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Reducing volcanic risk on Fogo Volcano, Cape Verde, through a participatory approach: which outcome?

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Abstract. This research paper presents the outcomes of Work Package 5 (socio-economical vulnerability assessment and community-based disaster risk reduction) of the MIAVITA (MItigate and Assess risk from Volcanic Impact on Terrain and human Activities) research programme conducted on Fogo Volcano, Cape Verde. The study lasted for almost 3 years (May 2010 to January 2012), of which most of the time was spent in the village of Chã das Caldeiras, situated within the 9 km wide caldera of the volcano inside Fogo Natural Park. The objectives of the programme included assessment of the vulnerability of the community at risk in terms of livelihoods, access to resources, and power relations between the local people and the different public and private institutions. These are important factors that need to be investigated in order to understand the root causes of vulnerability of the local people. This case study shows that the voluntary exposure of people to volcanic threats is linked to daily access to sources of livelihood, especially agriculture and tourism. This is despite the perception of people of the risk to their lives and properties. In order to counter the factors of vulnerability, the study also aimed to identify and enhance local capacities. To achieve such an objective, a participatory three-dimensional mapping (P3DM) activity was conducted to facilitate the dialogue between the local people and the different stakeholders as well as to prepare plans and measures to reduce volcanic risk. The P3DM was a half success considering that it has not yet led to an operational plan which takes into account the local capacities. The main reasons included (1) the non-participatory aspect of the project at the beginning which should have identified priorities for people and let them lead the project to ensure the sustainability of (2) deep conflicts within the community which complicated the focus group discussions around the 3-D map, and the difficulties in involving more marginalised people like women and the youth, and (3) the fact that volcanic risk is not a priority for the people, who are more concerned with daily difficulties due to unsustainable livelihoods, a lack of access to water, land tenure, and the restrictions by the Fogo Natural Park administration and the municipal officials.

Still, the study was successful in creating a space for dialogue between the local people and the outside stakeholders such as the Natural Park Administration, the Civil Protection, and the Municipality of Santa Catarina, who have all participated actively during the course of the project.

1 Introduction

Presently, the development of communities in developing countries is hindered by numerous factors. Among the most important is the occurrence of disasters associated with natural hazards (floods, volcanic eruptions, tsunamis, cyclones, etc.), which affected and continue to threaten many communities, especially those situated in hazard-prone areas.

As a result, many practitioners' handbooks, scientific publications, and international policies on disasters and development goals emphasised the importance of disaster risk reduction (DRR). There is consensus within the scientific community that efforts for DRR should integrate the socio-economic factors from daily activities of local people in order to strengthen their livelihoods (O'Keefe et al., 1976; Hewitt, 1983; Chester, 1993; Blaikie, 1994; Wisner et al., 2004;

Chambers and Conway, 1991; Benson and Twigg, 2007). Secondly, it should adopt context-appropriate measures to develop the capacities of local communities against disasters (Anderson and Woodrow, 1989; Maskrey, 1989). Thirdly, it should be based on a real multi-stakeholder collaboration at different levels (institutional, different levels of government, local communities) to merge scientific and local knowledge including technical and political capacities (Gaillard, 2007, 2009; Texier, 2009). The theoretical arguments on the integration of bottom-up and top-down for the betterment of efforts for DRR are well established. However, some difficulties remain, particularly in the methodological aspect, which could combine the knowledge and capacities from different actors and could help practitioners in the field to facilitate efforts for DRR as well as resource management (Gaillard, 2007; Texier, 2009; ISDR, 2009).

Difficulties in DRR are often embedded in inappropriate strategies (toward the social realities and economic constraints especially at local level) which further enhance vulnerability. These difficulties are thus not linked to a lack of knowledge about risk or low capacities from the local people. For example, some conflicts between actors may come out of the land-use restrictions and pressure and the strong technocratic and top-down approach in resource and risk management. They are real difficulties in building integrated and efficient DRR characterised by merging of both scientific knowledge (from outside stakeholders who retain political power and financial capacities) and indigenous knowledge (from local communities who are at risk and possess significant local capacities).

Thus, the general objective of Work Package 5 of the MIAVITA research programme was to analyse the strategies and relationships between various stakeholders, including those in the local communities, and to enhance dialogue between actors for a more efficient DRR. The research programme was conducted on four volcanoes, which include Kanlaon (Philippines), Merapi (central Java in Indonesia), Mount Cameroon and Fogo (Cape Verde).

This paper focuses on the Fogo case study. First, we present the conceptual framework of the study. Secondly, we assess the exposure of the community of Chã das Caldeiras to volcanic hazards as well as the people's vulnerabilities and capacities in facing such hazards (Sect. 3.1). Data collection and the analysis of the results have been done using combined methods and tools from quantitative (survey questionnaire), qualitative (key informant interview and anthropological observation), and participatory research methods (focus group discussion, participatory 3-D mapping, and film).

Secondly, we argue on two conflicting priorities – the necessity of protection of people from volcanic risks and the necessity of protection of nature from human activities. These conflicting priorities had caused conflicts between the community and the outside stakeholders such as the municipal government and the Fogo Natural Park administration (Sect. 3.2).

Thirdly, we elaborate on the role of P3DM in promoting participatory management of both volcanic risk and resources (Sect. 3.3). The process of conducting P3DM as well as its limits and contributions are discussed in the last part.

2 State-of-the-art in disaster risk reduction

The increasing disaster on a worldwide scale is a clear indication of the failure of the traditional disaster management system that is basically reactive and focuses on crisis management (Bankoff, 2003). This system is basically the product of the traditional technocratic top-down government framework wherein the state and the concerned government agencies decide and act according to their mandates. The government considers itself to be a "technician" who could "fix environmental problems" such as disasters associated with natural hazards (Wisner et al., 2004). In most cases, indigenous knowledge, vulnerability and capacity at local level are not recognised (Mercer et al., 2007). The government favours the usual command-and-control disaster prevention policies and actions that fail to address many issues of DRR. In the Philippines, for instance, government itself admits that the current policies and responses are inadequate and unsatisfactory both at local and national level (Heijmans and Victoria, 2001). In some cases, the "bureaucratic rationalisation, complexity, and the high social status of technology" in DRR efforts even increase the vulnerability of the local population (Mercer et al., 2007; ISDR, 2004; Wisner, 1993).

