THE DECONSTRUCTION OF VOLCANIC RISK
CASE STUDY: GALERAS, COLOMBIA

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“It would be nice if all of the data which sociologists require could be enumerated because then we could run them through IBM machines and draw charts as the economists do. However, not everything that can be counted counts, and not everything that counts can be counted”

William Bruce Cameron, (1963)

Abstract

History has shown that the combination of active volcanism and human populations can lead to devastating consequences, which at their most extreme have resulted in the collapse of entire societies. However these losses have not only been attributed to the impact of volcanic hazards but also the management strategies put in place to try to mitigate them, criticised for the detrimental long-term socio-economic impacts they have had on communities involved.

General risk management theory argues that the failure of risk management strategies can be in part due to the poor risk assessment methodologies used to inform decision-making. 'Insufficient' or 'inaccurate' data is often attributed to disciplinary biases, a weakness in methodological tools and a focus on top down prescriptive approaches lacking in participation from those living with the risks in question. This thesis, acknowledging these broader debates, examines whether the way in which volcanic risk is assessed is fully representative of the complexities of the relationship between society and volcanoes. Using an empirical study of communities living on the Galeras volcano in Colombia, it compares the public experience of risk with the way in which it is interpreted and measured within Volcanology.

Results of the study show that whilst previous volcanic risk assessments have been strong in their ability to capture data on volcanic hazards, assessment methods have been significantly weaker in their ability to address the threat of other non-volcanic hazards, social vulnerability and the social, economic and cultural value of the volcano environment. This thesis argues that a more sustainable approach to volcanic risk management is dependent upon risk assessments methodologies being developed that combine both the analytical frameworks of Volcanology with the experiential influences that drive the attitudes and behavior of the communities in question.

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Author’s Declaration

I declare that the work contained in this thesis is my own. I declare that the work contained in this thesis has not previously been presented for an award at this, or any other University. All sources are acknowledged as references.

Jessica Kate Roberts

Chapter One:

Introduction

An eruption of the Galeras Volcano, Colombia (Author, 2012)

1.0 Research outline

In a press statement released by the UN Office for Disaster Risk Reduction (UNISDR) on the 13th November 2015, head of the organisation Margareta Wahlström, described the eruption of the Nevado del Ruiz volcano in Colombia on November 13, 1985, as "*a major turning point in the history of disaster risk management*", continuing to add that a failure to evacuate the towns of Armero, Chinchina and their surrounding villages, despite multiple warnings, had led to the loss of 25,000 lives (UNISDR, 2015a). In discussing the future management of volcanic risk, Wahlström advised governments that the lesson to take from Armero, if they wanted to achieve a substantial reduction in the number of lives lost and economic costs incurred, was to "*take responsibility for early warnings and other elements of disaster risk management and to avoid the creation of risk in their planning and development activity*".

This research builds on Wahlström's warning that the disaster risk management of all environmental hazards has the potential to create risk and vulnerability as well as minimise it. With a specific focus on the management of volcanic risk, this thesis examines the way in which 'volcanic risk' is manifested within communities and the influence that not just environmental processes have on the vulnerability of communities from which risk emerges, but also the social, economic and political context that volcanic communities are exposed to. This research recognises that sustainable disaster risk management interventions need comprehensive risk assessment to inform them, capable of capturing the complexities of why and how communities live with volcanic risk and questions where previous approaches may have failed and where new approaches may benefit.

This chapter introduces the rationale to this research by first discussing the global impact of natural disasters before specifically addressing the impact of volcanic activity. It then explores how volcanic disasters materialise and the challenge for Disaster Risk Reduction (DRR) within volcanic communities. Finally it argues the need for risk assessments approaches that capture the complex adaptive systems of volcanic communities in order to inform more sustainable DRR interventions in volcanic regions in the future. Finally a case is made for using bottom up participatory approaches of volcanic risk assessment before the research aims and objectives are outlined. The chapter concludes by outlining the structure of the thesis that follows.

1.1 Research rationale

1.1.1 The global impact of natural disasters

Courtesy of news reports and humanitarian appeals that appear regularly on our television screens we are reminded time and time again of the suddenness and extreme impact of natural disasters on communities across the world. Requests for donations for shelter, food, water and medication, as a result of such devastating levels of damage and loss, are indications that when the usual local social systems are no longer functioning normally that external help is now a necessity to help people recover. At the point when such a disruption occurs, a seemingly natural event such as an earthquake, cyclone or volcanic eruption becomes labeled a 'natural disaster' (United Nations, 2007). In the last decade the Disaster and Emergencies Committee (DEC), a group of 13 lead UK aid agencies, have made public appeals to raise money for those affected by a range of natural disasters across the globe, including; a 170 mph typhoon in the Philippines, a 7.0 magnitude earthquake in Haiti, a tsunami across many countries in Asia, the Ebola crisis in Africa, floods in Pakistan, typhoons and earthquakes in Indonesia, the Philippines and Vietnam, and a 7.3 magnitude earthquake in Nepal (DEC, 2015).

The magnitude and frequency of different types of natural disaster events varies spatially and temporally across the globe. In the decade between 2004 and 2013 the Centre for Research on the Epidemiology of Disasters catalogued 3,867 reported disasters worldwide relating to natural events (Guha-Sapir et al, 2014), more commonly referred to as natural hazards, defined as a 'natural process or phenomenon that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage' (UNISDR, 2015). These natural hazard events included droughts, earthquakes, tsunamis, extreme temperatures, floods, forest and scrub fires, insect infestation, dry mass movement, wet mass movement, volcanic eruptions and windstorms. During this time period flooding (1,752), windstorms (1,011) and earthquakes and tsunamis (269) ranked the highest frequency events (IFRC, 2014). Cumulatively these events resulted in 979,537 deaths, with the highest three tolls attributed to earthquakes and tsunamis (650,321), windstorms (183,457) and flooding (63,207) (Guha-Sapir et al, 2014). An estimated US$1,641 billion in economic losses was attributed to those same events during the same decade, with windstorms ($713, 472,000), earthquakes and tsunamis ($507, 484,000) and floods ($312, 035,000) resulting in the largest costs (Guha-Sapir et al, 2014). The largest numbers of people were affected by flooding (943, 464), drought and flood insecurity (528, 901) and windstorms (344, 423) with those living in China, the US, Philippines, Indonesia and India experiencing the most frequent events (Reliefweb, 2015).

1.1.2 The global impact of volcanic disasters

Of the 3,867 reported disasters between 2004 and 2013, 57 events were attributed to volcanic eruptions resulting in a cumulative death toll of 363 people and a suggested cost of 'disaster estimated damage' of US$179million (Guha-Sapir et al, 2014). Volcanic eruptions like other natural disasters not only impact society by way of loss of life and damage to property but can also result in long term physical and mental health illness, homelessness, joblessness, food insecurity, loss of public infrastructure and public spaces and marginalisation. Historically the greatest impact of volcanic activity has been the destruction and demise of whole cities and greater still, whole civilizations, such as Pompeii in Italy in AD79 as a result of an eruption of Mount Vesuvius (Merill, 1918) and the Minoan civilization in Greece in 1500BC due to an eruption of Thera volcano on Santorini (Rampino and Self, 1992).

Since AD1 approximately 275,000 deaths have been attributed to volcanoes (Simkin et al, 2001). In comparison to the death tolls incurred by other natural events, those incurred as a result of volcanic eruptions may appear comparatively low (Kelman and Mather, 2008), especially when compared to the statistics of many other single events of which have led to more deaths than every historic eruption put together. Such events as the 1970 Bhola cyclone in East Pakistan (now Bangladesh) that killed 500,000 (Fritz et al, 2009), the 1976 Tangshan earthquake in China that killed between 242,000 and 655,000 (Bulut et al, 2005) and the 2005 Indian Ocean tsunami which killed approximately 280,000 (Athukorala and Resosudarmo, 2005). However, impact statistics of volcanic eruptions have often been disputed, criticised for their ambiguity and often incompleteness of the parameters measured and the indeterminateness of the true cause of the impact (Luongo et al. 2003), therefore forming the argument that the true impact of volcanic eruptions on societies around the world is far greater than statistics may have us believe. This discourse centers on the following three main arguments.

The first argument is that death toll estimations often only take into account the impact of the primary eruption, when one characteristic that makes volcanic eruptions different from other natural hazards is that eruptions can comprise of multiple different events, some occurring significantly after the primary eruption (Blong, 1996). However, official impact statistics may not take these secondary impacts into account. Volcanic eruptions are in fact not one hazard but a combination of many different processes that form many different products. These hazards are classified as either 'primary', 'direct' hazards, referring to those processes that occur at the time of the eruption, or they can be 'secondary' or 'indirect' hazards, occurring several years after the initial eruption such as secondary lahars (Bryant, 2005). Secondary hazards can result in both immediate deaths as well as deaths from malnutrition, disease and starvation caused by food

insecurity resulting from a loss of agricultural land. During the 1783 Laki eruption in Iceland for example, clouds of sulfur dioxide were released into the atmosphere causing the death of approximately 25% of the countries human population, a direct result of the complete devastation of crops and death of 50% of the country's livestock population and the subsequent famine that followed as a result (Sigurdsson, 1982).

The second criticism of official disaster statistics for volcanic disasters is in the estimation of the economic costs incurred, which are also based largely only on direct losses and not the large number of indirect and secondary costs that can also occur (Marti and Ernst, 2005). In addition, many impacts are difficult to put a monetary value on and therefore accurate figures often cannot be applied to total calculations (Bachri et al, 2015). An example of this can be found in the accounts of the 2010 eruption of Mount Bromo in Indonesia, considered the worst ever volcanic disaster ever recorded. The event had a severe impact on agriculture, tourism and loss of property, impacts valued at USD$15.5million. However, indirect impacts such as a decline in water availability, a disruption to electrical supplies and transportation, a loss of trading activity, and either a partial or complete loss of 70,000 agricultural jobs were reported as 'difficult to value' (Bachri et al, 2015).

The final criticism is that volcanic hazards and their impacts are not constrained by political boundaries, therefore if estimates are only calculated for the country that the volcano is located in then a true estimate of total impact may not be established. During the 1783 Laki eruption in Iceland, clouds of sulphur dioxide were released into the atmosphere. These clouds were suspected of having travelled beyond the coast of Iceland and across Europe, Northern Africa and parts of Asia causing a global drop in temperatures, which led to widespread crop failures, drought and the death of an estimated 6 million people as a result of malnutrition and starvation (Thordarson and Self, 2003). Although humanitarian relief would today help prevent such large scale losses, in more recent times the 2010 eruption of another of Iceland's volcanoes Eyjafjallajökull also exemplified other ways in which eruptions can affect populations in countries other than where the erupting volcano is located. During the 2010 eruption ash particles from Eyjafjallajökull's eruption plume again travelled beyond the countries coastline causing a disruption to global air travel at a scale said to have not been experienced since World War two, the cost of which included a loss of $1.7bn just in cancelled flights (Eurocontrol, 2010).

1.1.3 The root causes of volcanic disasters

In the early analyses of the manifestation of disasters, natural hazards were treated as the cause as disasters with the level of impact treated as a product of the event's magnitude and frequency. Such natural hazards included processes meteorological in origin including; hurricanes, cyclones, flooding and drought, biological; insect infestation and disease and geological: tsunamis, earthquakes and volcanic eruptions (UNISDR, 2015). But a conceptual shift in the 1940's saw a progression away from the previous technical focus on hazards towards an understanding that such natural events were only the 'trigger' and not the direct cause of disasters (White, 1945; Wisner et al, 2004). The real cause was now understood to be the actions and behaviours of those people exposed to hazards (Blaikie et al, 1994). From this point forwards it was contested that natural disasters were not in fact natural events at all but 'a combination of both environmental change and societal conditions' (Bankoff, 2001).

Discourse and analysis of the cause of natural disasters today places emphasis on what Cannon (1994) referred to as the root causes of 'social vulnerability' within a community otherwise described as 'the condition of society', characteristics of individuals and whole societies that make people 'sensitive to change and predetermine the consequences of a hazardous event' (Blaikie et al 1994). These characteristics include a lack of self-protection, and a weak livelihood (Cannon, 1994). Such characteristics are said to be directly linked to the social, economic and political context of a population. Poorer people are said to be likely to suffer more from hazards than richer people living in more developed countries as poorer people have less finances available to fund insurance, find additional homes if required and to use in reserve to cover both normal and additional costs when a loss of employment after disasters means people loose their means of earning an income (Hardoy and Satterthwaite, 1989).

The occurrence of natural disasters are also unevenly distributed throughout the world with more occurring in the 'developing' world or 'global south' than the 'developed', 'global north' in countries where people are significantly poorer and public services and infrastructure regarded as deficient. This uneven distribution, Blaikie et al (1994) explains, is not caused by a higher frequency of natural events occurring in countries across Asia, Africa and Central and South America, but due to increasingly high population densities living in areas of those regions exposed to natural hazards, forced to live in such areas as a result of the conditions of their societies constraining their options (Bankoff, 2001, Wisner et al, 2004). However, this is not to say that those living in more developed, richer countries are not also vulnerable, only that poverty exacerbates the vulnerability of those exposed to hazards as they are in theory less able to 'anticipate, cope with, resist and recover from the impact of a natural hazard' (Wisner et al, 2004).

Rich people, Bankoff (2001) stresses, can also be vulnerable, a factor of a greater value of assets owned that can be lost in an event and of infrastructure being more costly to repair or replace in more developed countries.

In analyzing the cause of volcanic disasters, volcanological data supports the conceptual shift in natural disasters research that natural events are not the sole cause of disaster. Impact data from past eruptions clearly shows that the largest losses incurred historically have not directly linked to the largest eruptions. Many smaller, less explosive eruptions have in the past reportedly killed far more people then some large scale, more violent eruptions. An example of such can be seen in a comparison between the 1991 eruption of Mt. Pinatubo in the Philippines, a Volcanic Explosivity Index (VEI) 5 eruption that ejected approximately 10 km^3 of magma, and a far smaller VEI 3 eruption of Nevada del Ruiz in Colombia in 1995. The Volcanic Explosivity Index rating is given as a measure of explosivity that relates to a logarithmic scale of VEI 1 to VEI 8 representing a tenfold increase in the volume of products ejected by an eruption (Newhall and Self, 1982). The explosivity of a volcano is determined by the geology of the magma of a volcano. Strato volcanoes otherwise known as composite volcanoes such as Fuji in Japan, Colima in Mexico and Galeras in Colombia, formed from magma high in levels of silica, characteristically exhibit explosive eruptions far more violent than lower lying shield volcanoes such as those in Hawaii, formed by magma lower in viscosity which exhibit much gentler effusive eruptions (Francis and Oppenheimer, 2004). The 1991 eruption of Pinatubo, although far more explosive than the 1995 eruption of Nevado del Ruiz, resulted in a considerably lower number of deaths comparatively, only 847 people in comparison to 23,000 (Francis and Oppenheimer, 2004).

The cause of greater losses due to volcanic disasters today is largely discussed within the study of Volcanology, the study of volcanoes, as a product of exposure; large numbers of people living in areas alongside volcanic hazards (Small and Naumann, 2001). At a time where the global population sits at approximately 7.3 billion (United Nations, 2015), approximately 450million people live within 100km (Thierry et al. 2008) of 550 active volcanoes (Tilling, 2008). This estimate is inclusive of some of the largest cities in the world including Tokyo in Japan (37 million), Jakarta in Indonesia (26 million), Manila in the Philippines (21 million), Mexico City, in Mexico (19.5 million), Surabaya in Indonesia (4.6 million) and Naples in Italy (4 million) (Worldatlas, 2014). In addition to these high population centers, it has been regularly observed that there is often reluctance of many people to leave their homes and reduce their level of exposure even once volcanoes have entered a period of activity.

