
SC_1	Is there a Monitoring Network?	0-1	1	1	1
SC_2	Is there a Volcano Warning System?	0-1	0	1	0
SC_3	Is there an Event Tree of expected volcanic activity?	0-1	1	1	0
SC_4	Is there a Volcano Hazard Map?	0-1	1	1	1
SC_5	Is there a Volcano Risk Map?	0-1	1	0	0
SC_6	Are there volcano research programs?	0-1	1	1	1
SC_7	Is there an Official Assessor Scientific Team or institution?	0-1	0	1	1
SC_8	Is there cooperation between volcano research groups?	0-1	0	1	1
SC_9	Is there a communication channel between the scientific team and authorities?	0-1	0	1	1
	Total	**9**	**5**	**8**	**6**

Nº	Civil Protection response	Max Value	Teide	Popo	Chichón
CP_1	Is there any public or private INSTITUTION dedicated to managing emergencies?	0-1	1	1	1
CP_2	Does the INSTITUTION have experience in organizing preventive massive evacuations?	0-1	1	1	1
CP_3	Have the INSTITUTION personnel received training related to volcanic hazards?	0-1	1	1	1
CP_4	Have volcano drills or exercises been carried out by the INSTITUTION?	0-1	0	1	1
CP_5	Is there any interaction between the INSTITUTION and the community to elaborate an Emergency Plan?	0-1	0	1	1
CP_6	Is there a National/Federal Volcano Emergency Plan?	0-1	0	1	1
CP_7	Is there a State/Regional Volcano Emergency Plan?	0-1	1	1	1
CP_8	Is there a Local Volcano Emergency Plan	0-1	0	1	1
CP_9	Is there a Volcano Warning System?	0-1	0	1	0
CP_10	Is the Volcano Emergency Plan suited to the expected volcano activity?	0-1	0	1	1
	Total	**10**	**3**	**10**	**9**

Nº	Community response	Max Value	Teide	Popo	Chichón
CR_1	Has the community got the the capacity to self-evacuate?	0-1	1	1	0
CR_2	Is there a volcanic hazard perception in the community?	0-2	1	1	2
CR_3	Is there an official volcanic hazard educational program in schools?	0-1	0	1	1
CR_4	Is there a periodic self-protection educational program for the community?	0-1	1	1	1
CR_5	Is the Volcano Warning System known by the community?	0-2	0	2	0
CR_6	Is the Volcano Warning System understood by the community?	0-2	0	2	0
CR_7	Is there an official public report about volcano activity?	0-1	0	1	0
CR_8	Does the community trust its volcano emergency managers?	0-2	1	2	1
CR_9	Has the community got volcano historical memory about VEI <3 eruptions?	0-1	1	1	1
CR_10	Has the community got volcano historical memory about VEI ≥3 eruptions?	0-1	0	1	1
CR_11	Does the community remember causalities due to volcanic activity?	0-1	0	1	1
CR_12	What knowledge do people have about volcanic hazards?	0-2	0	1	1
	Total	**17**	**5**	**15**	**9**
	MITIGATION EFFORT INDEX	**36**	**13**	**33**	**24**

MEI scale	VERY LOW 0 - 7.2	LOW 7.2 - 14.4	MODERATE 14.4 - 21.6	HIGH 21.6 - 28.8	VERY HIGH 28.8 - 36

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