Since the 1980s there has been growing interest in alternative strategies, which involve the local people at community level at all stages of DRR efforts as an alternative to the approach of the government and other aid agencies. This approach addresses not only issues associated with disaster events but also larger social and political issues such as inequity and underdevelopment that can be considered as root causes of increasing vulnerability (Heijmans and Victoria, 2001).

Recent efficient and remarkable initiatives are being devoted to community-based disaster risk reduction (CBDRR) as a framework for DRR.

For example, UNDP (2010) and Gautam (2009) have compiled the best community-based practices of DRR (or CBDRR) from countries in South and Southeast Asia, southeastern Africa, and the southwestern Indian Ocean. These examples of best practices have emphasised the empowerment of the marginalised sectors, the integration of DRR into broader development planning to address the root causes of disasters, and the roles of the state and the local government units in risk reduction.

CBDRR emphasises the participation of communities in both the evaluation of their vulnerability and in the ways to reduce it. It further empowers communities with indigenous and culturally acceptable ways of coping with crises brought by the occurrence of natural hazards.

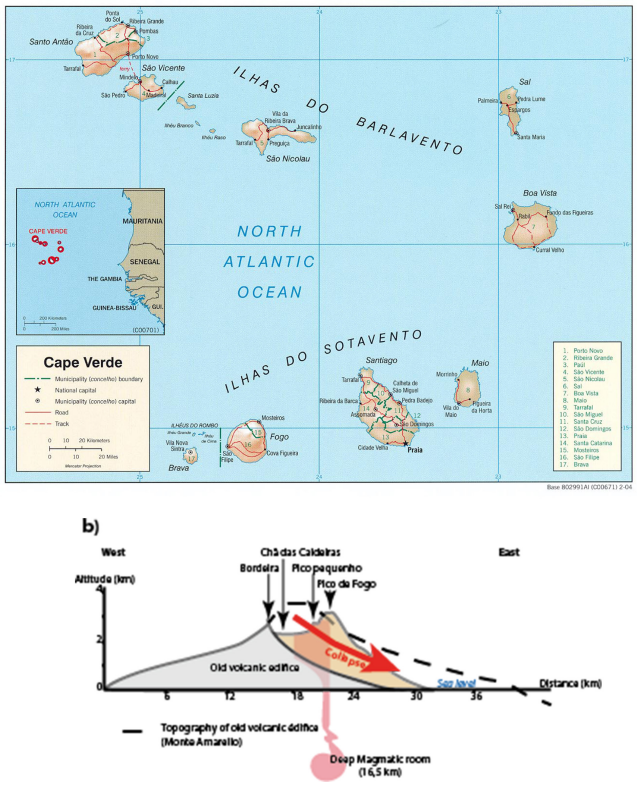

Figure 1. (a) Map of Cape Verde, and **(b)** scheme of Fogo Volcano (modified from Day et al., 1999; Day and Amelung, 2002, p. 3; Da Silva et al., 1999).

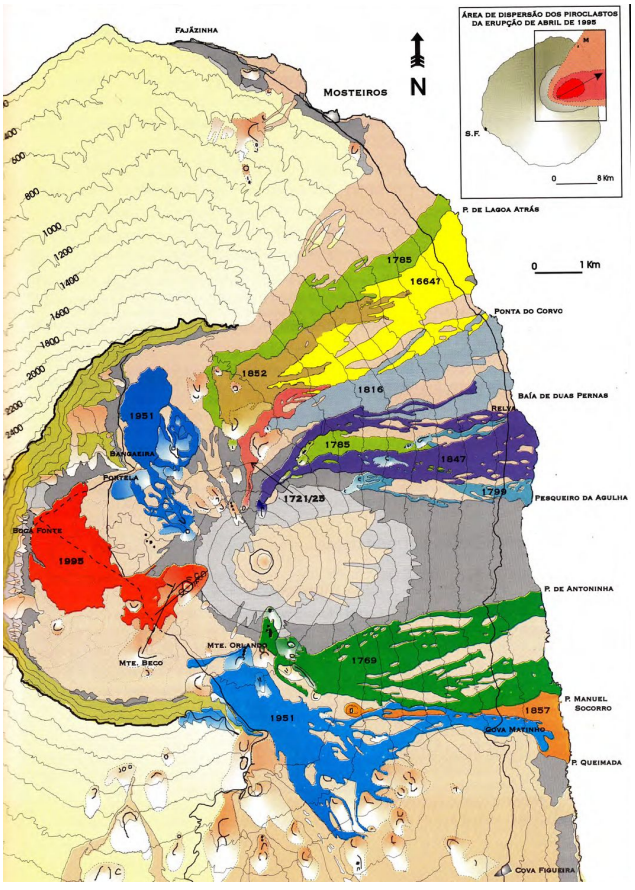

Figure 2. Historical activity of Fogo Volcano (source: Torres et al., 1997; Da Silva et al., 1999).

CBDRR is now increasingly promoted among local governments in order to strengthen the links between the official disaster management system and community-based organisations. The local authorities are instrumental in fighting poverty and providing vulnerable communities with better resources and services as well as technical and financial assistance to mitigate disaster risk. They also play a critical role in raising disaster management awareness and early warning at local level. It is further recommended that local officials should be the ones organising community-based disaster reduction in their respective territories (Kafle and Murshed, 2006).

The use of participatory methods has become central to CBDRR to facilitate the participation of local communities. Some of the methods include calendar sand timelines, problem trees, Venn diagrams, transect walks, participatory mapping, etc. Practitioners have also developed more specific tools and toolkits such as the vulnerability and capacity analysis (VCA) matrices, which have become widespread in terms of application in the field, especially among NGOs (non-governmental organisations) (e.g. Anderson and Woodrow, 1989).