During the 2010 eruption of Mt Merapi in Indonesia, it was reported that there were significant difficulties experienced by the Indonesian government in persuading the 80,000 residents living in

the high elevation villages to evacuate as people wanted to continue to tend their crops and care for their livestock (Lavigne and Gunnell, 2006). Even when evacuations have been initially successful during eruptions people have often been observed returning to their homes, either to the same homes they left behind or when those have been destroyed, to another part of the volcano. At Mount Etna in Sicily, communities have long continued to return to the volcano after periods of eruptions, rotating around the flanks away from recent lava flows to re-establish their agricultural and tourism activities (Dibben, 2008). Populations that have been permanently relocated to new sites have also been reported to sometimes return to their original homes despite continuing levels of threat from volcanic activity, such as was the case at the eruption of Soufriere Hills on the Caribbean island of Montserrat in 1995. This eruption resulted in the evacuation and resettlement of 90% of the islands population, who were moved to neighboring islands in the Caribbean as well as to the United Kingdom (Avery, 2003). Despite being no longer at threat from the volcano in their new locations many returned to the island once the risk had ceased.

However, despite the argument that those living on volcanoes in the developing world have a greater vulnerability to volcanic disasters, it should also be noted that unlike many other natural hazards, the intensity of volcanic hazards can be so great that they often lead to the death and destruction of anyone or anything in their path, unavoidable by anyone or any means regardless of how rich or poor an individual is. Unlike other natural hazards such as earthquakes or flooding, the impacts of most volcanic hazards are largely unmitigatable by any action other than removing people or property away from the proximity of the hazard. In the case of the Lake Nyos disaster in Cameroon in 1986 when a cloud of CO2 gas covered people as they slept killing them instantly it was said that people were just ‘in the wrong place at the wrong time’, ‘just unlucky’ (Nafday, 2001).

1.1.4 The challenge for reducing volcanic risk

In addition to the specific characteristics of individuals and societies that make people ‘sensitive to change’, Cannon (1994) and Blaikie et al (1994) also argue that a lack of government social protection can also enhance people’s vulnerability. Although the loss and devastation incurred in disasters should make mitigating the impact of natural phenomena and protecting citizens from harm a priority of governments, some management strategies or indeed the lack of such, can in fact lead to further losses in the community by exacerbating peoples vulnerability (Comfort, 2005; Gerber, 2007).

There are many different methods used by governments worldwide to reduce the impacts of disasters; including risk management, emergency management and disaster management. Risk

management, although often used synonymously with the other terms is, as Vanneuville et al (2011) distinguishes, the management of risk that focuses on 'the long time frame threats of a range of events'. Although risk management was originally based on the understanding that natural disasters were a direct cause of natural events and that therefore such events could be managed by taking a technical, often-engineering, approach to address them, the shift to understanding disaster as a function of social vulnerability argued that disasters should not be surprises (Blaikie et al 1994). They reasoned that disasters could be predicted by understanding what determines them, and in many cases they could be avoided by putting in place policies and interventions to decrease vulnerabilities within those communities exposed to natural hazards. With this development in understanding emerged what is commonly described as the modern paradigm of risk management (Parvin and Shaw, 2014), Disaster Risk Reduction (DRR), a systematic approach to identifying, assessing and reducing risks to disaster (UNISDR, 2015). Its approach is not only to deal with environmental hazards but also to reduce the socio-economic vulnerability of communities living alongside them. As a concept DRR was embraced by risk management practitioners, governments and NGO's worldwide yet it was not until the United Nations World Conference in Japan in 2005 that a clear framework to achieve it was identified, The Hyogo Framework for Action (2005-2015). The emphasis was placed on goals of global development, based on the understanding that DRR is inextricably linked to both sustainable development and poverty alleviation and that neither is achievable without the other two. In regions where non-sustainable land use practices are allowed it warned that the vulnerability and therefore risk of citizens would be higher (UNISDR, 2015).

In order to achieve the objectives of DRR emphasis was placed on the need for countries to invest in prevention, *'the outright avoidance of adverse impacts of hazards and related disasters'*, and the building of resilient communities (UNISDR, 2015), described by Manyunga (2008) as 'capable of anticipating, preparing a response to, and recovering quickly from impacts of disaster'. Both goals were said to be achieved firstly by lessening the vulnerability of people, property and infrastructure, managing the use of land and environment, and improving preparedness and early warning for adverse events and secondly by building capacity within communities (UNISDR, 2015). The value of investing in prevention and resilience was outlined by the calculation that for every $1 invested in preparedness and resilience, a saving of between US$4 and US$7 is made in response to disasters that may occur without it (Shreve and Kelman, 2014). Such money spent on response it was stressed would take funding away from that of which should be spent on policies to help countries meet global development goals in education, health and food security, which would in turn only increases levels of vulnerability (Shreve and Kelman, 2014).

Strategies to reduce volcanic risk, have according to Kelman and Mather (2008), have previously fallen into four key categories; do nothing, protect society from volcanic hazards, avoid volcanic

hazards or live with risk. Each option presents both the potential for loss and gain at the community level presenting challenges to decision makers for how to achieve the goals of DRR and to not themselves create further risk and vulnerability.

The first option, 'Do nothing', is based on the recognition that volcanic disasters will happen and that impacts on lives, property and infrastructure will occur (Kelman and Mather, 2008). No intervention is made in advance of an eruption and a level of acceptance is had that in such an event losses and costs will be incurred, both at the household and government level. This may be the case in countries without the finances available to invest in disaster risk reduction.

The second option, 'Protect society from volcanic hazards', looks to structural mitigation strategies in an attempt to defend people and property from volcanic hazards. However strategies to deal with volcanic hazards such as strengthening roofing against tephra fall (Spence et al, 2003) and diverting lava (Barberi et al, 1993) are not always feasible or even possible, depending on the characteristics of the individual volcano. The danger of such methods if carried out warn Kelman and Mather (2005), is that communities may become 'overconfident' in their safety, having developed a 'false sense of security' over the levels of protection that such structures provide. In past cases this has resulted in what is commonly referred to as 'risk transference' where the community places the responsibility of risk management onto the engineered solution.

The third option, 'Avoid volcanic hazards' focuses on the relocation of communities or the zoning of land to limit or prevent use in order to reduce exposure of people and their belongings to volcanic hazards (Kelman and Mather, 2005). Yet relocation and resettlement has been criticised for exposing people to new hazards and social challenges such as unemployment that they have no knowledge or experience of, in turn increasing people's vulnerability to new risks. In response to the 2006 eruption of Mt Mayon, the Philippine government elected to resettle communities, however, although this decreased their exposure to volcanic hazards, communities faced considerable challenges in maintaining their livelihoods (Perry and Lindell, 1997). Usamah and Haynes (1997) reported that despite the resettlement program at Mayon providing new houses for people, it did not provide farmland for the farmers to work which left people complaining that any concerns for '*how to sustain their lives'* had been '*left aside'* by the government'. In response to this lack of concern, Usamah and Haynes (1997) described how many of the men in the communities returned to their original homes during the week in order to tend their farms despite the fact that Mt Mayon remained active. In addition a number of other complaints included the inadequate design of the new houses and the costs incurred of their children having to commute to school.

The fourth option 'Live with Risk' is based on the understanding that environmental hazards are a 'usual part of life and productive livelihoods' and that living with natural events does not only lead to loss but also can create and maintain livelihoods and habitats (Bankoff, 2011). However, leaving people to live with the uncertainty of eruptions still presents the challenge of how to protect people in the event of an eruption. The uncertainty of when eruptions will commence often presents decision makers with the dilemma of when to evacuate communities in order to ensure people move and that they have an adequate amount of time to do so. The failure of the Colombian government to evacuate the population living alongside Nevado del Ruiz during its 1985 eruption was largely blamed for the death of 21,000 people (Voight, 1985). A separate challenge is that in the event of evacuations communities may be placed in emergency shelters for significantly long periods of time, keeping them away from their homes and livelihoods. In 1999 the entire population of Banos in Ecuador, a total of 16,000 people as well as many rural communities, were evacuated to emergency shelters due to the eruption of Tungurahua (Whiteford and Tobin, 2009). Here conditions were described as 'grim' and livelihood opportunities 'extremely limited' (Lane et al, 2004).

1.1.5 The case for using participatory approaches in risk assessment

In order to address the goals of DRR, The Hyogo Framework for Action 2005-2015 prioritises the assessment of risk, defined as 'the combination of the probability of an event and its negative consequences' (UNISDR, 2015). Risk assessments are tools commonly used in the majority of approaches to risk, used to gather data on both hazards and the physical, social, economic and environmental vulnerabilities within communities. An analysis is then made in order to support or justify policy making (United Nations, 2007). Traditionally carried out by academics, practitioners, scientists, engineers, policy makers, NGO's and businesses, the results of risk assessments often provide a quantification or ranking of the level of risk upon which decision makers can decide what risks are tolerable, what the priorities are for mitigation and what types of intervention can be administered (Smith 2013). With many different methods of risk assessment tools available, selection is dependent upon cost, adaptability, complexity, usability, validity, credibility and comprehensiveness (Lichtenstein, 1996). Some methods have been rated better able to inform decision making than others, in turn more likely to inform more sustainable long term risk management policies than others and therefore able to better protect people's health, the economy and the environment (Mehta, 2005).

The weakness of many tools, Mehta (2005) warns, is that they only focus on identifying the short-term immediate dangers and therefore subsequently influence interventions that only alleviate those immediate dangers. In doing so little or no consideration is often given to the long term

implications for communities taking those risks or the potential impacts that interventions might have both at the present time or in the future. One reason for this narrow focus Mehta (2005) reasons is that risk assessors are often siloed by their disciplinary background. This bias, (Jones and Preston, 2011) say, may in turn have led people traditionally to approach risk from a top-down, reductionist orientation, seeking to scope and identify particular risks through the assessment of key hazards and vulnerability characteristics rather than looking at the bigger picture within which those risks have developed. Whilst developing knowledge of risk to key factors is important, such as the risk to buildings from earthquakes or the risks to specific crops from cyclones, many argue that such approaches do not seek to explore the perspectives and behaviours of the people suffering the risks, asking only 'how' people live with hazards and 'how' disasters will happen rather than 'why' people live in hazardous areas and 'why' they choose to use regions in the ways that they do (Jones and Preston, 2011). This approach may perhaps be a response to the view that risk is a function of probability and that therefore it only refers to 'a consequence that can be measured' such as is described by Lambrusco (2007).

Traditionally the risk assessment of volcanic communities has been carried out by volcanologists, scientists studying volcanic processes from largely a chemical, physical or geological perspective, focused on understanding the processes' involved in the formation of volcanoes and their eruptive activity, history and current behaviour. This increased level of understanding has been vitally important in developing detailed hazard assessments (Newhall, 2012). However, less ground has been made in identifying the characteristics of volcanic communities that make them vulnerable or the characteristics of a resilient volcanic community able to deal with the challenges that living on active volcano might present; both requirements of DRR. Data is still lacking on 'why people live on active volcanoes' and 'why they utilise the volcanic landscape in the way that they do?' The emergence in recent years of 'Social Volcanology', which has taken a more social science approach to research, has begun to provide such insight. However, studies of the risk perception of volcanic communities as carried out by Gregg et al, (2004) and Bird et al, (2010), focusing on people's knowledge of environmental hazards and how they deal with them, still focus on nature as the primary cause of disasters, and largely ignore the wider social dimensions of volcanic hazards (Bankoff, 2011). In explaining the choice of people to live with volcanic hazards Gaillard (2006) supports Wisner et al's (2004) more general argument that many people are 'forced' to live with environmental hazards because of poverty, only able to live in 'unofficial' areas often at high elevations up volcanoes at greater levels of exposure. Many volcanoes and their residents are situated in the developing world due to their position on tectonic plate boundaries, in countries in South and Central America, Asia and the Pacific, where the social, economic and political context may, as Wisner et al (2004) say, constrain people's choices in terms of where they live. Yet Kelman and Mather (2008) argue that not all people residing on volcanoes do so because of lack of

choice, highlighting that many actively choose to live in volcanically active regions because of the multitude of opportunities that the volcanic ecosystem presents on which people can build their livelihoods strategies. The benefits of fertile soils in volcanic regions, (a product of volcanic ash and favourable climatic conditions), and the way in which those soils incentivize agrarian populations to settle close to active volcanoes is a well established perspective in the literature particularly in Geography (Marden, 1944; Robert, 1944; Maro, 1988, James, Chester and Duncan 2000, Howes and Hokin, 2000; Small and Naumann, 2001; Waugh and Bushell, 2001).

Siswowidjoyo et al (1998) suggest that perhaps those approaching volcanic risk assessments from a 'classical deterministic scientific perspective' focused on specific target risks, may be surprised or may even disbelieve that people may perhaps choose to 'live with danger' in volcanic regions. Here a lack of perspective of those challenged with assessing risks may impede both how risk is measured and how it is communicated, both to those communities living with hazards and to policy makers charged with developing and integrating DRR interventions. Donovan (2014) says this is of particular significance for disaster risk reduction in volcanic regions since scientific advice is important in the assessment of volcanic activity and stakes are particularly high. Volcanologists may discuss hazards that the community do not agree should be a priority and they might not place a level of importance on the same assets as the community feel is important to their wellbeing and livelihoods (Van Aalst et al, 2008). As a result of such disparity, communities may become dissatisfied with what they feel is the level of protection being provided to them and may in turn disengage from cooperation with decision makers. In addition, without engagement of public opinion, risk assessments may have a tendency to analyse and therefore publically portray the public as 'homogenous entities' and not represent the often-significant cultural differences between subgroups, which may influence their values and decision making (Wilson and Crouch, 1987). As a result of generalising communities, minorities may be ignored as a result of the social, economic and political context influencing community decision making being disregarded and the priority needs of individuals ignored (Burgess, 2003).

In light of this noted weakness of traditional top down methods of risk assessment, in recent years alternative 'bottom up', 'participatory' approaches have emerged within DRR, based on the reasoning that when you involve communities themselves in the decision making process that you achieve more sustainable outcomes. This approach has been adapted from earlier work of Chambers and others in the 1980's who established methods for participatory rural appraisal and related techniques for acquiring information at the grassroots level (Van Aalst et al, 2008). Participatory methods have since been further established in natural resource management (for example in agriculture, Gonzales, 2005; in forestry, Everett, 2001 and in upland management, Glass et al, 2013), in the studies of peoples livelihoods and daily existence (Chambers, 1983,

1984), in the determination of levels of hunger across different households (Sen, 1981), and in the estimation of vulnerability as a result of people's access to resources (Blaikie et al, 1994).

During the late 1980's and 1990's the use of participatory methods was introduced into the discussions of disaster relief by Anderson and Woodrow (1989) who argued that emergency assistance should involve the participation of affected people. Pelling (2007) advocates that the application of such approaches sought to broaden the understanding of risk by generating knowledge that incorporated the wider range of perspectives at the community level rather than relying solely on technical assessments. In contrast to top down approaches, participatory approaches were advocated as being more diagnostic and inductive, enabling a better evaluation of the contextual issues at grassroots level as experienced and understood by the community themselves. Such methods were said to present an opportunity to analyse risk in the context of everyday living, taking into account the connections between risks and the characteristics of communities that Blaikie et al (1994) argue make them vulnerable including; cultural, historical, social, economic, geographical and political factors that influence individuals behaviours and practices (Beazley and Ennew, 2006).

Gathering such data allows the risk assessor to identify and analyse risks as they emerge from the complex interactions of such multiple factors (The Actuary, 2015), in turn leading to a better understanding of the drivers of risk and interventions that may be put in place to manage them. The reinvention of participatory approaches from development and natural resource management into DRR, and their subsequent popularity amongst practitioners to help meet the goals of the Hyogo Framework, has led to a number of approaches being used by organisations to assess risk. Collectively these have been labeled under the umbrella term of participatory disaster risk assessments (PDRA's). A selection of various PDRA approaches can be seen in Table 1 where 6 models are listed along with the methods that they utilise such as community maps, seasonal calendars and focus group discussions.

Table 1.1 A summary of PDRA approaches and potential methods.

Participatory Research Approaches	Toolkit Methodologies																														
	Oral histories	Semi structured interviews	Direct observation	Focus groups	Transect walks	Seasonal calendars	Historical visualisations	Household vulnerability assessment	Livelihood coping strategies analysis	Venn diagrams	Wealth ranking	Social mapping	Feedback sessions	Matrix scoring	Hazards seasonal calendar	Validation of secondary information	Key informant interviews	Value mapping	Public meetings	Data collection	Data analysis	Development of technology	Dissemination of data	Timeline	Hazard mapping	Livelihoods calendar	Sketch maps	Surveys	Asset inventories	Livelihood surveys	Risk mapping
Participatory Action Research (PAR) / Community Based Participatory Research (CBPR)	/				/																										
Participatory Rural Appraisal (PRA)		/		/	/					/	/	/	/	/																
Vulnerability Capacity Assessment (VCA)		/	/	/	/	/	/	/	/	/																					
Community Risk Assessment (CRA)				/	/	/	/			/		/			/	/	/								/		/	/	/	/
Public Participatory Geographical Information Systems (PPGIS)	/	/	/	/														/	/	/			/		/		/	/			/
Citizen Science																				/	/	/	/								

Many have praised the success of using participatory approaches in DRR, referred to as participatory disaster risk assessments (PDRA's), and herald them with having made a significant impact on our understanding of the manifestation of disasters (Van Aalst et al, 2008). Pelling (2007) particularly praises their ability to empower communities otherwise lacking a voice in decision making process, enabling them to be involved in negotiating local change. This argument is particularly prevalent in cases of indigenous or traditional communities whose culture is different to that of the researcher (Pain and Francis, 2003) and whose knowledge is understood to have been accumulated through experiences, society-nature relationships, community practices and the passing of knowledge down through generations (Stilitoe, 2000). The strength in the ability of participatory methods to capture the value of indigenous knowledge, Dekens, (2007) attributes to their ability to collate and analyse qualitative data not traditionally incorporated into top down approaches. Mercer et al, (2009) highlight the value of such knowledge in DRR as a way of identifying local strategies for dealing with environmental hazards, and discusses that previous DRR strategies have often failed to adequately ensure that members of such communities have been reached with the right strategies to meet their needs. As a result of greater involvement Pyrch (2007) describes how fear and alienation often felt within communities can be replaced with hope for their futures.

However, despite their many strengths, a number of criticisms of bottom up approaches have also been made. In order for robust results to be gained, claiming scientific rigor, an assessment needs to be made of a number of separate communities, which can be resource intensive and timely (Van Aalst et al, 2008). The participation of community members may not necessarily assure a high

quality of data as discussions may be dominated by individual community members or groups and individuals may be indecisive in the discussion process leading to extended or return visits (Chambers, 1994). The trust of the public in the approach may also be of concern warns Steelman and Asher (1997), as despite the invitation to engage, many individuals suspect that decisions have already been made. Although a popular approach with good intentions, some scientists also remain skeptical of the benefits of participatory methods stating in some cases that experts make more robust decisions than the public. Their argument is that scientists are able to think longer term than the public and can better understand all aspects of decision making (Teles, 1997). A limitation on the level of information that can be dealt with at the community level has also been identified as it is not possible for approaches to encompass all hazards and all vulnerabilities (Aalst et al, 2008). For policy makers, Van Aalst et al (2008) note the difficulty in scaling up knowledge from participatory approaches. As there are identified strengths and weakness to both top down and bottom up approaches of risk assessment, a combination of the two is often recommended (Jones and Preston, 2011).

This introduction has identified that the impacts of volcanic eruptions can lead to significant losses at the community level both in terms of life, property, infrastructure and livelihood strategies but that despite the threat of such losses large populations continue to live alongside volcanic hazards. It has also acknowledged that whilst disaster risk reduction strategies for the management of volcanic risk should in theory prevent such losses they have in the past lead to further unnecessary consequences. One reason given for such failings lies in the inability of past risk assessment approaches to capture, interpret and inform decision makers of the complexities of vulnerability, resilience and risk at the grassroots level. Whilst traditional top down, prescriptive approaches to volcanic risk assessment has led to an increased understanding of what hazards volcanic communities are exposed to, they have not provided enough information to reason why people are socially vulnerable to those hazards or how resilience within such groups can be increased. In order to capture the complexities of the adaptive social systems of volcanic communities a bottom-up participatory approach to risk assessment may also be needed to provide an insight into the perspectives and experiences of communities living with volcanic hazards and to increase understanding of how and why volcanic risk emerges. The implications of this knowledge would not only aid decision makers in the design of DRR interventions but also inform humanitarian organisations of the needs of volcanic communities, both remaining living on active volcanoes or when evacuated or permanently relocated.

1.2 Research Aims and Objectives

This thesis aims to evaluate what insights a bottom–up, participatory assessment of risk faced by those living with volcanic risk can offer decision makers about the realities of the complex adaptive systems experienced by volcanic communities. This is to enable the development of risk assessments that can guide Disaster Risk Reduction practices to achieve more sustainable community outcomes.

In meeting this aim this thesis seeks to meet the following objectives:

1. To critically review past academic, mostly technological assessments of volcanic risk, including components, measures and methodologies.
2. To use identified components of volcanic risk to guide an analytical framework that can be operationalised during empirical research with communities living on an active volcano.
3. To explore the experiences and perspectives of risk of those living on an active volcano using an ethnographic approach.
4. To re-evaluate what components best comprise volcanic risk and should be included in future volcanic risk assessments.

1.3 The structure of the thesis

The approach taken to this thesis in order to answer the research aims and objectives separates into nine parts; an introduction, a literature review, a methodology, an examination of the case study context, a three part analysis of the empirical research, a discussion of the research findings and a concluding summary. As a thesis these sections are divided into nine chapters of which are described below.

Chapter two presents a literature review of which examines the influences of decision making of those living with volcanic risk. To do so it not only explores theoretical discussions and empirical evidence of volcanic communities but also draws valuable insight from discussions of those living with ‘environmental risks’, those living with ‘mountains risks’ and those engaging in ‘voluntary and involuntary migrations’.

Chapter three sets out the research methodology used to collect and analyse the empirical data on which to address the research aims and objectives outlined in the introduction to this thesis. It begins by setting out the case for using a case study approach and describes how the site and its

participants were selected. For the purpose of formulating the interview questions it then provides the analysis of a systematic review that explores how volcanic risk assessment has been traditionally undertaken. The chapter then identifies the interview transcript devised and how the questions provide data with which to address the research aims and objectives. The analytical approach is then discussed.

Chapter four presents a detailed background examination of the case study site of Colombia. To provide context to the research and its data it discusses the countries climate and natural resources; its people, livelihoods and the economy; its environmental and social issues and its natural hazards and risk management. To end it provides an introduction to Galeras, the volcano at the centre of this case study and describes its history of eruptivity and risk management.

Chapters five, six and seven each presents one subsection of data gained from the empirical research. Each chapter focuses on different components of volcanic risk as identified in the systematic review outlined in chapter three: Value, Hazard, Vulnerability and Resilience. Each chapter follows the same format. Firstly it revisits the summary of how each component has been assessed in past technical assessments of volcanic risk. For each individual interview question the data is coded and a frequency of key themes identified in order to guide the discussion of the results. The qualitative data from the five highest-ranking key themes is then discussed.

Chapter eight presents a detailed discussion of the results of this research in line with each of the research aims and objectives. It first discusses the degree of fit of the technical framework of volcanic risk assessment to the empirical data findings. Secondly it places this discussion within the wider literature in order to identify any potential implications of the variances between the two data sets that have been found. Thirdly a series of recommendations are discussed on how to improve volcanic risk assessment and risk management in the future.

Finally chapter nine concludes the findings of this study in order to address the research aims and objectives set out within the introduction and considers the wider implications of the research.

Chapter Two:

Choosing to live with volcanic hazards – A literature review

A view of the Galeras volcano from the city of Pasto

2.0 Introduction

In outlining the rational to this research, chapter one highlighted the argument that the root cause of volcanic risk was not volcanic hazards themselves but the social vulnerability of a volcanic community, a result of exposure to volcanic hazards (high numbers of people living and engaging in livelihood strategies nearby) and sensitivity (characteristics of the community which influence the level of impact experienced e.g. age, occupation, ethnicity). It reasoned that people's lives, property and livelihoods were placed at risk to volcanic hazards due to their 'vulnerability context', the physical, social, economic and political context of the location in question (Blaikie et al, 2004).

To explore the complexities of the 'vulnerability context' further, this chapter first explores the broader, more abstract root causes of social vulnerability through a review of four academic vulnerability models. It first seeks to identify the micro-factor components of the 'vulnerability context' which influences community decision making to 'live with volcanic risk' as opposed to 'avoid the risk' through permanent relocation. To do this a literature review was conducted of decision making by volcanic communities. In addition in order to add depth, clarity and consensus a review was made of the literature surrounding living with environmental hazards. To add further detail 'volcanic communities' were reframed as 'mountain communities' presenting the opportunity to explore why communities opt to live with mountain hazards. A final discussion was made exploring the migration literature, asking why some people elect to voluntarily migrate preemptively, and why when relocated some people opt to return to their original homes.

2.1 Understanding the complexity of social vulnerability

Vulnerability is as Birkmann (2013) describes, 'dynamic and complex'. In order to fully understand it, Twigg (2001) argued it is necessary to both identify the many components and to explore the many 'systematic links' that exist between them. Many models of vulnerability have been conceptualized, four of which are presented here to identify those components and some of the many links between them.

The first, Anderson and Woodrows (1989) 'Capacities and Vulnerabilities Analysis', model highlights the links between vulnerability and poverty. It reasoned that people were often made vulnerable as a result of their economic activity or level of poverty and that poor people suffer more in disasters because they have limited access to financial capital. However it was highlighted that despite the poverty of such groups they may still be 'organised and cohesive' in their approach

to crisis' and therefore able to 'get things done'. In addition it was said that if those groups of individuals had shared belief systems or an experience of managing crisis events, then they might be better able to help each other in times of disaster than those groups without.

The second model Blaikies et al. (2004), 'Pressure and Release' model argued that disasters are caused by vulnerability and hazard, and that certain factors can increase pressure on either. They argue that despite poverty being one cause of such pressure, it is not the only factor, and that demographic or political pressures, also shape peoples livelihood strategies and location, often forcing them to live in dangerous place.

In the "Access" model, Blaikie et al. (2004) identify unsafe conditions emerging when people are not able to maintain their livelihood strategies as a result of being unable to access the assets and resources that they require. The ability to 'access' assets and resources is described as being determined by both the economic and political processes within the region. In addition some individuals are better able to take advantage of the opportunities and resources present than others. Individual ability is said to be dependent on characteristics including; gender, ethnicity, status and age. It is stressed in the model that the level of access does not remain static and that people are able to increase their level of access over time but that at times of disaster people's access to assets and resources may decrease, in turn exacerbating vulnerability.

Although some ma regard the DFID's Sustainable Livelihoods (SL) model (DFID's, 1999) as a resilience model as opposed to a vulnerability model, it has been included in this review as it views people as operating within a context of vulnerability and aims to uncover what factors and processes can help diminish vulnerability to shock and stress. Whilst the above three models look at disasters and hazards as the starting point of vulnerability, the SL model places livelihoods at the centre of discussion (Twigg, 2001) with most applications of the SL model focusing on livelihoods in rural areas where farming or other primary production is the key activity. The SL model views a person's external environment as responsible for many of the difficulties that some of the worlds poorest people face, and describes vulnerability as arising when people cannot access the assets they require on which their livelihood options are built (DFID, 2000). By making this distinction the model explains why some groups are more vulnerable than others, dependent upon which assets their livelihoods are reliant upon.

The SL model groups people's assets into five 'capitals', human, social, natural, physical and financial.

- Human capital: skills, knowledge, ability to labour, good health

- Social capital: social resources upon which people draw in pursuit of livelihood objectives – membership of groups, networks, connections, trust relationships,
- Natural capital: natural resource stocks from which resources flow and services are derived – land, forests, marine / wild resources, water, protection from storms and erosion
- Physical capital: the basic infrastructure and producer goods needed to support livelihoods - transport, secure shelter, adequate water supplies, sanitation, access to information, tools and equipment.
- Financial capital – savings and credit, inflows of money

Within its 'vulnerability context' it identifies many external forces, which may influence an individual's ability to maintain access to those assets they are dependent upon. Such forces may include:

- Trends: Long term, large scale events such as population changes, resource level changes, economic fluctuations or changes in governance, politics or technology
- Shocks: Events that can destroy assets immediately such as human health problems, natural phenomena, economic crashes, conflict and crop disease.
- Seasonality: Seasonal shifts in market prices, production, food availability, employment and health.

In summary these four models have identified a conceptual relationship between vulnerability, resilience, sustainability and livelihoods, which in turn are each influenced by the social, economic and political context of the location. The second half of this literature review will explore what these systemic links mean in practice and how they influence the way in which communities interpret risk and act on it. It presents a list of micro-level influences identified from both conceptual discussions and empirical data gathered from field observations. It describes first a summary of why people live with environmental hazards in general including issues of knowledge, trust, priority and resilience. It then highlights which of these influences have been identified specifically within volcanic communities. It then reasons that volcanic communities have developed resilience to the challenges they face in part because they are in essence mountain communities with experience and knowledge of multiple risks not just those comprising volcanic hazards. Finally it draws links between the 'living with risk literature and the 'migration' literature to discuss in greater depth why people choose not to voluntarily migrate preemptively before being forced to.

2.2 Living with environmental hazards

2.2.1 Risk perception

In a review of the literature exploring why people live with environmental hazards, two dominant opinions emerge. The first is the argument that many people worldwide are 'forced' to live in areas exposed to natural hazards as a result of poverty and political systems disempowering their choices (Wisner et al, 2004, Wisner et al, 1993, Cannon, 2008). A second set of literatures meanwhile presents an opposing perspective, that people are not 'forced' to live alongside hazards but in fact often choose to do so willingly (Butry, 2002 and St Cyr, 2005). This perspective argues that individuals make their decisions based on their interpretation of risk, what they think that risk may entail, how severe they think the outcomes might be and what opportunities people have to make adjustments (Burton et al, 1993). It is this 'perception of risk' and the decision making that it leads to it that Dibben (2008) argues in fact drives risk, as it has the ability to both persuade people to coexist with hazards and increase their level or to move away and decrease it.