Scientists, government officials, local communities and non-governmental organisations (NGOs) seldom work with each other simply because of the absence of a common tool or a methodology that is acceptable to all stakeholders of DRR. Local communities, usually in collaboration with NGOs, conduct community-based programmes such as CBDRR, which emphasise initiatives at grassroots level promoting local knowledge in the planning process and actions. As explained by Gaillard and Maceda (2009), however, scientists tend to dismiss CBDRR as they find it "too subjective and removed from scientific methodologies and rigorous protocols". Local government officials, on the other hand, are constrained by a structured national disaster management framework wherein compliance means dismissal of alternative methods such as participatory methods.

In order to bridge the gaps mentioned above, Work Package 5 of the MIAVITA programme utilised P3DM in association with other qualitative and quantitative methods to assess the vulnerabilities and capacities of the local people. They were realised following the guidelines and ideals of CBDRR.

3 Geographical context of Fogo Island

3.1 Geological context: a volcanic island

Fogo is an active volcanic island in the southwestern part of the Cape Verde archipelago, some 700 kilometres off the African coast (Fig. 1a). Fogo Volcano is a stratovolcano of which the origin of formation is consistent with the drifting hotspot model. The volcano is relatively small (476 km^2) but has an elevation above sea level of 2829 m, which ranks this volcano second in the North Atlantic after the Teide in the Canary Islands. The geological formation of the volcano occurred in two main stages. First, a large flank collapsed and led to the removal of the summit and the eastern flank of the former volcano (Foeken et al., 2009). The collapse then produced a 9 km wide escarpment locally known as *bordera* (the rim) with a height of at least 1 km (Fig. 1b). The event triggered a large-scale tsunami which occurred probably between 123.6 ± 3.9 ka U–Th age and 86 ± 3 ka K–Ar age (Paris et al., 2011). Earlier dates have been proposed by Foeken et al. (2009).

Early historic accounts have indicated that between the mid-16th century and the early 18th century, Fogo Volcano was in frequent and prolonged eruption with lava erupting from volcanic fissures (Ribeiro, 1960; Day et al., 1999, 2000). The lava flows reached the eastern coast of the island, especially during the 18th century (1721–1725, 1769, 1785, and 1799) and the 19th century (1816, 1847, 1852, and 1857) (Fig. 2). Two eruptions occurred during the 20th century (1951 and 1995) (Fig. 3). In both cases, lava flows entered the central part of the caldera called Chã das Caldeiras where lava fountains were observed. In April 1995, about 46×10^6 m^3 of lava erupted for almost 8 weeks from the vents situated on the southwestern slopes of the volcano (Amelung and Day, 2002). All the small vents that were active only in the few days following the beginning of the eruption were located along two fissures intersecting themselves, comprising one about 1 km long (cf. Fig. 2). After the first week following the beginning of the eruption, only one vent was active (Torres et al., 1997).

3.2 Socio-economic context: a remote area

Fogo Island regularly experiences a dry tropical climate with a very short rainy season from July to November each year (Ribeiro, 1960). The caldera presents a relatively rich biodiversity thanks to its altitude and exposure to Alizee humid winds. The volcanic origin of the island offers fertile soils that are fit for agricultural activities. Within the 9 km wide caldera of Fogo Volcano are the villages of Portela and Bangaeira which compose the so-called Chã das Caldeiras. The villages are part of the municipality of Santa Catarina and also situated within the Fogo Natural Park created in 2003 (Figs. 3, 4).

Encouraged by long-term drought and a lack of arable lands, the first settlements within the caldera were established in the 1860s during the Portuguese colonisation (Ribeiro, 1960; Lesourd, 1995; Andrade, 1996; Madeira Santos, 2007). Since then, only two eruptions have occurred. Despite a large diaspora to the United States and Europe of the local populations, the community of Chã das Calderas continues to grow due to the high birth rate. From 600 inhabitants in 2000 and 697 inhabitants in 2010 (INE, 2010), the communities are permanently exposed to volcanic hazards.

The inhabitants are observably more family-centered than community-centered in terms of way of life and daily social interaction. A complex network of family ties shapes the social structure. Most of the people are relatives and they claim a common French forefather, Armand Montrond. Many families are decomposed and recomposed with single mothers often living with their parents, while many men have several households. De facto, families are of a matrifocal type. Above the family unit there is no formal or informal chief who ensures community links. However, there is a permanent representative of the municipal authorities in Chã das Caldeiras. This liaison officer, who was born and lives in in the community, handles social services and tax-related issues. Despite strong kinship, social conflicts are frequent but are usually settled through public debates. The 7th Day Adventist and Roman Catholic churches are the two religious groups that are prevalent in the communities and regularly conduct weekly activities.

Farming is the main component of people's livelihoods especially for food sustenance and commercial purposes. All families rely on cattle and goats. They also cultivate several types of crops (mainly beans, corn, manioc, apples, grapes and figs) which are harvested throughout the year for the sustenance of people's needs. Farmlands are not irrigated and water supply depends on irregular rainfall. Grapes and pomegranates are processed to produce wine and liquor and are sold outside the village. The local wine cooperative is composed of 102 farmers and is a group with a major economic stake in the community. Tourism is a growing economic activity which comprises important additional resource for many households of Chã das Caldeiras. Since the last eruption in 1995, tourists have been continuously attracted by the volcanic landforms and eventually led to geotourism industry. The male members of the community often serve as guide of tourists in climbing the summit of the volcano while kids and women make souvenirs. Tourism activities are still volatile sources of livelihoods because they are totally dependent on international demand. However, they bring many opportunities for local development.

Other economic resources include remittances from overseas workers which are similarly dependent on international political and economic conditions.