Each person, describes Slovic (2000), perceives risk in a unique way. An individual's subjective framing is influenced by an exclusive set of assumptions, experiences (Elspeth Young 1998), attitudes, values (Douglas and Wildavsky, 1982), personal feelings, cultural beliefs and societal dynamics (Chester et al, 2008), each of which people draw from to make their interpretation of risk. Within social science it has been observed that there are often significant variances between the way in which communities and scientists interpret risk (Vaughn and Nordenstam, 1991). These variances Slovic (2000) reason are because whilst the culture of science tends to comprehend risk using an analytical system of 'algorithms and normative rules such as probability, calculus, formal logic and risk assessment', the lay person in contrast relies on an 'experiential' system, comprising 'intuition and reaction', framing risk not as a calculation but as a 'feeling'. The literature surrounding the many influences of risk perception is large and diverse.

2.2.2 Prioritisation

Another reason why people might choose to live with hazards despite having a level of knowledge and awareness about the risks in doing so is that the hazard in question may not be their main priority (Eakin et al (2006). Individuals may well understand the warning they have been given however other factors may take a greater influence in their judgment, even if those particular risks have less of a likelihood of occurring (Pidgeon and Fischoff, 2012). Eakin et al (2006) cautions that it should not be assumed that just because some people do not follow warnings and advice of the

authorities, that it is their intention to increase their level of risk. As Gaillard (2008) further expand, in such situations people's priority may be in actual fact to decrease their vulnerability by securing their livelihood strategies, therefore other risks such as unemployment and hunger may take a greater precedence. The exact order of prioritization that an individual decides upon is dependent on the subjective meaning that different risks have to the individual, which is influenced by both their ethnic or cultural background (Douglas and Wildavsky, 1982), and their specific needs (Kuester and Forsyth, 1985). The priority to secure livelihood strategies will often mean that people will choose to stay in areas where they have access to the resources that meet their needs, even if that area is associated with danger (Kuester and Forsyth, 1985). Despite many peoples preoccupation of natural hazards as dangerous and only responsible for negative consequences, a number of natural processes actually provide people with natural resources (Blaikie et al, 2004). Examples of such resources include floods depositing alluvium on floodplains increasing soil fertility, cyclones bringing water to often drought ridden areas and volcanic ash increasing the amount of water that soils can hold which in turn increases its fertility (Blaikie et al, 2004).

2.2.3 Resilience

Although traditionally people living with risk have been generalized by a number of somewhat negative terms, such as; 'uneducated' (Bankoff, 2011), 'irrational' (Dibben, 2008) 'disorganised' (Dynes, 2006) and 'failing to act to lessen their risk of death or damage to property' (Peek and Mileti, 2002), more recent debate has emerged arguing that people living in such areas do so in order to secure natural resources on which to establish livelihoods. In doing so Dibbens (2008) argues they are in fact 'rational' and 'knowledgeable'. These assumptions Bankoff (2011) reason link back to the historical way in which western world cultures have denigrated large numbers of the World's population due to the geographical characteristics of where they live. Dating back to early pioneering explorations of the world such as Christopher Columbus in the 1400's, large areas of the world close to the equator, in Africa, Asia and Latin America, became noted for their 'unrelenting climate, tempestuous weather, violent landscapes and an abundance of deadly diseases and fierce predators' (Bankoff, 2011), a discourse that Arnold (1996) called 'topicality'. Such discussions led to the view of those living with such dangers as being 'vulnerable', 'helpless victims of the unsafe world' (Bankoff, 2001). With this labeling came the association that such 'victims' were hence in need of being 'made safer', 'modernized', 'advanced', and 'educated' by those in the more 'developed world' (Bankoff, 2001) and the emergence of 'otherness' that is seen in the literature today followed (Arnold, 1996).

Despite these generalizations, Hilton (2000) observed that many 'tropical' cultures themselves, such as the Nepalese living in the Himalayas, do not associate with the concept of vulnerability or

see themselves as being vulnerable, or 'helpless' in the face of natural hazards. This disparity between the scientists and community perceptions has in recent years been explored within the discourse of risk management. In contrast to past assumptions it has become increasingly acknowledged that people are able to defend themselves and that they have as Berke and Campanella (2006) identify, 'an ability to survive' and 'an ability to 'cope with disaster with minimal impact and damage'. Alexander (2010) adds that when placed under stress human society is able to 'devise' ways in which to 'resist' disaster and 'maintain integrity', and is able to 'adapt to circumstances to lessen the impact'. This strength and capacity has become commonly referred to as 'resilience'.

The concept of communities having resilience, enabling them to cope and adapt to the risks they face, has started to replace in part much of the 'negativity and pessimism' that Keimer and Munasinghe, (1991) identify as usually being associated with vulnerability discourse. However whilst some go as far as to say that resilience is in fact the opposite of vulnerability (Alexander, 2012, Folke et al, 2002), other interpretations contest this (Cutter, 2008) and instead provide a vast, multitude of definitions and indicators of what makes a resilient community (Manyena, 2006)

Having originated as a term in engineering to describe the strength of materials and their ability to withstand severe conditions (Alexander, 2014), the concept of resilience was later adopted in ecology in the 1970s, to describe the capacity of ecosystems to respond to disturbance and recover (Douglas and James, 2014). Such 'disturbances' included fires, flooding, windstorms, insect population explosions, human activities and the introduction of exotic plant or animals species. Those systems resilient to such events were identified as having 'sensitivity' and 'adaptive capacity' to enable disturbance to be absorbed before the system changed to a radically different state (Holling, 1973). Having later been adopted by those discussing risk management and disaster preparedness, a review of the literature shows that whilst some descriptions of resilient communities have retained much of the same original ecological interpretation, others have modified it in some way.

Those who regard human society as part of the wider socio-ecological system, retain that a resilient community is one with the ability to respond and recover from disasters. Paton et al (2013) and Timmerman (1981) both emphasize an ability to recover with Timmerman adding a need to be able to 'absorb' the impacts of hazardous events. To enable such recovery Adger (2006) lists inherent conditions that must be in place that allow the system to 'cope with events' and to 'change and learn' in response to threat, the ability to 'cope' with hazard stress re-emphasized in the works of Pelling (2003) and Few (2003). The ability for the complex social system to be able to 'change' whilst 'remaining the same' Almedom (2011) describes as necessary for it to be able to 'retain its

core identity, integrity and core purpose'. Whilst a common term of phase to discuss resilience is an 'ability to bounce back' to what was before (Manyena et al, 2011), Almedom (2011) argues a need to change or to transform as what was before, in the aftermath of a hazard might not continue to exist therefore requiring a new set of skills in order to 'sustain key functions'.

A focus on being able to change, to 'adapt' and to have an 'adaptive capacity' is recognised by a number of authors including Pelling (2003) and Bennet (1996). In order to 'adapt', and in addition 'survive' Bennet (1996) adds that communities need to be able to 'adjust' whilst continuing to go about life as normal. To do this he says requires them to 'modify their behaviour, form new cultural patterns, make collective decisions and take collective actions'. Gardner and Ekens (2009) describe an ability to 'learn and adjust', which requires a system to be able to 'use all forms of knowledge, to self organise and to develop positive institutional linkages with other ecological systems'. Bennet (1996) also adds an ability to be able to 'anticipate' and 'conceive new possibilities'. In addition to coping and adapting, a number of other characteristics have also been highlighted; 'a capacity for self help' (Paton and Johnston, 2001), those able to maintain a 'stable trajectory' of physical and psychological health (Bonnanno et al, 2011), those able to recover spiritually (Chester, 2005) and those able to 'limit poverty by conserving and developing resources (Manyena et al, 2013).

Although Disaster Risk Reduction (DRR), as outlined in the United Nations Hyogo Framework for Action 2005 (UN, 2005), advocates the need for resilient nations and communities to be built, much empirical evidence suggests that resilience is often already inherent within many populations. Lewis (1990) describes coping mechanisms as being 'built in' whilst Peek and Mileti (2002) outline that 'under-reaction' to threats is rare in many places. Every community Dynes (2006) adds, shows evidence of past problem solving in emergencies. In contrast to common misconceptions of chaos breaking out after natural hazard events, Dekkers et al (2011) reasons when left to self regulate it is order that in fact emerges, a product of a multitude of 'relationships and interactions between component parts'. Norris et al (2008) agrees that when all the right components are within a place, including wellness, quality of life and emotional health, resilience can emerge naturally without the need for it to be built with policies. Gaillard (2006) however argues that such policies and foreign relief aid can in fact be detrimental to people's natural resilience as it disrupts indigenous systems that have built up over a number of generations, systems high in social capital from which resilience is known to emerge. However Dynes (2006) argues that in disaster assessments, there is a predominant focus on damage to physical and human capital whilst such social capital within communities to deal with emergencies is often ignored.

2.2.4 Social capital

Social capital refers to the quality of relationships and the level of continued interactions between community members (Barrios, 2014). This interaction, Vale and Campanella (2005) describes, builds a sense of community, a set of ideals and a sense of place in individuals which together leads to the desire people have to preserve or return to pre-disaster norms. Characteristics of social capital that enhance resilience include; vibrant leadership, shared goals and values, establish institutions and organisations, external partnerships and linkages and the availability and the use of resources and skills (Buckel et al, 2000), as well as a capacity to: build trust and reciprocity, adhere to commonly agreed rules, norms and sanctions, work together and work with other institutions (Ostrom, 1992). Even in communities where crisis may not have previously occurred and therefore not presented the opportunity to test levels of resilience, resilient behavior will often emerge, even if it seemingly absent before (Drabek, 2004). It may emerge from existing social capital or at other times it may appear as new, generated in direct response to meet new problems that the crisis or disaster has presented.

2.2.5 Traditional societies

Many traditional societies also referred to as "indigenous" or "folk", are reported in the literature as having exhibited resilient behaviors in times of crisis and an ability to adapt (Gaillard, 2007). One examples of such a community includes the indigenous inhabitants of the floodplains of Bangladesh who have over a number of generations developed a series of 'adjustments' to flood events, including placing their homes on stilts to lift them above the ground and changing their agricultural practices (Rasid and Paul, 1987). Another example can be found in the indigenous people of American Samoa, who in the aftermath of the 2009 tsunami built lines of communication between villagers and external emergency decision makers, assigned roles and responsibilities to specific members of the community, provided a system of accountability for their vulnerable people and mobilized groups within their society to act (Rumbach and Foley, 2014). The reasons why such resilience can be found specifically within traditional communities is, the literature suggests due to their strong relationship with their environment, their traditional knowledge system that allows them to pass on knowledge and experience from generation to generation, and their strong levels of social capital. Indigenous people have a particularly strong, relationship with the natural environment, including natural hazards (Eiser et al, 2012); a more 'intimate' relationship than other groups of people describes Kottack (2003). This is often because of a culturally implicit belief of the need to co-exist with nature (Eiser et al, 2012). As a result they form part of a larger interconnected system referred to as a socio-ecological system. A resilient socio-ecological system, as identified by Nelson et al, (2001) is one that is able to 'self organise, reorganise and learn'. It is

also able to ‘anticipate and react to external stimuli or stress’. Indigenous communities are able to anticipate and react because they often have a well developed knowledge system built on generations of experience and observations of environmental change which is continuously passed on (Dekens, 2007). With each event acting as a ‘catalyst’ for change according to Blong (1984), people have continuously adapted their cultural practices, in order to help them better cope. This includes where they live, how they structure their homes and what foods they include in their diet (Oliver Smith, 1996; Ostrom, 1990). Yet it is these same strong links between indigenous communities and their environments that help enhance the resilience of such communities that also increase their level of vulnerability to hazardous events as in the case that they have to relocate, because all those same links and feedback mechanisms will be broken. If the site of relocation does not match the conditions of the original settlement then this can lead to a loss of social capital, livelihoods and food security (Jha and Duvne (2010).

2.3 Volcanic communities

The literature discussing why communities live with active volcanoes mirrors much of that exploring why people live with environmental hazards that have already been discussed in this chapter. The more dominant theory traditionally presented is that people only live with volcanic hazards because of poor risk perception and lack of understanding of regional hazards, a lack of choice due to poverty and political systems in place, and volcanic ash of which fertilizes farmers soils (Gaillard, 2008, Lavigne et al, 2008 and Gregg et al, 2004). However in contrast, other literatures suggest that people living on active volcanoes often do have risk perception (Dibben 2008), that they often appear to make rational, informed decisions to live on volcanoes (Dibben, 2005; Kelman and Mather, 2008) and that as well as ash, there appears to be an abundance of other opportunities and gains for people to build their livelihood strategies and meet their needs (Kelman and Mather, 2008). In addition case study observations have shown that many volcanic communities, many of whom are indigenous have shown great resilience in the face of volcanic activity making adaptations to lessen the impact (Blong, 1984).

Levels of risk perception within volcanic communities have traditionally been described as low, supposedly indicative of people not understanding volcanic hazards or the threats that they pose and the reason why they do not relocate. However in his studies of the communities of Mt Pinatubo in the Philippines, Gaillard (2008) concluded that there were high levels of risk perception within those he talked to, but that it had not persuaded them to move. Similarly in a study of communities living on Mt Etna, in Italy, Dibben (2008) reported that risk perception in fact played a relatively unimportant role in people’s decision to remain or relocate. Even some of those having directly

experienced eruptions have reportedly not engaged in higher levels of preparedness such as witnessed at Mt. Ruapehue in New Zealand in 1995 (Paton et al, 2000). This is despite Gaillard and Dibben (2008) and Lindell and Perry (1992) claiming its strong influence on decision-making.

Factors influencing people to live on active volcanoes appear to focus in part on the trust that some volcanic communities have that the volcanic hazards they face will not cause them harm. This includes trust being placed directly in the volcano itself, when some cultures do not perceive them as dangerous hazards or interpret the risk they present in the same way scientists and authorities do. An example of this was reported by Hernandez (2004) who reported that the communities living on Popocatepetl in Mexico described the volcano as 'peaceful and caring'. Religious and spiritual beliefs of community members are reported as having a particular impact on people's levels of trust (Donovan, 2012). At Mount Merapi in Indonesia, Lavigne (2008) reported communities having had developed alternative explanation for the activity of the volcano other than it wanting to hurt them. Chester et al (2008) reported that in 1971 some of the inhabitants of Mt Etna were parading through the streets with images and bones of local saints and holding special masses so that the volcano would not hurt them or cause damage. At Mt Bromo, in Indonesia, Lavigne et al (2008) found that many community members believed that the eruption was a gift from God, providing them with the benefits to continue with their livelihoods, reasoning that they had shown the volcano respect and in return it had done the same.

Paton et al (2000) hypothesized that risk communication material when distributed to community members at Ruapehue may have increased trust in risk management authorities to protect them as the public awareness campaign had resulted in 28% of those surveyed reporting a reduced need for preparedness. Over-trust in the authorities and a 'transfer of risk' was also reported of those living at the Sinla crater of the Dieng volcano in Java in 1979, where despite 47 families having migrated due to poisonous gas emissions from the volcano, many returned when they found out that their homes did not lie within the designated danger zone that the scientists and local authorities had established (Lakonsa, 1988).

Another factor outweighing risk perception in people's decision making to live on many of the world's highly active volcanoes was their need to maintain their livelihood strategies. In concluding his evaluation of the community response to the eruption of Mt Merapi, Lavigne et al (2008) stressed again that peoples decision to live on volcano had not been because they had misperceived or miscalculated the threat, but that maintaining their livelihoods, primarily based on agriculture and animal husbandry, had taken priority. Reestablishing economic security also identified by Dibben (2008) as a strong influence on people's choice to remain living on Mt. Etna after its eruption periods, adding that risk perception had played very little part. In his discussion of

his results Dibben (2008) added that people had moved to towns and villages on Etna for the same reasons that other people around the world had moved from the city into rural areas, ‘to improve their quality of life’, emphasizing that living on an active volcano was to these community members just normal life, ‘routine nature’, not risky behaviour as the scientists and local authorities had argued.

The opportunity to secure livelihood strategies on active volcanoes and earn an income not only focused on agriculture benefitting from volcanic ash particles raising soil fertility levels (Baxter, 2003), but also an array of other opportunities for communities to take advantage of other natural resources. Kelman and Mather (2005) argued that although the negative impacts of volcanic activity are well documented and accepted, that during quiescent periods there are there are many benefits of living in such regions that could be maximized such as minerals, energy resources and flora and fauna species. As a result of such a diversity of opportunities Kelman and Mather (2005) contended that volcanic communities are not ’just surviving’ but that they are creating and maintaining livelihoods by using the resources available to them, many of which technical assessments had identified as the hazards themselves. Wisner et al (2004) description of Taal volcano in the Philippines, provides a rich example of the opportunities available to anyone choosing to live on one of most dangerous volcanoes in the world, ‘a prosperous economy of fishing, fish farming, agriculture, scoria mining and tourism, growing at a rate of 9.6% per year, three times the national average’. In his discussions of Kawah Ijen volcano in Java, Baxter (1993) reported how people had prioritised the opportunity to earn higher wages over their health. Describing how approximately 300 people a day hard mine the volcanoes crater for its sulphur deposits. Baxter listed the many health complaints that were prevalent such as lung disease, stomach problems, eye problems, rotting teeth and bone complaints. The people however, he described argued that mining the sulphur could earn them up to five times the wages that they would on coffee plantations down the valley and that moving to another such job would mean that they wouldn’t have enough money to ‘grow old on’.

Despite the possible devastating impacts of volcanic eruptions on communities, many examples of resilience being both already present and having had emerged in times of eruption can be found in the literature, showing that people have coped with the changes that eruption bring. Whilst they have not necessarily been able to ‘bounce back’ as Manyena (2011) reasons a resilient community should be able to do, due to the damage to land that eruptions have caused, many have adapted either to new surroundings, new cultures or new livelihoods. The Orokaivan people of Papua New Guinea were reported to have left their ancestral homes and cultivated new and unfamiliar crops at a new site in response to the eruption of Mt Lamington (Blong, 1984). In 1961, inhabitants of the island of Tristan de Cuhna were evacuated to England in preparation of the eruption of the Tristan

volcano. Largely farmers and fishers, the community were reported to have adjusted to urban life in England, including 'home rentals, industrial and service jobs and punctuality' (Blong, 1984). In 1968, residents of the island of Nila in the Maluku archipelago were documented by Pannell (1999) as having had relocated and subsequently converted from a maritime society to a land society. Following the 1991 eruption of Pinatubo the Aeta people were reported as having changed; settlement patterns, religion, language, medicinal treatments, clothing, diet, land tenure and farming practices. Societal relationship structures, communal food and land sharing and kinship patterns were all also reported as having been affected (Gaillard and Masson, 2007). The resilience of the Aeta, was accounted in particular to their ability to adapt from their highland cultural frames of reference to those of the lowland communities (Gaillard and Masson, 2007). In addition to volcanic hazards Agrawal et al (2008) highlighted adaptations that volcanic farmers undertake to deal with other types of hazards, in this case climate variations. Farmers in Guatemala, Honduras and Mexico were described as operating with some degree of variability in climatic conditions having developed a number of different strategies to cope with annual and interannual vulnerability.

Although many communities have been reported to have relocated in order to adapt to volcanic hazards it is important to note that in doing so their knowledge and experience of how to build livelihood strategies, built up through generations, have often been lost as a result of having had to move to unfamiliar surroundings and losing their frames of reference. Unless the receptor site has been able to replicate the same environmental, social and economic characteristics of their original home on the volcano then many communities have often failed to cope, leaving them unemployed, facing poverty, homelessness and food insecurity. The relocation of Mt. Pinatubo although praised for the number of lives it saved, was criticised for being 'centralised' and 'top down' with very little participation in decision making being given to community members. In addition government officials were reported to have lacked cultural knowledge of the Aetas and made attempts to 'civilise' their traditional ways through social programs. The relocation site provided by the program failed to provide land suitable for cultivation and housing was deemed as inadequate by the Aeta. Unable to re-establish their livelihood strategies at the relocation sites some Aeta decided to return to their old homes and fields despite the continued levels of volcanic activity, whilst others moved again to other sites that they deemed more suitable without the assistance of the government (Gaillard and Mason, 2007). A lack of participation in the decision making process such as experienced by the Aeta, Oliver Smith (1991) argues means a lack of opportunity for communities to voice their needs and outline all the resources they require to underpin their livelihoods, resilience and sustainability. Such a loss Kelman and Mather, 2008) add, despite its intentions to reduce vulnerability, actually results in an increase of levels and further exposure to other risks.

2.4 Mountain Communities

Many observations of resilient behaviours reported within the case studies of volcanic communities appeared inherent, without the influence of external bodies, or as Lewis (1990) described it, 'built in'. Even within communities who had had no previous experience of volcanic hazards, resilient behaviors appeared to emerge that enabled them to cope. Insight into where the resilience of volcanic communities derives from, it appears is largely lacking within the Volcanology literature. However reframing volcanoes as mountains and making the association that volcanic communities are in fact actually mountain communities provides researchers with an additional set of well developed 'mountain geography' literature, which provides a great level of insight into how mountain communities interpret risk but how they cope with the challenges presented by living with it. Although to some it may seem an obvious association to make it is one that is noticeably absent within the Volcanology literature in discussions of social vulnerability, volcanic risk and resilience. However Lavigne et al's (2008) study of the communities of Sumbing and Sindoro volcanoes in Java highlighted that some volcanic community members themselves associate as mountain communities even if those studying them do no. This is an important observation to make in an attempt to understand drivers of decision making within such groups. Of those people interviewed in Java, 70% considered their volcanoes as ordinary mountains and not volcanoes and when asked to draw a volcano 30% of school children in the same region drew a simple mountain without an eruptive activity.

In order to be able to argue the credibility of applying social mountain research to the volcanic risk discourse, the link between mountains and volcanoes needs to be firmly established. However whilst numerous definitions of what constitutes a mountain are discussed in the literature, no firm definition has been agreed (Gerrard, 1990). A range of both quantitative measures and more qualitative, subjective, and often abstract descriptions are presented to describe elevation, steepness, ruggedness, relative relief, volume and size, each of which could also be used to describe a number of the World's volcanoes. These include areas of; 'over 1000 meters above sea level (Ives et al, 2007), 'with a relative relief higher than 1500m' (Thorsell et al, 1997), 'steepness (slope angle to the horizontal) which causes the forces of gravity to shape them and create habitat types and disturbances typical for mountains and which make exposure a driving factor of life' (Körner, 2004), 'possessing sufficient relief to produce a marked vertical zonation of vegetation (Preston James, 1935), 'characterised by steep slopes, small summit areas and strong relief', (Finch and Trewartha, 1949) and 'impressive, possess individuality and should enter into the imagination of the people who live near them' (Peattie, 1936).

In analyzing the way in which volcanoes are defined, multiple variations are also apparent. These fall into two distinct groups, those that refer to the volcanic system and movement of material (Canon-Tapia and Szakács, 2010, Francis, 1993) and those that refer to the landform. To make the connection that many volcanoes can be identified as mountains, those definitions referring to landforms provide the strongest argument. Volcanoes are, according to Francis (1993) "a commonly conical mound or mountain built up by the eruption products around the vent. In comparison The United States Geological Service (USGS, 1999) also use the same description as Francis, but make the added distinction that whilst "volcanoes are mountains", "they are very different from other mountains' due the processes involved in creating them. The definition goes on to highlight that they are built not by folding or uplift but by the accumulation of their own eruptive products. A much less technical definition provided by Decker and Decker (1991) makes the connection that volcanoes are mountains by describing volcanoes simply as "mountains gone mad".

Studies relating to mountain hazards and the ability of human and natural systems to adapt to changes within them bring together expertise in a wide range of disciplines (Fuchs, 2009) including; natural science, development studies, disaster management, health, social science, policy development and economics. Having made the link between volcanoes and mountains and the communities that reside upon them, a review of the mountain literature provides further depth to the discussions of what might make many volcanic communities vulnerable but also where their inherent resilience may derive from.

2.4.1 Social vulnerability in mountain communities

According to Tulaher et al (2015) mountains have become increasing disaster prone throughout the 20th century, the number of events being disproportionate when compared with other environments. Mountain regions are subject to a range of hazardous processes including earthquakes, landslides, avalanches, debris flows, epidemics and fires, yet it is not the frequency and magnitude of these processes that have resulted in the disasters argues Gardner and Dekens (2005), but the changes in social and economic conditions within mountain communities. Mountain communities have been disproportionately affected by the greater problems of the world such as climate change, population growth, urbanization and migration, states the Food and Agricultural Organisation (FAO, 2011), and people have, accordingly to Price (2004), found themselves at a clear disadvantage in comparison to other regions.

Discussions of social vulnerability within mountain communities present the following arguments. Mountain people are among the World's poorest and most disadvantaged (FAO, 2011), a product

of not only being exposed to harsh environmental conditions but also political, social and economic marginalization and pressures from population expansion, intensification of activities and increased land use (Gardner and Dekens, 2009). High levels of widespread poverty (FAO, 2011) have led to people being driven into remote, marginal areas (Tuladhar et al, 2015). This remoteness has meant that communities often live away from centers of commerce and power and so have little opportunity to influence policies and decisions making (FAO, 2011), which in turn has led to issues of power, equity and inclusivity (Schild and Scharma, 2011). Their remoteness has also meant that communities have limited livelihood options, poor access to services and inequitable access to productive assets (Maraseni, 2012). Increasing populations not just within mountain communities themselves but also globally, has led to increased pressures being placed on mountain communities from farming and food production, timber and recreation (Bonn et al, 2009) which have led in turn to high levels of environmental degradation from unsustainable practices. A lack of management of mountain resources has led to increasing soil erosion, landslides and rapid loss of habitat and genetic diversity (UNEP, 1996). This has in turn has led to devastating impacts on the communities reliant on natural resources for their livelihoods, including; poverty, unemployment, poor health and bad sanitation (UNEP, 2011). Hillside areas of the Andean countries of South America, the Himalaya, south East Asia and East and Central Africa have all experienced rapid deterioration of land resources (UNEP, 1996). Ruiz et al (2008) argue that in order to improve the quality of life of many mountain communities, there is much need for management to; 'reduce standards of living disparities', 'provide well built housing, higher levels of employment and more social housing', 'to increase levels of innovation, skills and competencies to build capacity', 'to build independence from financial support' and to build 'robust, adaptable and sustainable economies'.

Yet despite their status as highly vulnerable, empirical evidence has often proved that within mountain communities there are significant levels of resilience that enable people to cope with and adapt to the challenges they often face. One such example can be seen in the following descriptions of the Enga people of Papua New Guinea and their response in 1972 to substantial losses of crops and natural vegetation as a result of severe frosts. All of the following information comes from Waddels (1975) report. In response to the frost the Enga elected to relocate them and their livestock in the lowland valleys to new locations up to seven days walk away. To reduce the demand for resources and to provide a temporary alternative food source they were reported to have slaughtered their pigs. To organise hosts for their families to stay with they gave gifts of meat and livestock to kinsmen and friends living in separate communities in the valleys. During the period of relocation the men continued to move between the old and new settlements in order to continue harvesting at the higher altitudes and to try and restore their crops. Although some members of the community returned to their original homes after six months, once their gardens were back in production, others stayed for up to three years.

Such reports of resilience within mountain communities have been reasoned to be a result of their the communities experience of the multiple hazards that occur in mountain ecosystems, their traditional knowledge systems which enable them to both deal with those hazards and to maximize the opportunities for livelihoods that mountains present and the high levels of social capital often found within communities. People have inhabited mountains for generations and in doing so they have lived alongside a multitude of hazards (Hewitt, 1997). As a result they have developed knowledge and experience of dealing with these processes and their impacts, which has been passed down from generation to generation (FAO, 2011). Not only have people had to adapt to the fragile environment and its associated hazards but they have also had to develop ways to deal with their highly differentiated landscape. Due to the influence of both verticality and latitude mountain climates can alter every few hundred meters, leading to a great 'topographic, geological, climatic, hydrological and biological diversity within relatively small areas' (Gardner and Dekens, 2009). These resultant 'multifunctional' (Schild and Scharma, 2001), mosaic landscapes provide communities with a range of choices on which to build their livelihood strategies and greater economies such as; fertile soils, access to water, cooler climates, minerals, forest products, energy and biological diversity to be utilised (UNEP; 2006, Bonnet et al, 2009; FAO, 2011). The ability of communities to adapt not just to the fragile, hazardous mountain environments but also to these 'highly differentiated landscapes', is evidenced by the great diversity and sophistication of cultural land use practices and indigenous knowledge that they exhibit (Duffield et al, 1998) including their choices; of settlement location, building design, building materials, agricultural practices, crop and animal type and annular patterns of life all designed to fit the particular opportunities and constraints of the mountain environment (de Scally and Gardner, 1994).

Community knowledge of how to utilise the mountain landscape and how to deal with the risks and hazards involved in doing so highlight the acute levels of understanding that these communities have of their environment (Duffield et al, 1998). Knowledge of which has been generated through the experiences of multiple generations each retaining knowledge and then passing it on through a variety of different ways (Gardner and Dekens, 2009). Even in extreme events the vulnerability of mountain social systems has been reportedly 'considerably lower', due in part to the strong social networks in place (FAO, 2011). The ability of some mountain communities to adapt so well has meant that in many cases mountain cultures have actually developed faster than those in lower lands such as the Inca civilization which extended over the Andean mountain range in Argentina, Chile, Colombia, Ecuador, Peru and Boliva, who are well renowned for their organisation and architectural achievements (FAO, 2011).

2.5 Voluntary and involuntary migrations

The final literature reviewed in order to examine why communities might choose to live on active volcanoes is the more general migration literature. This allows us to step back from discussions of how people specifically interpret and react to natural hazards and looks at the broader reasons why people choose to move from where they live to an alternative location. Two specific discussions are reviewed which relate to the context of volcanic risk discussed more broadly in chapter one. The first explores 'voluntary precautionary migration' otherwise referred to as 'precautionary displacement' which questions why people do not migrate despite there being risk and why people often do not move before that risk has materialized. The second explores 'forced migration' or 'involuntary resettlement', the impacts on communities being forced to move and why such schemes often fail.

Voluntary precautionary migration or precautionary displacement occurs when households identify fear despite not being immediately threatened, and as a response displace to prevent potential impact (Ibanez and Velez, 2008). As discussed earlier in this chapter as well as within chapter one, this is the position many volcanic communities find themselves in during periods of quiescence, knowledge of a potential threat in the future but not at that particular time experiencing any direct impacts. The decision making process to migrate preventatively at this point is described by Ibanez and Velez (2008) as being 'less hasty', as it allows the individual time to assess both the economic possibilities for income generation and the costs of migrating. Although Ibanez and Velez (2008) identify that individuals will choose the location with the greatest net benefit, any costs incurred will also have a particularly strong influence on choice. Such costs may be incurred not just in the moving process itself but also when receptor sites fail to replicate the assets and resources of the individual's current home which may result in a loss of income or the need to purchase something of which an individual is used to being able to access for free. In addition public services such as schools of which may have been accessible at the original site may not be available at the receptor site and therefore may require the individual to cover transport costs. Receptor sites may also increase costs if people are unable to secure work because of discrimination (Fischer et al, 2008). Costs will be higher for poorer households (as better-educated individuals will be able to find employment more easily and therefore be able to generate larger incomes after migration (Ibanez and Velez, 2008). Costs however can be saved at receptor sites if people have contacts there that can help provide housing, support to find employment and social networks (Becker, 1975). Those with access to media will be further influenced by how receptor sites are portrayed say Dustmann (1992). Positive information regarding social and economic opportunities at the proposed site will

improve the expected benefits that may be gained from relocation but information about poor conditions will raise the expected relative benefits of remaining at the original site.