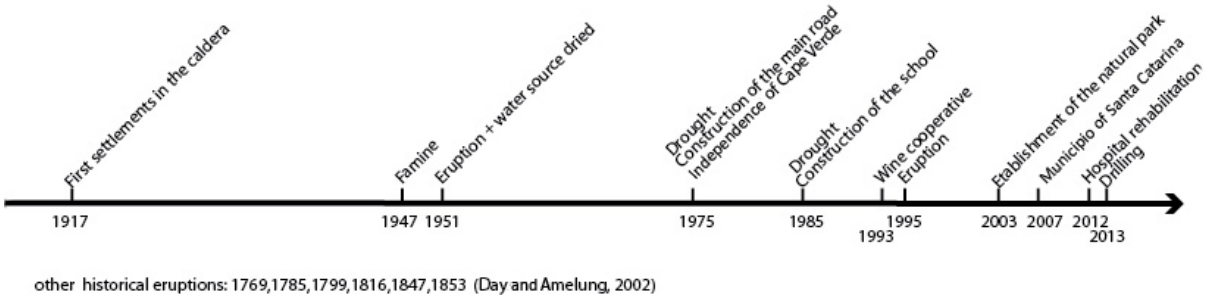

Figure 3. Timeline.

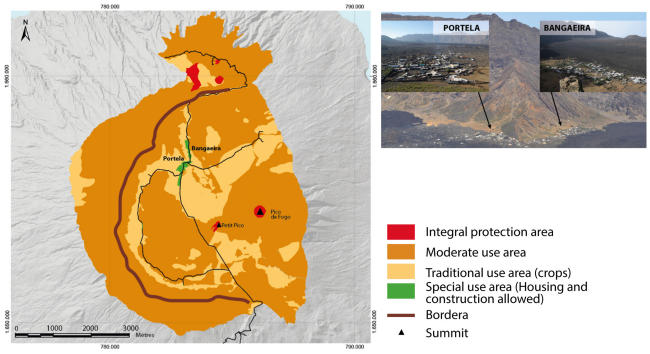

Figure 4. (a) Villages of Portela and Bangaeira situated within the caldera and the Fogo Natural Park, a very narrow space to develop livelihoods (**(b)** general photography taken from the Pico, J. R. Cadag; zoom on the two villages taken from Monte Amarello, P. Texier, April 2011).

4 Results

4.1 Vulnerability and capacity assessment in Chã das Caldeiras

4.1.1 Vulnerability and capacities of the community in facing volcanic hazards

The volcano is both a threat and an asset. The community is directly threatened by volcanic eruptions, since they can lose all their farmlands and houses in case of lava flow like in 1995. No one was killed during the 1995 eruption of Fogo Volcano, but many families were relocated beyond the rim of the caldera. Most of the people came back to Chã das Caldeiras shortly afterwards. It is important to note that the steep and elevated caldera which surrounds the community may also collapse. However, the most severe hazard is drought. It is frequent and endangers people's main resource, i.e. farming, which has caused severe food shortage in the past.

Socio-economic factors have been identified as more important compared to hazard-related factors in explaining risk behaviours during an eruption as well as in pre-disaster and recovery periods. People suffer from social deprivation and marginalisation characterised by low access to public services. The community had been self-sufficient for more than fifty years until the Portuguese built the first paved road in 1975. At present, access to Chã das Caldeiras still relies on a single road to the south and one small trail to the north. The undeveloped road system is a critical factor that could hinder the evacuation procedure in case of volcanic eruption. Presently, the road leading to the south is the most efficient for facilitating evacuation. However, considering the past eruptions, there is a greater possibility that the road could be blocked by lava flows. In that case, the north trail is the only remaining option. However, the trail is not well developed, which could slow down the evacuation procedure and make it more complicated. The community suffers from a lack of communication facilities, which could be problematic in terms of emergency planning and evacuation. The effects of decades of isolation are still evident today in the absence of police forces. Thus, in order to settle conflicts, people resort to informal agreement between the stakeholders involved.

Another consequence is the lack of public facilities. The construction of the primary school is fairly recent, while the health centre operates only on an intermittent basis. In order to access proper healthcare, people need to go to Fogo's main city Saõ Filipe where hospitals and health facilities are located. The failure to provide medical services in Chã das Caldeiras is the factor responsible for the high maternal and infant mortality rate. In fact, the absence of healthcare services has caused more deaths compared to deaths resulting from volcanic activity in Fogo, which has killed only 2 people in the last 200 years (Ribeiro, 1960).

Furthermore, there is neither electricity nor running water in Chã das Caldeiras. Only electric generators provide the wealthiest families with electric power, while the poorest households have no choice but to rely on candles. People rely on water tanks filled with rain water and bottled water purchased from municipal delivery trucks which sustain their daily water needs. Presently (in 2013, note that Fig. 5 was fixed in 2010, when access to communication was a weakness), the community is being connected to telephone and internet networks.

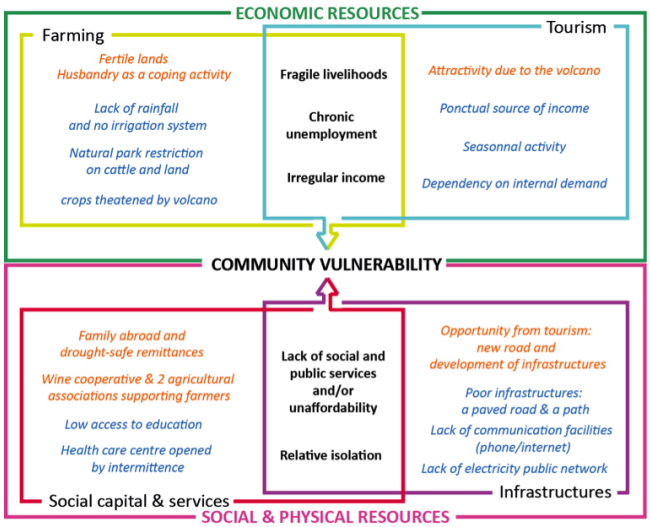

Figure 5. Construction of vulnerability of the community living within the Fogo caldera (analysis from focus group discussions led in Chã das Caldeiras, July 2010).

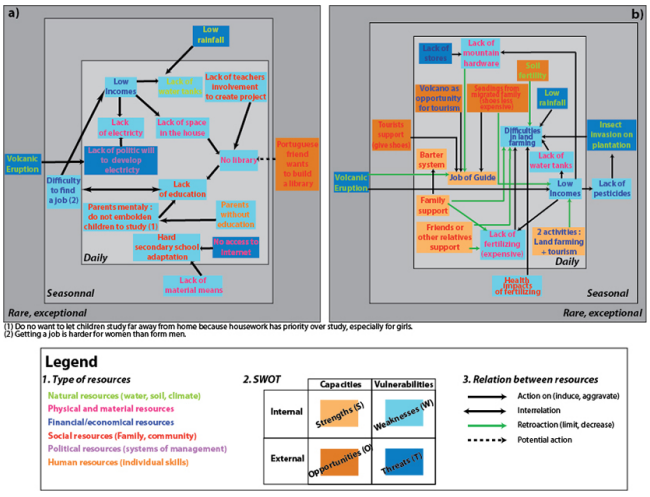

Figure 6. Multifactor targets for **(a)** young women with children and **(b)** guides (from FGDs, July 2010).

Cultural factors may explain the strong attachment of people living in the caldera to the volcano. Despite the absence of local beliefs, local people consider the volcano to be a "friend", underlying a source of life or livelihood which may be a crucial factor in determining the response to volcanic hazards. However, people's response is more likely due to economic reasons and constraints and a lack of alternatives to access to livelihoods outside the caldera. The volcanic soils within the caldera are fertile, the climate conditions are better than in the lowlands, and the volcano has been a source of additional income since 1995 with the development of geotourism. People might choose to stay inside the caldera in order to sustain their livelihoods despite apparent threats from volcanic hazards. However, livelihoods are fragile for many reasons: farming is climate dependent, farmlands can be buried by lava flows, the absence of land registration, which implies an absence of insurance which could compensate for potential losses, limited alternatives for livelihoods (especially secure and formal employment), growing dependence on unstable national and international economies (wine industry, tourism, remittances).

Many households are also headed by single women with several children who have not yet experienced a volcanic eruption. Vulnerability is thus principally embedded in daily activities and cultural factors (Fig. 5). These results highlight why the community does not perceive volcanic threat as the main threat (only 12.8 % of the respondents). People have identified other human-induced threats as more important, such as alcoholism and violence (26.6 %), and crop disease (19.1 %).

The vulnerabilities derived from socioeconomic factors are indeed major determinant of risk face by the people in Chã das Calderas. Still, people possess some strengths and resources which provide them with capacities for facing volcanic hazards and recovering from their impacts. Among the most important resources include the great diversity of the farming products throughout the year, the reliability of local associations as supports for farmers to market their products, and the presence of a permanent liaison officer who could lobby for assistance and support from the municipality of Santa Catarina, etc. Although weaknesses have been identified in the social structure at Chã das Caldeiras, it can be translated to strength in case of volcanic crisis in at least two ways. Firstly, owing to the persistence of polygamy (or "serial monogamy"), extended families in Cape Verde are extremely large and members are distributed in several villages including those outside the caldera. During the 1995 eruption, many people who evacuated from Cha relied on their relatives in other villages for assistance, which could not be provided by the government (e.g. boarding of evacuated livestock on land owned by extended family members in areas not affected by the eruption which permit people to preserve their capital in the form of livestock). Secondly, in times of disasters, a large number of Cape Verdeans overseas workers and expatriates send emergency remittances for their affected families in order to recover. The remittances from abroad directly uplift as well the national economy.

An additional strength is the good knowledge of volcanic hazards of the local people. Based on the MIAVITA database, 77 % of people who experienced the last eruption in 1995 fled from danger. Others waited until the last moment (paroxysm of eruption) before they left the caldera (12.5 %), while some stayed in the village. Those memories and experiences of past volcanic events are also strengths in facing volcanic hazards. The permanent monitoring of the volcano and the enhancement of a contingency plan through a two-day simulation are helpful. However, in addition to the

potentially catastrophic hazards with a very low probability of occurrence (e.g. flank collapse: Day et al., 1999), a resumption of the early historic period pattern of intense volcanic activity is likely to render Chã das Caldeiras unfit for habitation. However, it is very unlikely that a period of very frequent eruptions as it was until the mid-19th century will happen again in the near future (next 100 years, see for example Blong, 1996).

The results of our inquiry through survey suggest that there is strong variability between different social groups of people in terms of perception of vulnerability and capacity. Figure 6 illustrates the gap between the perception of vulnerabilities and the capacities of touristic guides and young women living alone with children. The guides are more open to external opportunities (numerous orange colours) and can rely on stronger livelihoods than women, who perceive themselves to be a lot more vulnerable and threatened by a lack of internal strengths (numerous blue colours).

4.1.2 The community's ability to recover from a volcanic event

The analysis shows that the community of Chã das Caldeiras can rely on some strengths and local resources to be able to recover in case of a volcanic eruption. During the last event in 1995, most of the families were relocated for 6 months within refugee camps in São Filipe, then in new houses funded by the German government, beyond the rim of the caldera. However, most people came back to Chã das Caldeiras afterwards because they had no sustainable sources of livelihood in the relocation areas. Even if they lost a lot of farmlands, the aftermath of the volcanic eruption offered a new economic activity, tourism, which is now a complementary activity.

These results highlight the fact that DRR should focus on measures aimed at reducing vulnerability by addressing socio-economic root causes that are linked to unsustainable livelihoods and lack of access to resources.

The people of Chã das Caldeiras are closely tied to their place of origin, which caters for their economic and social needs. This is evident in the abandonment of the 1995 relocation site. Reducing the risk of rare volcanic disaster is not a priority for the locals. People are more concerned with droughts and basic services, which are pertinent to their everyday life. These results are noticeable during the FGD (focus group discussion), interviews and P3DM. All these findings should then be integrated into a holistic resource and risk management plan.