Both in chapter one and earlier in this chapter reference has been made to the impact of relocation on communities and the influence it sometimes places on people either to move again to another new site or to move back to their original location on the volcano therefore re-establishing their exposure to risk from volcanic hazards. A loss of land, jobs, homes, cultural space, food security, common property, an increase in social marginalization and disarticulation, as well as negative impacts on health, can all lead to 'counter-development' argues Cernea (1990). Discussions of 'forced migration' or 'involuntary resettlement' as it is labeled within the migration literature refers not to evacuation and relocation due to natural hazards but to when large numbers of people are forced to move away from an area because of a government development such as a dam or an airport being built (Cernea, 1990). Due to the many negative impacts that can be incurred by such programs, the World Bank's policy guidelines advise that any such development projects should avoid or minimize resettlement (Cerne, 1990). However in the eventuality that such a program is carried out it advises that 'resettled people should be better of or at least not worse of'. People are often left worse off it explains because compensation packages prove to be inadequate. This is, they reason because the true cost of resettlement has not been estimated (Pearce, 1999) and any losses incurred are externalized to those being displaced rather than project budget (Cernea, 1990). Poor estimates are made and 'under-compensation' provided says Cernea (1990) because of a lack of accurate valuation of the assets, resources and income channels that people have access to at the original site, a problem particularly persistent with relocation programs in developing countries. If people are not provided with a replication of assets and resources from their original location then they will not be able to recover their livelihoods, in turn rendering unable to secure the needs of their family and reducing their quality of life.

2.6 Summary

This chapter has outlined a number of arguments why volcanic communities may not choose to engage in preventative relocation in order to decrease their levels of risk. It has not only reviewed literatures in direct reference to volcanic communities but has also examined a number of other external literatures where comparisons could be drawn. The review has highlighted that in contrast to the dominant theory within the Volcanology literature that volcanic communities only live on active volcanoes because of poor risk perception and social, economic and political constraints placed upon them, communities actually engage in rational, methodical, strategic and informed decision making in an attempt to secure livelihoods and wellbeing both for themselves, their

families and wider social networks. Where knowledge of volcanic hazard and associated risk maybe be high there are a complexity of other factors relating to experience and observation as well as prioritization and cultural values which may have a greater influence on an individual's decision making process. In addition where the common perception of those living with volcanic risk has been of them being vulnerable, empirical data has argued an inherent ability to cope with and adapt to a multitude of challenges that the volcanic socio-environmental system might present to them. This resilience, a product of being a mountain community well experienced in environmental change, is what appears to have enabled many volcanic communities to maintain their livelihoods and meet their needs in the past and arguably should therefore enable them to do so in future. However the greatest paradox is presented when communities are relocated for their safety, removed from volcanoes and their hazards. In doing it is those same environments, which are argued by risk managers to pose a threat to lives and livelihoods that communities themselves argue in fact help to secure them. In order to secure the welfare and safety of volcanic communities in the future a balance must be sought not only to understand the behaviour of volcanic hazards but also to understand further the connections between volcanoes and their communities and in particular to seek to better value the contribution volcanoes make to the sustainability of volcanic communities worldwide.

Chapter Three:

Methodology

PPGIS activity during community focus group in Genoy (Author, 2012)

3.0 Introduction

As was discussed in chapter one, this research seeks to evaluate the comprehensiveness of volcanic risk assessments to capture the complexities of the adaptive social systems of communities living in volcanic regions, in order to identify how people utilise the volcanoes on which they live and how in turn this use may influence their vulnerability and risk.

A methodological framework was designed in order to capture what Slovic (2005) identified as the 'experiential' system in regards to the way in which communities themselves experience risk and behave in accordance to it. To do this required working directly with community members and engaging them in a series of participatory activities. To collate these data a qualitative social science research approach was applied, with a focus on 'face to face' interactions which Loflan and Loflan (1995) argue to be the best way to be able to describe life in the mind of other human beings.

This chapter begins by outlining the case study approach taken to this research and the formation of the interview themes. An analytical framework is then outlined to show what interview questions were used to explore each theme. Detail of the data analysis and reporting is then provided. Finally an account of the research experience within the communities of Galeras is detailed; outlining issues of reflexivity and positionality that arose during data collection and what steps were taken to manage them.

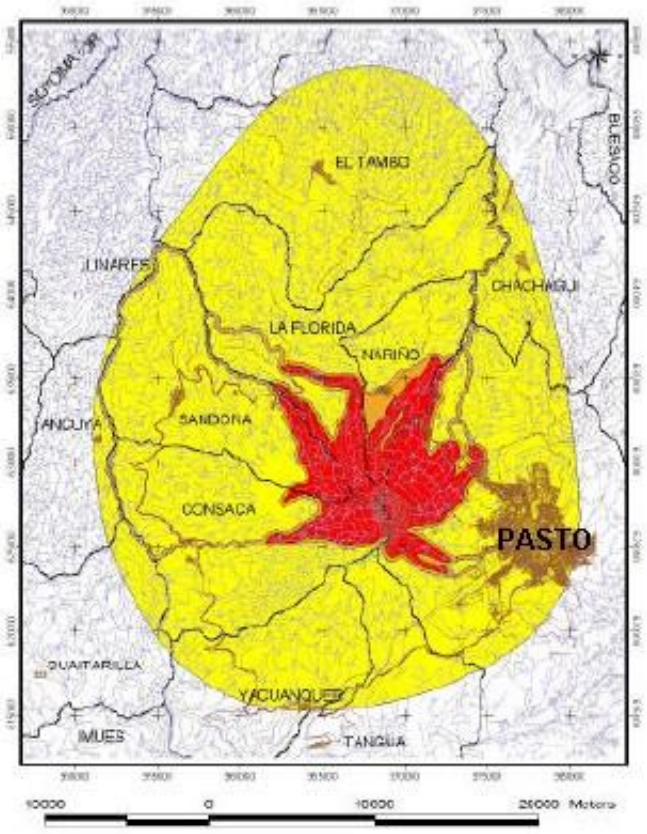
3.1 The case study approach

In order to understand the complexities of volcanic risk experienced at the community level this research took a case study approach, advocated by Yin (2009) due to its ability to enable the researcher to "retain the holistic and meaningful characteristics of real life events". This research focused on six communities living on the Galeras volcano in Southern Colombia, close to the border with Ecuador. An initial scoping visit of one month in 2011 was followed by a four-month field period in 2012 when the main data collection was undertaken.

Galeras was chosen as a case study due to its historic high levels of activity and high population density of which combined gives it great potential for disaster. For such reasons it was designated a 'Decade Volcano' in 1990, alongside 15 other volcanoes worldwide, by the International Association of Volcanology and Chemistry of the Earth's Interior (IAVCEI) (Gates and Ritchie, 2009). After an increased period of activity in 2005, the Colombian government declared Galeras a "zone of disaster". The terms of this declaration had ordered the permanent relocation of 9,000 inhabitants and the prohibition of new developments and investment within the "zone of disaster",

identified by the red and orange high and medium zones of hazard on the INGEOMINAS (government institute for geology and mines) volcanic hazard map shown in figure 3.1.

Figure 3.1 Volcanic hazard map of Galeras (INGEOMINAS, 2004)



At the time of the study (April-September 2012) the communities were found in a phase of 'post disaster', however, many residents were in contest of there actually having been a 'disaster'. This was due to their argument that the designation of 'disaster' is usually given after a significant death toll and amount of damage to property and infrastructure has been incurred. The common opinion within the community members spoken to was that there had been neither loss of life nor damage to property because the volcano had not in fact entered a phase of high explosivity. Many of those interviewed exhibited high disregard for the governments relocation policy that had been put in place in response to the 'disaster' and for the lack of engagement that they had had with the communities in the decision making process. As a result, large numbers of the community were no longer attending meetings organised by the government's emergency planning department and INGEOMINAS, complaining that officials were not listening to their arguments. In addition numbers of people evacuating to the emergency shelters had fallen considerably during periods of

increased activity, reportedly due to the fear of residents that their homes would be taken away during these times. Community members were also heard complaining of a lack of government investment into key public services within the towns and villages on Galeras, such as roads, education and health; money that some argued was 'rightfully theirs'. Three of the communities, Nariño, Mapachico and Genoy, had recently hired human rights lawyers to represent their will to remain living in their communities and were in the process of drafting a document to submit to the government. Finally there were rumors told to the researchers of community plans to protest and set up road blocks in challenge to the proposed plans. In regard to the provision of the relocation program, community members interviewed argued that what the government was offering them was insufficient, their key argument being that the compensation package comprised only of a house but no farm land. In addition they argued that people were expected to move as individual families and not whole communities as there was no location available big enough to place whole communities together.

Although the declaration of disaster had been passed due to the proposed 'high risk' of many of the communities, it was highlighted by some community members, as well as other expert informants interviewed, that a 'risk assessment' had not been carried out, only a hazard assessment with an absence of an assessment of vulnerability. At the time of this study no evidence was found of an assessment of potential socio-economic impacts that the relocation program would have on those community members involved. Therefore the detailed evaluation of community perspectives and experiences of risk, that this research proposed to undertake, would in fact form a somewhat retrospective assessment to identify where the root causes of current vulnerability and risk had stemmed from.

3.2 Study area

Research was conducted within six different communities (figure 3.2) around Galeras; Genoy, Mapachico, Nariño, La Florida, Consaca and Sandona, noting that Nariño is both the name of a community and the municipality which these six communities are located. These multiple sites were chosen in order to capture variation within the perceptions, experiences and livelihood activities of the communities, an approach recommended by Bryman (2008) due to its ability to enable the researcher to identify the 'significance of the context', and the way in which it 'influences behavior'. Sites were situated along the Circumvalor road, the main paved road that runs around the majority of Galeras.

Communities were selected due to their spatial dispersion on Galeras. By selecting communities at various locations around the mountain different ethnic cultures were captured. Community members identified themselves as either indigenous or civilian with the largest indigenous

populations found at Genoy and Mapachico. The vast geographical dispersal also meant that a variety of change in the physical landscape and climate was also captured, both of which influenced many of the natural resources available and therefore many of the livelihood strategies that people have developed. A criterion of logistical and security measures were also in place as defined by the University of York insurance regulations due to the state of Nariño being an area of high drug trafficking and guerrilla activity. This meant that only main settlements were worked in and not the smaller villages away from the main road.

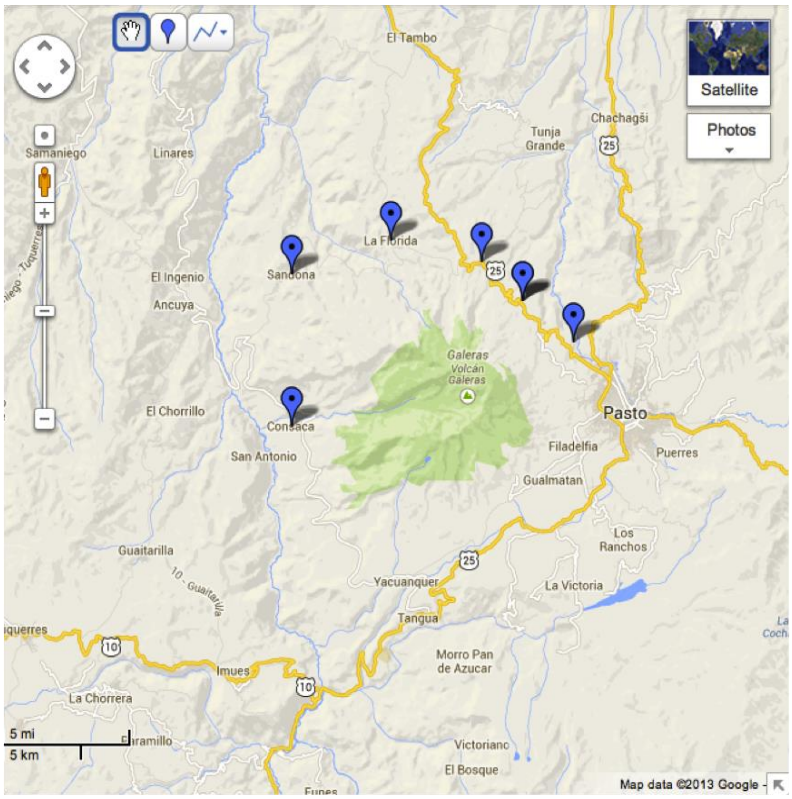


Figure 3.2. The six case study sites (Google maps, 2013)

3.3 Accessing the community

As identified, due to the declaration of disaster, it had been reported that many of the community members had become disengaged with discussions with the government and associated organisations. This, along with the fact that much academic research had already been carried out in the region had appeared to have left the communities fatigued, frustrated and somewhat untrusting of outsiders. This scenario presented a series of challenges to the research approach in terms of getting communities to engage in the activities identified. Initial access was gained

through a partnership with the University of Nariño via a number of different researchers who had already worked within the communities. This identified a series of "gate-keepers" in Genoy, Mapachico, La Florida, Consaca and Sandona with which we could liaise and whom it was hoped would help bridge the gap between the community members and us. Links with the Nariño Red Cross identified a further gatekeeper in Nariño. However as will be described in greater detail at the end of this chapter the association of this research with the University of Nariño also presented an issue in that the community were frustrated and disappointed with many of the researchers due to them not having shared previous research findings. Therefore after the initial introduction to the gatekeepers further research was done independent of the University of Nariño.

3.4 Method selection and subject sampling

A four-stage approach of data collection was carried out. This comprised of a triangulated system of consecutive community expert interviews, community focus groups and household representative interviews conducted within each community. Figure 3.3 shows the order in which each activity was carried out. Each method asked the same themes of interview questions in order to allow for cross verifying of the answers provided during analysis and therefore 'enhanced confidence' of the data (Bryman, 2012). A fourth stage of data collection was then carried out, conducting interviews with external experts off of the volcano. This was done in order to provide insight and clarification on key points raised within the community discussions in order to 'buttress' inferences from the community data (Bryman, 2012). All interviews were semi structured, recommended by Bernard (1988) to be used when the interviewer is not likely to get more than one chance to conduct the interview and when several interviewees will be used, both of which was the case in this field study. All interview questions were open apart from the demographic questions, selected in order to allow the respondent the opportunity to present their 'own perceptions rather than those of the researcher' (Lewis-Beck et al, 2004). The open-ended question was also used because of the wide amount of responses that the respondent could have provided to many of the questions, many more than could have been included on provide on a response list (Fowler, 1995). In selecting this method it was appreciated that open-ended questions may prompt lengthier, more detailed responses than closed questions which may have taken longer to ask and record responses, been difficult to code and taken longer to analyze (Fowler, 1995).