4.2 Double necessity of protection and conflicts

The present situation has induced two important priority objectives for the authorities: Firstly, there is indeed a need to protect people from the next eruption. After the last eruption of 1995, the government of Cape Verde created the National Civil Protection, led by the army, who had conducted several emergency supports and evacuation exercises. This new risk management organisation included land-use restrictions and a permanent relocation of people outside the caldera. However, this relocation did not succeed since people decided to come back to the villages inside the caldera after two years. Since then, risk management has mainly consisted top-down strategies such as the monitoring of the volcano by a local observatory. However, the formal responsibility for the monitoring of the volcano remained unclear until 2013. Actually, after the DR 9/2000 and DR 13/2009, INMG has the responsibility for volcano monitoring in Cape Verde, whereas LEC reclaimed his own responsibility for several years, in a conflicted atmosphere Therefore in case of ongoing volcanic crisis, the local authorities in charge of the crisis management will receive scientific data from two different institutions, namely the Cape Verde Civil Engineering Laboratory (LEC, located in Praia, Santiago) and the National Institute of Meteorology and Geophysics (INMG, located in Sal and São Vicente),

A first exercise in evacuation was organized in 2006. However, it appeared unrealistic and impractical considering that, even if it involved the concerned communities in the process, the real situation of animals staying on the active volcano was not taken into account, whereas helicopters from overseas were used (but Cape Verde does not have any). More recently, a table-top exercise was organised in June 2012 by INGM and the civil protection of Cape Verde with the support of the MIAVITA research programme through the Italian Civil Protection. The government of Cape Verde wishes to create a local civil protection within the Municipality of Santa Catarina but outside the caldera. Presently, it is not yet operational.

Secondly, since the local socio-economic activities imply high pressure on the fragile natural environment, the Ministry of Environment, Agriculture, and Fisheries decided in 2003 to create Fogo Natural Park, to enhance the protection of endemic species and regulate the tourism industry. However, its creation caused some constraints on land use and local economic development and induced conflicts among local people and the government agencies involved. The most important constraint is the limitation of space for land cultivation and cattle farming of which most of families rely on. On the other hand, some others take profit from the natural park through tourism. Indeed, this new structure imposed some restrictions of land uses within the caldera (Fig. 2) in conformity to a bio-focused ideology (Depraz, 2008). The restriction on livestock inside the national park is an important issue in Fogo. The economic and ecological consequences of these restrictions differ between different types of livestock. The efforts to reduce and remove goats in order to prevent destruction of vegetation and loss of soils predate the national park (since the mid-1990s) and are widespread throughout Cape Verde. On the other hand, the other types of livestock including cattle, pigs and horses are less destructive of the environment.

Some changes in economic activities were observed as adaptive strategies. One example is the progressive abandonment of cattle activity and the shift to new activities such as tourism and transport.

All these measures of protection of people and nature imply high constraints and pressure on local activities and development. There is thus some contradiction at stake in terms of territorial management, between the development of "green" tourism at a high-risk site, and the development of the local community (access to infrastructures such electricity, road, water, agriculture). Generally, although our results from survey suggested that DRR should focus on measures aiming at reducing vulnerability by addressing socio-economic root causes associated with difficulties of access to livelihoods, the present system of management does not address that point.

Furthermore, the management of the caldera is largely top-down. There are some efforts to make people participate in several government programmes. One example is the AERIAS PROTEGIDAS national project, a pro-nature protection programme led by the Fogo National Park administration. However, the programme is likely to induce further management conflicts between inhabitants and institutional stakeholders because of the possible negative impacts on people's livelihood.

The local capacities and knowledge about risk of the community, on one hand, and the persistent local conflicts between external institutional stakeholders and the community (about land tenure, land restrictions, and access to water) on the other, justify a real need to build a dialogue among them. The dialogue should promote a more integrated and community-based approach in resource management and DRR. In this study, we utilised P3DM to accomplish those objectives. The realisation of the participatory 3-D map aimed at assessing vulnerabilities and capacities of people, and to integrate them into the broader development plan and in harmony with the objectives of the protection of the natural park.

4.3 A P3DM to build dialogue in DRR in Fogo?

The P3DM for DRR is one of the recently developed mapping tools. P3DM basically comprises the building of standalone scaled relief maps made of locally available materials (e.g. carton, paper, etc.), which are overlapped, with thematic layers of geographical information (Rambaldi and Callosa-Tarr, 2002). This tool requires the participation of both the local communities including the marginalised sectors and the outside stakeholders such as the government, scientists and NGOs. People's vulnerability and capacity, hazards and other community information are depicted in the 3-D map using local materials such as pushpin, yarn and paint. P3DM is credible to both the local people who make it and to the scientist and authorities, who can overlap their hazard maps and other scientific data. P3DM thus allows the integration of local and scientific knowledge as well as bottom-up and top-down actions in DRR.

The development of CBDRR as a framework largely depends on the efficiency of its participatory methods and tools in encouraging the participation of the local people in the process (e.g. vulnerability and capacity analysis or VCA, participatory vulnerability analysis or PVA, focus group discussions or FGD) as well as the collaboration between stakeholders of DRR. It should be noted that both the outcome and process of CBDRR should aim to empower the community. It should also be integrated into the larger development framework aiming to promote sustainable livelihood and development and considering them to be part of DRR efforts.

This study follows a six-phase process, which is in conformity with other similar P3DM projects within Work Package 5 of the MIAVITA programme. Figure 7 illustrates the step-by-step process of the P3DM.

Phase 1: organisation and communication. This stage has set the ground for the main P3DM activities. This has involved integration of the facilitators and the researchers into the community, which is necessary for understanding the social dynamics and gaining the trust of the community. Preparations of logistics and a base map as well as the selection of participants and venue were accomplished at this stage. A vacant room in the liaison office was chosen as the venue and the scale of the base map was set at 1:2500. The precise scale is one of the advantages of the 3-D map compared to a traditional participatory sketch map. This stage was very crucial in gaining the trust of the people and in ensuring their participation.

This stage has also highlighted the lack of access to resources for the livelihood of the local people. Thus, it is important that the DRR activities should be accompanied by efforts to promote sustainable livelihood. For example, the evacuation plan should also include building roads and facilities for water and electricity, which are critical resources in case of evacuation and during post-disaster periods.

Phase 2: building the blank model. This stage has required at least 5 days. The participation of several sectors of the local population including farmers, women, children, teachers and students was very helpful in accomplishing this stage. Participants were grouped and organised to carry out specific tasks. For example, a group of children was tasked with preparing the cartoons. Another group prepared the small materials such as pushpins, yarns, paint, etc. that were used to depict information on the 3-D map.

The activity was self-organising and the participants were observably very active and excited. The teachers and the students conducted a parade and circulated in the village to encourage many participants (Fig. 8). The campaign was successful and about 70 participants attended the kick-off meeting. In general, the number of participants during the four-month activity was sufficient. A local team composed of 6–7 permanent residents of the community was remarkably active and had helped facilitate the activities.

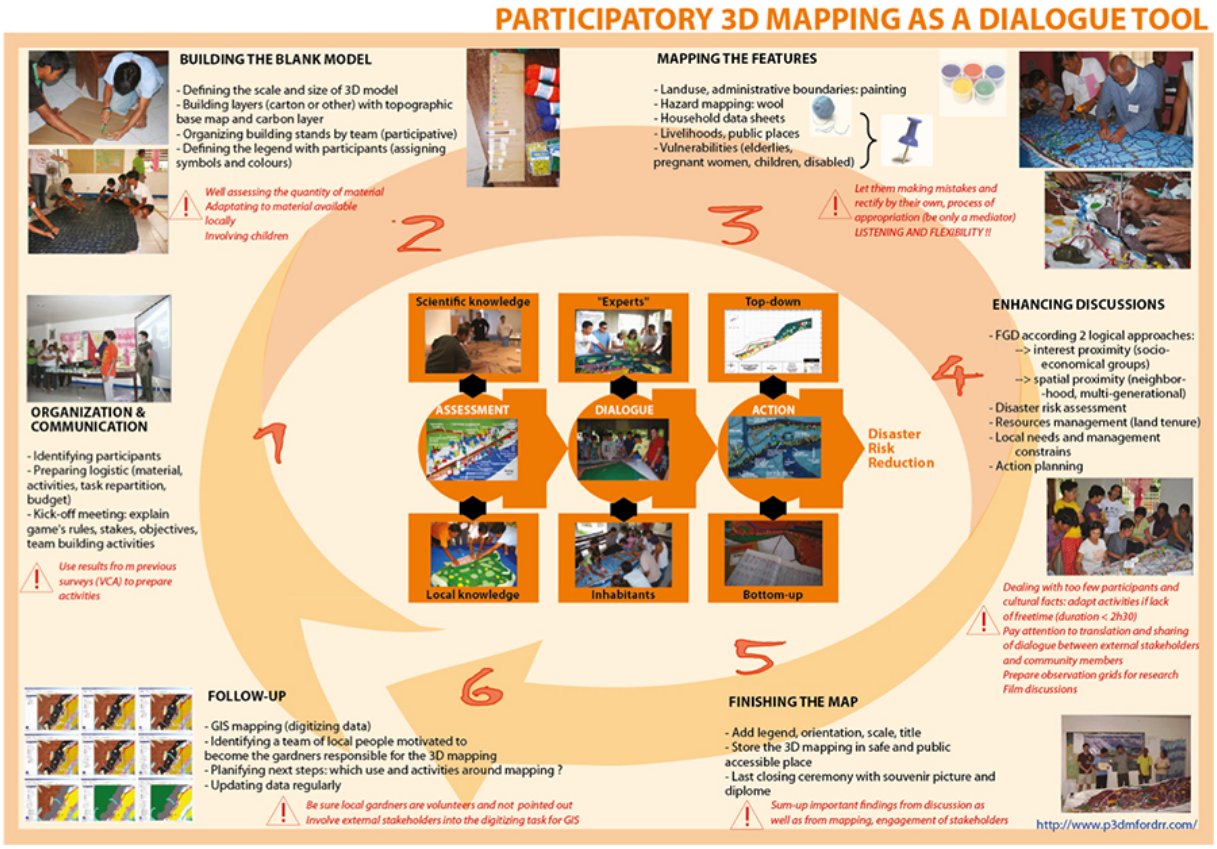

Figure 7. Main steps of the P3DM methodology.

On the other hand, the participation of the institutional stakeholders was very limited. They attended only for 2 days during a month of project implementation.

Phase 3: mapping the features. After the construction of the blank relief model, participants were gathered around the 3-D map to depict information. The depiction of information was based on a certain legend, which was agreed to by the participants. The legend consisted of a series of symbols represented by lines, points and polygons. The points symbolised individual features such as houses, schools, public buildings, farms, and other important landmarks. The lines represented linear features such as roads, trails and borders. Finally, polygons were used to depict information such as land uses.

The cultural significance of the symbols in the legend was taken into account through consultation of the participants of the colours they preferred for each element on the 3-D map. For example, the black sands were used by the participants to represent the large deposits of lava within the caldera. Also, rectangular grey foams were used to represent the houses, which in reality are mostly rectangular in shape.

The activity provided the opportunity for the several stakeholders to integrate their local and scientific knowledge, especially in the depiction and assessment of people's vulnerabilities and capacities.

Phase 4: enhancing discussions: the discussions centered on risk assessment and the participatory planning and action for DRR. This stage started by conducting CVA (community and vulnerability analysis). On the 3-D map, hazards, vulnerabilities and capacities were easily represented and made more evident. For example, information that portrays household vulnerabilities (the presence of disabled persons, pregnant women, children, etc. and other resources of the household at risk) and capacities (the presence of water reservoirs, livestock, vehicles, etc.) were plotted for 75 households (60 percent of the total households). Using these data, five group discussions involving different sectors were conducted to discuss the ways and means of reducing the factors of vulnerabilities and enhancing the capacities identified on the 3-D map. Thus, risk assessment became more efficient.

Based on the results of risk assessment, the necessary plans and actions were discussed. The participants were able to plan and decide more efficiently in locating the evacuation centres and routes in terms of distance and practicability since they have a bird's eye view of their territory through the 3-D map, but this step has not yet been achieved.

Phase 5: finishing the legend. This stage involved polishing the 3-D map. The participants finalised the legend and added the map components such as the title, scale, and north arrow.