Structured focus groups were selected as a method in order to help further understand people's experiences because of their ability to capture more qualitative information than a questionnaire, in a shorter amount of time than conducting several additional interviews (Bryman, 2012). They were also selected because of their ability to give greater insight into why certain opinions are held, which the interviews may not provide (Liamputtong, 2011).

In order to identify a sample of the population for the interviews a purposive sampling strategy was applied. In wanting to give as much power to the community, this placed them in the position of the 'expert', applying their knowledge of their own community to select a cross section of the population. Whilst the community gatekeeper selected participants for the community expert interviews and community focus groups, the community focus groups selected the families for the household interviews.

Community expert interviews were conducted with members of the community that were identified by the gate-keepers as being representatives of health, education, agriculture, emergency management, faith and leadership. These themes were chosen to present a variety of viewpoints and experiences. One individual was identified in each community although in some more than one person was invited.

Community focus groups were conducted with groups of approximately ten members of the community identified by the gatekeeper as being representative of each community's social structure. These profiles changed in each community and included descriptions such as 'single mother', 'musician', 'coffee farmer' and 'elderly'. Representative Interviews involved semi-structured interviews with household members. Participants were selected by those participating in the community focus groups that were asked to identify ten community members leading a 'good quality of life' on Galeras and ten that lead a 'bad quality of life'.

External Expert Interviews involved semi-structured interviews with individuals deemed experts in fields of specific interest that arose as important within the community interviews. Such fields included; water, roads, culture and coffee. Individuals were identified via links at the University of Nariño, Nariño Red Cross and Pasto Chamber of Commerce.

A target of 6 community expert interviews, 1 community focus group and 20 household interviews was set for each community. Guest et al (2006) had suggested 12 to be the number of household interviews needed within the same community before saturation is reached and people begin repeating the same ideas, therefore a target of 20 was thought adequate enough to ensure a comprehensive range of ideas would be raised.

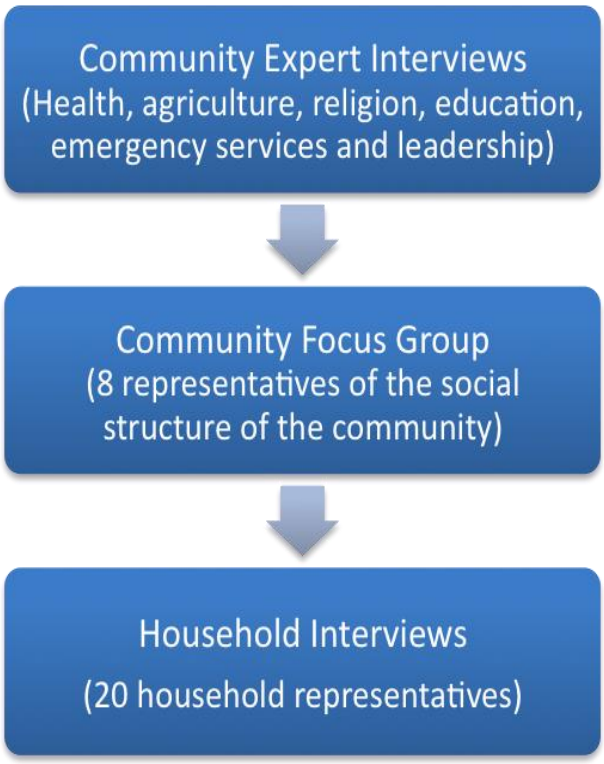


Figure 3.3 The data collection methodology

The data set achieved can be seen in table 3.1, a total of 39 community expert interviews, 8 focus groups and 91 household interviews. In addition external expert interviews were conducted with 40 different individuals from a range of different government and non-government organisations which can be seen in table 3.2. As can be seen variations in data collection methods occurred within the communities. Absences of some community expert interviews and additional occurrences of others were as a result of the availability of such people within the community and the input of the gatekeeper. For example Mapachico is only a small community and therefore without emergency services. In comparison the larger numbers recorded at Nariño were as a result of the gatekeeper inviting multiple representatives. In such cases these interviews were carried out as mini focus groups. Due to high tensions within the community at the time of the interviews it was decided to conduct three individual community focus groups in order to represent the different social groups as these three groups would not agree to participate together.

Although a target of 20 households had been set, the logistical challenges of conducting research within mountain communities without private transport were considerable. On some occasions only five household interviews could be conducted in one day due to the amount of time to get to the communities and the amount of time to move between the different locations. In addition, as specific households had been identified by the focus groups participants, often the only details

given were a family name and community name where the individual lived. Where participants could not be found or did not wish to participate, a replacement house of similar condition was identified as close to the original house as possible.

Table 3.1 Summary of data

	Leaders	Health	Education	Emergency Services	Agriculture	Religion	Community Focus Group	Household Interviews
Mapachico	YY	Y	YY	-	-	-	3	14
Genoy	YYY	Y	Y	Y	-	-	1	19
Nariño	-	Y	YY	YYYYY	YY	-	1	20
La Florida	YY	-	YY	YY	YY	-	1	8
Sandona	-	Y	Y	Y	Y	Y	1	11
Consaca	Y	Y	Y	-	Y	-	1	19

Table 3.2 Summary of external expert interviews. *Alcalde refers to the local government administration

Theme	No. Interviews	Organisations
Agriculture	5	1 x Agro engineer and 1x geneticist (University of Nariño), 1 x Coffee federation, 1 x Minister of agriculture, 1 x independent coffee trader
Business and Economics	3	1x Camara de comercial (Chamber of commerce), 1 x government minister for business, 1 x ACOPI (Independent organisation for the protection of small and medium size businesses
Emergency Services	3	1 x Independent community brigade, 1 x community hospital response team, 1x CLOPAD (*Alcalde)
Infrastructure	2	1 x Institute of engineers, 1 x *Alcalde
Health	4	1 x Dental university, 1x psychologist (University of Nariño), 1x psychologist (Nariño Red Cross), 2x public Health (*Alcalde)
Culture	4	2 x University of Nariño, 1 x *Alcalde
Environment	2	2 x Ecologists (University of Nariño, CIGAR research institute)
Law	1	Private lawyer
Natural Resources	1	University of Nariño
Tourism	4	*Alcalde, 3 x Independent consultants
Petrol	1	Owner of petrol station
Vulnerability	10	Nariño Red Cross, Colombia Red Cross, Fundau Laurel (NGO), Rotary International, UNDP (United Nations Development Program

3.5 A synthesis of volcanic risk assessments

In order to meet objective one, a review of fifty journal articles was undertaken in order to provide a perspective of the 'technical framework' of volcanic risk used previously within Volcanology. A content analysis of the articles sought to identify how volcanic risk is defined and conceptualised, what components are used to measure it and how each of those individual components are in turn conceptualised and measured. This review presented a picture of how volcanic risk is interpreted within Volcanology of which could in turn be compared to the experiential data at the community level gathered in the field research.

3.5.1 Method

Using the criteria 'volcanic' AND 'risk' AND 'assessment' an investigation of the literature was made using the search engine Google Scholar. A total of fifty papers on volcanic risk assessment were selected and reviewed in order to present an overview of the different way volcanic risk is conceptualised and measured. The first fifty papers identified from the search were reviewed. Papers were excluded if they were found not to be based on volcanic risk and were replaced by the next selected paper. Papers ranged in publication date from 1998 to 2013.

In order to identify the perceptions and approaches within Volcanology, a thematic content analysis was carried out to qualitatively analyse papers and identify how each of the themes of interest were described within them (Daly, Kellehear, & Gliksman, 1997). The method was selected for its ability '*to give expression to the communality of voices across participants'* (Anderson, 2007). Described by Braun and Clarke (2006) as a method used for '*identifying, analysing and reporting themes within data'* the analysis used a specific set of interest points as predefined codes with which to search the data. These were; the definition of risk, the measure of risk, and what element risk was deemed to. Depending on what components each paper used to measure risk presented a second set of codes to be searched. These emerged collectively as value, hazard and vulnerability, although not all papers viewed risk as being comprised of all three components. A definition of each of these terms was then identified along with a description of the methodology used to measure it. Every attempt reasonable was made to only repeat sections of the text and to keep interpretation to a minimum.

3.5.2 Key themes emerging from the synthesis of volcanic risk

Perhaps the most surprising theme to arise in a review of a collection of papers focused on 'assessing volcanic risk' was that the vast majority of papers did not actually provide a definition of volcanic risk or a description of what they perceived it to be. It emerged throughout the review of each code that failure to define key terms was in fact a common practice. Volcanic Risk appeared to be perceived in three main ways. The first group of papers (Lirer and Vitelli, 1998, Alberico et al, 2000 and Alcorn et al, 2013) were anchored in a definition of volcanic risk as a 'product of the element of risk x vulnerability x hazard.' This definition was referenced both to the proceedings of a UNESCO meeting on natural hazard risk in 1972, UNESCO (1972), where the equation was described as helping to 'understand the threat of disaster', and to the work of Fournier D'Albe (1979) of whom had been a pivotal discussion member at the UNESCO meeting. Reference to volcanic risk as 'a product of hazard vulnerability and value" was replicated also in a papers by Pareschi et al (2000), Hornwell and Baxter, 2006 and Thierry et al, 2007, although no reference was given to the source of the concept. A second group of authors used the equation of 'hazard x vulnerability', but without including a factor of 'value' (Mendoza Rosas and De la Cruz Reyna, 2008 and Kaye et al, 2009). A third variation was seen in Gislason et al (2011) which although referring to volcanic risk only actually calculated hazard.

A final set of papers which again did not provide a definition of volcanic risk, spoke of 'risk to' specific elements. These included 'risk to'; population numbers and density (Gómez-Fernández, 2000; Aceves-Quesada et al, 2007, Alberico et al, 2008), property (Robertson, 1995), high-value crops (Blass, 2012), industry (Aceves-Quesada et al, 2007), agricultural land (Aceves-Quesada et al, 2007), and major elements of infrastructure (Robertson, 1995). Robertson (1995) focused not only on specific elements but also on specific processes including productive capacity and human resource systems. Another group of papers identified the 'risk to' value rather than just specific elements or processes including, 'things of regional value e.g. nuclear waste disposal (Valentine et al, 2006), cultural value (Pomonis et al, 1999), architectural value (Pomonis et al, 1999) and traditional values (Biass and Bonadonna 2013). Patella and Mauriello (1999) also talked of risk to 'importance' when identifying 'risk to' things of historical importance. Robertson (1995) spoke not just of the 'risk to 'but the 'potential loss of' which in this case he was saying in reference to human life.

In light of volcanic risk being viewed as a product of value, hazard and vulnerability a review of each component in terms of definition, measure and methodology to assess was made, the results of which are summarised.

3.5.3 Key themes emerging from the synthesis of volcanic value

Although there was variation in the way in which value was conceptualised and defined, the predominant focus appeared to be again on the "element of risk" as was used to describe volcanic risk itself, which Lirer and Vitelli (1998) referenced back to the UNESCO, (1972) proceedings. Whilst some spoke of the value of individual elements others identified "the calculated value", a combined value of all elements at risk (Gómez-Fernández, 2000), However neither of these papers gave reference either to what they meant by value or what elements they were referring to. A focus on value being 'economic' was made by Robertson (1995), Alberico et al (2008), Biass and Bonadonna (2013) and Cronin and Neall (2001). Biass and Bonadonna (2013) in turn described a 'combined value' of both 'capital value and productive value' and number of human lives. A couple of authors suggested that value was not economic, with Kaye et al (2009) identifying value as a 'percentage of damage', and Robertson (1995) identifying 'potential loss of human lives'.

In discussing how to measure value, not every paper detailed a methodology, only referring to "the value of" such as Marti et al (2008); often this was without, as already noted, even providing a definition of value itself. Those that did describe provide a methodology focused largely on various forms of quantification, including 'calculating' (Robertson, 1995), 'measuring' (Robertson, 1995) and 'estimating' (Leung et al, 2003). Only a couple of specific methodologies were given, 'estimating the monetary value of property damage and production losses' (Leung et al, 2003) and 'calculating the mean market value of each single municipality per unit' (Lirer and Vitelli (1998). Whilst some papers focused specifically on 'the value' of singular elements (Lirer and Vitelli, 1998) others referred to "the whole system" (Robertson, 1995). In addition to the value of specific elements Marzocchi and Woo, 2009 also included a focus on the value of lives, which he quantified by estimating population density. Choosing not to identify a specific element, Donovan et al, 2012 presented a unique perception of value suggesting that the element should not be predetermined as it was 'relative to the individual ' and dependent on "cultural outlook and personal standards".

3.5.4 Key themes emerging from the synthesis of volcanic hazard

Once again in reviewing papers for their definition of hazard, the greatest trend to be observed was in fact the absence of a definition. Of those papers that did provide a definition or at least a description the majority focused on two things, the source of the hazard, referring to its cause and/or the probability of an event occurring. Causes identified were all volcanic products or processes of which included any "volcanic hazard" (Lirer and Vitelli 1998, Tralli et al. 2005), tephra fall (Costa et al. 2006, Horwell and Baxter 2006, Keating et al 2008), ballistics (Aspinall

2006), earthquakes (Marti et al. 2008), pyroclastic density currents (Lirer and Vitelli 1998, Kaye et al. 2009, Cherry et al. 2012, Jenkins et al 2013), lava flow (Vereszturi, 2012 and Alcorn et al. 2013), lahars (Leung et al 2003) and soil degassing (Ferreira et al 2005). Zuccaro and Gregorio, (2013) referred not to a specific product or process but the effects of a "violent explosive eruptions of sub-plinian type" in reference to a specific type of eruption (Zuccaro and Gregorio, 2013). Another variation on the same theme referred to a "set of events taking place in a volcano that may cause damage to people and properties exposed to them" (Arana and Ortiz 1996). Choosing not to focus specifically on a particular product or process, Bird et al. 2010 and Martin 2010, referenced the UNISDR (2007) classification of natural hazard defined as "natural processes or phenomenon that may cause loss of life injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption or environmental damage". Only one paper, Gaillard (2008), suggested that hazards could be anything other than a volcanic source referring specifically to everyday hazards of poverty and the threat to cultural heritage plus volcanic hazards.

Although still in reference to volcanic processes and products, a small selection of papers classified hazards depending on their specific impact. These included; Cuoco et al. (2013) who referred to "toxic hazards", created in the event of volcanic emissions interacting with water, Wilson et al. (2012) who referred to health, electrocution and visibility hazards and Jones and Berube (2011) who identified respiratory hazards. Only one paper, Gaillard (2008), suggested that hazards could be due to any other source other than those of volcanic origin. In doing so he referred to 'every day hazards of poverty' and their 'threat to cultural heritage'. In contrast to the rest of the papers Jenkins et al. (2013) identified hazard not as the physical process or product, but the physical response of 'humans and their environment' to the impacts those products and process had caused.

The second predominant focus in discussions of hazards focused on the probability of the occurrence of a given volcanic event such as Alberico et al. (2008). Expanding on this Magill and Blong 2005 referred to "the likelihood" of volcanic products and processes. Other papers described the 'possibility' of a hazardous event seen by Robertson (1995) as 'a product of the occurrence of a volcanic event in a specific area within a given time period' which again was referenced back to Fournier D'Albe (1979) paper, this same concept was mirrored also in Lirer and Vitelli (1998), Patella and Mauriello (1999) and Mendoza Rosas and De la Cruz Reyna (2008).