Phase 6: follow-up: the full realisation of this stage is beyond the project duration. In partial completion of the stage, a group of individuals was identified to monitor and regularly update the 3-D map. Among them are local volunteers and the representatives from government agencies such as the civil security, the Fogo National Park, and the liaison office of the municipality of Santa Catarina in Chã das Calderas.

The following discussions reflect on the achievements and shortcomings of the implementation of the P3DM. The P3DM activities, which we detailed above, should lead to fully operational CBDRR plans and actions. However, due to several constraints, they were not fully accomplished and an actual DRR plan was not finalised. Firstly, the time available for the planning was too short. Most of the time was spent during the actual P3DM activities. Secondly, the permanent involvement of the most important sectors (tour guides, women and farmers) was difficult to achieve. The long history of non-participation by these groups in democratic processes of public consultation and decision making which concern them is a major factor that makes them hesitant to participate in the participatory DRR activities conducted.

Presently, there are doubts about the sustainability of the 3-D map. These are primarily due to the disengagement of former stakeholders and also some political and technical constraints. For example, the liaison officer who was very active during the activity was replaced by someone who was not from the village and who had not participated in the P3DM activity. During the change in personnel (January to March 2013), the 3-D map was inaccessible to the local people and thus the necessary updates were not done. On the part of the institutional stakeholders, they encountered several constraints related to budget, which prevented regular monitoring at the site. Due to financial incapacity, the representative of the National Civil Protection Service (NCPS) who attended the whole month of mapping activity could not visit regularly. The organisation of a local group for DRR, which the agency's personnel aimed to organise, was not accomplished. Finally, due to a lack of political will and technical capacities, the integration of the 3-D map into GIS was not realised by the personnel of the Natural Park Administration and the NCPS. This activity was deemed critical by the institutional stakeholders on the dissemination of the results and follow-up activities.

In the end, the failure to accomplish the original activities and plans fully, especially the CBDRR planning activities, were due to the complicated political context, the absence of local leaders, internal conflicts between families, and engagement of the people to their livelihood activities. These are real challenges that future P3DM activities should take into consideration.

Figure 8. The building of 3-D mapping with children and adults from Chã das Caldeiras, April 2009 (Texier and Cadag).

5 Discussion and conclusion: which perspectives for participatory management?

In the case of Fogo, there are several factors which explain the difficulties in implementing CBDRR through P3DM activity. As an example, the members of the community prioritise their economic activities and thus it was difficult for them to dedicate time to the proposed activities for DRR. Furthermore, despite the huge effort to communicate with the identified actors during the P3DM and despite the commendable efforts of some local volunteers to organise the several activities, the main problem lies in the lack of involvement of the community in the origin of the project, which should be a local initiative and not an exogenous effort from a scientific team. Other experiences of P3DM realised in the Philippines suggested that it is a crucial aspect in the success of such a project. It is the same problem with the lack of participation of outside stakeholders. The government agencies should have been more involved from the beginning of the project in order for them to integrate their objectives and expectations, and schedule by themselves the implementation of the programme according to their availability. Those efforts should have stimulated more motivation and better communication on the part of the local and outside stakeholders. The evident outcome of the lack of participation is the insufficiency of final information plotted on the 3-D map. Thus, it was difficult to proceed according to the actual CBDRR plan. This lack of information is also linked to internal conflicts, competition between socio-professional groups and taboos toward local management of resources like wine cooperatives and the natural park. Indirect dialogues should have been necessary for developing self-confidence and trust between the actors involved. Involvement of all social groups from the community in the process also appears to be essential. However, this experience also shows that there is a risk of reproducing on a inferior scale and aggravating the existing inequalities between more powerful actors and the

marginalised groups (like women or unemployed youth). It is indeed one of the most important criticisms of participatory management (Rodary, 2001; Depraz, 2008).

Another difficulty that we encountered relates to the interpretation of collected data. In studies conducted using participatory approaches, the data depend heavily on the understanding of the history of the participating population in relation to the past occurrence of the hazards that produce the risks. In the case of Fogo, only two eruptions occurred since the establishment of the villages, whereas in the century 1760–1860 at least 7 eruptions were reported.

To legitimate access to resources and risk management for marginalised groups is a long-term process. It does not only depend on their knowledge and the recognition by the institutional stakeholders and the community itself (legitimacy). It also depends on the access of the marginalised groups to political rights and capacities (access to education, self-confidence to speak in front of people, time management) to build their citizen status and act based on personal choice (Sen, 1987).

To conclude, it is still possible to improve the methodology of such participatory projects. Initiative must come from the community itself, and involvement should start from the beginning of the project.

Participatory research should be built on a long-term partnership with stakeholders, which is difficult most of the time, since a research project is often required to follow a certain duration. It is thus essential to rely on local organisations and local people who are capable of sustaining the programme even beyond the project's duration. It should be noted that researchers can only stay a few months in the field; sustainability would always depend on the local stakeholders.

Furthermore, this research shows that the local people in the communities regard the threats of volcanic hazards as being less harmful than the human-induced hazards of political restrictions. For example, farmland restriction linked to the protection of nature (with restricted areas in Fogo Natural Park) or the protection of people (the will of the council to keep people away from the caldera for safety or economic reasons, or the will to make them pay a land registration fee and yearly taxes, or to prevent them from building a new water tank, when they do not have alternative sources of income and water which are crucial for their survival). The human (social, political or economic) threats from daily life thus appear much more important than hypothetical and temporary volcanic threats. In fact, the volcano is more a source of livelihood through fertile soils and geotourism than a threat.

DRR policies should therefore address these larger issues of development (education, health, basic services) to reduce people's vulnerability in facing not only volcanic hazards but also drought and socioeconomic hazards. Documentation of land tenure is crucial to secure people's livelihoods. Contingency planning should also consider all forms of resources which make up people's livelihoods, including food, water, farming equipment and livestock.

This P3DM activity is considered half a success. Although most of the external actors and community members worked together to build the model and filled them with important information, the actors, particularly the local people, have yet to organise a stronger and more efficient CBDRR programme that takes into account both people's livelihood and protection of the natural environment.

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