Hazard was predominantly measured by studying the previous behavior of individual volcanoes, and identifying what their previous activity and extent of individual products and processes had both been, the aim of this approach was to identify the likelihood of future events happening in a particular place (Patella and Mauriello 1999, Alberico et al. 2008, Biass and Bonadonna 2013). A couple of papers focused on identifying the 'maximum extent' (Robertson 1995) and ascertaining

the size of eruption that determined destructive potential (Mendoza Rosas and De la Cruz Reyna 2008). This historical analysis was carried out by interpreting geological data and identifying stratigraphic correlations. Focus was either given to singular products such as by Gislason et al (2011) ash assessment, (which looked at plume height, grain size distribution, dispersion rate, airborne particle concentration, toxic gases posing respiratory and ingestion hazards), or to the mathematical modelling of multiple hazard processes such as by Sahle and Potting (2013), who applied a compound stochastic process to ascertain how multiple hazards occurred in time and space. A common approach was to analyse spatial variation combining the physical models with digital elevation models in order to create maps that showed various hazard scenarios (Gómez-Fernández 2000 and Cronin and Neall 2001). This process allowed various simulations to be tested by identifying the different degrees of hazards happening in different zones (Barberi et al. 1993). In assessing hazard the paper by Aspinall (2006) was the only one to compare the risk exposure of volcanic hazards to that of hurricanes and earthquakes within a given spatial area.

Having identified high levels of uncertainty within the available data one study, Kerr (1996), applied a method of "expert elicitation' to fill the data gaps, a method used to synthesise opinions between multi-disciplinary researchers.

3.5.5 Key themes emerging from the synthesis of volcanic vulnerability

The trend of absent definitions followed into the review of vulnerability whereby only thirteen of the sixty papers reviewed gave a definition of vulnerability despite having identified it as a component of volcanic risk. Those that did provide definition or description focused on either 'losses or 'susceptibility'.

Lirer (1998) and Gómez-Fernández (2000) focused on loss as being the percentage of an element lost as a result of a given event. Aceves-Quesada et al. (2007) elaborated on this idea to also include not just complete loss but damage also. Alberico et al. 2008 and Pasquare et al. 2011, added a focus specifically on "lives and goods" and infrastructure. Marti et al (2008) did not identify either loss or damage referring only to the potential impact of a volcanic eruption.

One set of papers referred specifically to 'susceptibility' although again there was an absence of definition given of what susceptibility meant or how it had been interpreted. Some used it only as a descriptive term such as "susceptibility of an element at stake or group of elements" (D'Erole 1991) and the degree of susceptibility in (Patella and Mauriello 1999). Referring not directly to susceptibility Zuccaro and Gregorio (2013) referred to the 'tendency to show damage or changes', whilst Pomonis et al (1999) referred to the 'resistance' and Marti et al (2008) about the 'impact'.

Reference was often made to what specifically was being perceived as vulnerable. 'Economic vulnerability' was described as the measure of the economic cost of an event (Alcorn et al. 2013) whilst 'social vulnerability' focused on a 'person's ability to respond to and recover from' (Alcorn et al. 2013). Perhaps the most detailed description of vulnerability was given by Alexander (1991), who referred to social vulnerability being a function of; direct cultural values, risk amplification, risk mitigation and risk perception. Again without further clarification Patella and Mauriello (1999) referred to 'any kind of artifact,' whilst Kaye et al (2009) referred to an "affected inventory".

A review of the way in which vulnerability was measured revealed that it was predominantly descriptive rather than instructional. Two trends emerged of papers either providing somewhat more generic quantification of vulnerability or referring specifically to what exactly was vulnerable.

In quantifying vulnerability some papers stopped short of a description of an exact methodological process, providing instead only a direction such as Alberico et al (2008) direction to 'estimate' vulnerability. Other vague descriptions of what needed to be measured included; 'the degree of vulnerability' (Gómez-Fernández2000) the 'characterization of the vulnerability of different elements' (Leone and Lesales, 2009), the 'understanding of the mechanisms of emission, transport and deposition of volcanic products' (Patella and Mauriello, 1999), and 'relating hazard intensity and damage ratio to affected inventory to calculate expected damage' (Kaye et al, 2009).

A small focus was placed on estimating a percentage of damage or loss as a result of a specific event, (Arana and Ortiz, 1996, Tilling, 1989, Robertson, 1995). Following on in this theme Lirer and Vitelli, (1998) also talked of identifying the 'fraction of the value' of which is likely to be lost.

Two papers referred to location as being a determinant of vulnerability, with Robertson (1995) referring to vulnerability being a result of being close to the volcano', and Roscoe (2001) identifying specifically the 'midlatitudes'.

Placing an emphasis specifically on the vulnerability of the human population, Alberico et al (2008) described 'estimating' by 'counting' the resident area and urbanised area. Other concentrated on identifying the vulnerability of buildings, as 'vulnerability of people was based on building vulnerability'

Other papers lacking a methodology simply described what the vulnerability was to, such as, 'vulnerability to health' (Marti et al, 2008) and vulnerability to, 'roof collapse' (Sparks and Aspinall, 2013).

Social vulnerability was also attributed to whether or not an individual was in 'possession of hazard knowledge', as this was believed to be directly linked to the actions an individual would take in regard to personal preparedness which as a result would reduce their vulnerability (Blaikie et al, 1994, Siegrist and Cvelkovich 2000, Paton et al, 2008, Bird et al 2010).

3.5.6 Synthesis summary

This review of volcanic risk provides an understanding of how both volcanic risk as a whole, and the components identified as it being a product of, are perceived within the discipline of Volcanology. The result of this review is a collation of different perspectives, conceptual understanding, and methodological and analytical frameworks. It exemplified the range of approaches taken to assess volcanic risk and highlights the way in which different volcanologists have considered the subject from a range of different points.

This analysis shows that not only does the perception of volcanic risk differ between different disciplines, but that within the same discipline, there is also a considerable range. Despite such variation, common themes emerged presenting an overall picture of how volcanologists perceive volcanic risk. However despite this, perhaps one of the most surprising findings was the lack of definition of key terms or even a description of what the scientists perceived these terms to mean and the lack of detail provided on how they had measured different components.

Also of particular interest was that whilst all the papers seemed to share a common perception that risk was comprised of hazard and vulnerability, not all the papers reviewed included value as a component to be measured. When value was included definitions and descriptions lacked great detail. Ambiguity was also particularly high in discussion of vulnerability, whilst it was described; very little detail was given to its assessment. There did however appear focus and consensus within the hazard assessments with comparatively high levels of detail given to the identification of both causes of hazards and the scenarios that could develop as a result of their impact.

3.6 Developing a framework for the interview questions

Chapter one of this thesis outlined the need for risk assessment approaches to be capable of capturing the complexities of community decision making in order to inform risk management

decision makers both of the way in which communities live with volcanic hazards and how communities utilise active volcanoes, both sets of knowledge vital in determining the root causes of vulnerability to disaster within a community.

In order to identify the ways in which previous top down approach had approached the assessment of volcanic risk, research objective one of this study set out, **'To critically review past academic, mostly technical assessment of volcanic risk, including components, measures and methodologies'.** It sought to identify how previous approaches had conceptualized volcanic risk, what measures they had used to calculate it and what methodologies had been used to collect and analyse the data. The themes established from this review would then be used to inform the design of a bottom-up participatory risk assessment, the strengths of which was identified in chapter one, to be applied in the empirical field study meeting research objective two, **'to use identified components of volcanic risk to guide an analytical framework that can be operationalised during empirical research'.**

In order to capture the dynamics of living on the volcano as experienced by the communities themselves, a qualitative research approach was undertaken to underpin a bottom-up participatory risk assessment approach, the need of which was outlined in chapter one. An extended semi structured interview script was designed and used in various versions for each of the four engagement methods; household interviews, community focus groups, community expert interviews and external expert interviews. This interview script focused on exploring how each component of volcanic risk, 'value', 'hazard' and 'vulnerability', identified from the synthesis of volcanic risk assessment approaches, was experienced at the grassroots level. Despite 'resilience' not having been a component measured within the approaches reviewed in the volcanological papers, it was also added to the interview framework due to its prominence within the wider literatures surrounding disaster risk reduction. Although chapter two outlined the many different interpretations of resilience this approach sought to focus on the 'coping capacity' of household members to deal with the challenges they faced in maintaining access to those assets and resources which they identified as necessary for a good quality of life.

In order to capture as much complexity as possible regarding the perspectives and experiences at the community level, the design of the interview questions took the approach to frame the Galeras as a 'mountain' and not 'a volcano'. In chapter two it was argued that volcanoes are mountain regions and that therefore they too were:

- Regions rich in natural resources of great value to people because of the opportunities they present for people to build livelihood strategies upon

- Regions of complex social vulnerabilities due to high populations placing pressure on limited resources and fragile ecosystems, populations being geographically isolated and people having limited opportunities for livelihood diversification
- Regions of multiple hazards

In order to capture all of the potential vulnerabilities, hazards and values present at Galeras, which cumulatively might be influencing 'volcanic risk', the approach framed volcanic risk as a 'place' and not solely as a volcano as many of the volcanic risk assessments reviewed had done. A 'place' based approach was advocated by Cutter and Soleckis (1989) in their 'Hazards of Place' model. They reasoned that there was interplay of social, political and economic factors, each of which interacts with one another and with the physical environment to create a 'mosaic' of risks and hazards that affect people and the places they inhabit. This 'mosaic' of risks was also labeled a 'riskscape'.

In designing the interview questions a number of observations were made during the pilot study regarding references to certain terms and phrases used. Due to the levels of resentment and disregard within the communities surrounding the risk management strategies in place, the words 'hazard', 'vulnerability' and 'volcano' had particular negative connotations and associations with the relocation program. Due to the predominant focus on the volcanic activity, both 'hazard' and 'vulnerability' appeared to be by some members of the community, automatically linked to the volcano and its activity. In addition there was a significant difference between 'Galeras' and 'the volcano'. Whilst many 'outsiders' referred to 'living on the volcano', the community perceived the volcano being only the crater at the top of 'Galeras the mountain'. Therefore in designing the interview questions, and to ensure the most comprehensive set of responses, the terms 'value', 'hazard', 'vulnerability' and 'volcano' were not directly used in any of the questions and alternative questions selected to explore the general concept of each. The literature guiding the design of the research questions is discussed below.

3.6.1 Selecting questions to explore community experience of 'value'

As the community members of Galeras were used to discussing their life on the volcano in a negative light, interview questions were needed that would encourage the community to identify elements of their life that were positive and that they valued. The model of Appreciative Inquiry, a form of action research, was used as a guide to influence the design of the questions in order to capture the full range of prospective answers that might be given:

"More than a technique, appreciative inquiry is a way of organizational life – an intentional posture of continuous discovery, search, and inquiry into conceptions of life, joy, beauty, excellence, innovation, and freedom" Ludema et al. (2006)

More commonly applied in business to create new strategies, appreciative inquiry was developed as an alternative to the more traditional problem solving models used within business by Cooperrider and Srivastva (1995). With a focus on asking 'unconditional positive questions' (Ludema et al, 2006), it is a model used in organisations even where there are 'few moments of excellence', in order to focus in on them and discuss what made them possible (Ludema et al, 2006). The model summarises four main types of questions, discovery, dream, design and destiny, the first three of which influenced the research questions of this study. Whilst 'discovery' was used to identify what Ludema (2012) describes as the 'life of the organisation', interpreted as what the organisation is built on, 'dream' and 'design' allowed individuals to vision what they could aspire to. Table 3.3 identifies how each of these themes influenced the research questions used to discuss value.

Table 3.3 Value research questions influenced by Appreciative Inquiry (Ludema et al. 2006)

Appreciative Inquiry questions		Value Interview questions
Discovery	'What gives life' – the best of what is	Describe the quality of life at Galeras What is your motivation to reside in your community? What are your sources of income? What do you use your land for?
Dream	'What could be'- opportunities for the future	What is the future potential of your community?

3.6.2 Selecting questions to explore community experience of 'hazard'

In order to capture all the sources of problems for the communities and not those caused by the volcanic activity Cutter's model of 'Place vulnerability' was used as a guide (Cutter et al, 2000). Having identified that the potential of hazards is a direct product of the geographical influences of the area in which they occur, Cutter et al (2000) devised the concept of the 'hazardscape' or 'riskscape' to describe a landscape where different hazards are distributed spatially. Not only did

this model meet the research need to identify multiple hazards across Galeras but also it allowed the comparison of individual communities.

In order to collate evidence of events having occurred rather than perceptions of what might occur, a forensic approach was undertaken to identify 'what had' occurred within the recent ten year period. Conducted in 2012, the interview questions focused on the time period between 2002 and 2012. This length of time was decided upon as it was thought individuals would be able to recall the events, which had occurred, and because it included the 2005 volcanic eruption, which had prompted the Declaration of disaster.

In order to identify any disruptions that had occurred during this time period, 'quality of life' was chosen as an indicator of change as it was thought to allow for a full range of scenarios to be considered. In order to identify disruptions to their quality of life, participants were first asked what they needed for a good quality of life' and then if during the last ten years if they had had any problems in accessing those necessities.

3.6.3 Selecting questions to explore community experience of 'vulnerability' and 'resilience'

In order to capture the variance of impacts experienced within the communities to different events, a profile of vulnerability, specific to the communities of Galeras was identified. In order to capture the dynamics of the livelihood system, parallels were drawn between livelihoods and businesses as both being systems of inputs and outputs aimed at achieving an end goal. This comparison suggested that applying a risk assessment framework used to identify and manage risk in business might highlight specific areas of weakness within the livelihood framework that would make the impact of a disruptive event more likely. The business continuity model was identified, used to analyse the:

'Capability of an organisation to continue delivery of products or services at acceptable predefined levels following a disruptive incident" (ISO 22301, 2012)

Developed in the 1970's, business continuity was originally developed in response to the need for businesses to protect large investments (Cerullo and Cerullo, 2004). With its underlying principles lying in the need for businesses to ensure they can continue to function during disruptive events, business continuity provides a risk assessment framework that identifies both a business's critical functions and what threats there are to them (ISO 22301,2012). Finally the model seeks to identify what those businesses can do in order to ensure 'functioning' can continue.

Taking the notion of 'continuity' this research sought to explore vulnerability and resilience within the communities of Galeras. It explored vulnerability by exploring if the community had over the

last ten years, always been able to access everything they deemed necessary for a good quality of life. If any disruptions in access were identified then participants were asked what the impact had been on them. In order to explore resilience, when disruptions to necessities were identified participants were asked how they had coped with the disruption to ensure 'functioning' still occurred.

3.7 The interview transcript

A combination of all four sets of questions formed the interview script, which was applied in various arrangements within each of the four engagement methods. The complete interview script and its variations can be seen in table 3.4. As can be seen in the table, when the question 'What do you receive from Galeras' was asked at the community focus group meetings it was done using a public participatory mapping approach, where community members were asked not only to list what they felt they received from Galeras, but also the location of where those elements could be found. Using a printed map, participants were asked to identify and mark specific locations.

Table 3.4 The Interview transcript

Descriptive questions	**Data inferred**
Where were you born?	If participant had moved to Galeras
For how long have you lived here?	If participant had moved to Galeras
How many people live in your home? What is the age of each person in your home? What is the gender of each person in your home?	Description of population

Interview questions to explore 'value'	**Data inferred**
What is the quality of life for people on Galeras?	What are the good things that people experience living on Galeras?
What is your motivation to reside here?	What do people value about living on Galeras
What are your main sources of income? Who is responsible for each source? Where does each activity take place? What are the three main sources of income in order of importance?	What livelihood strategies do people engage in? How many options are linked to Galeras? Do the most important livelihood strategies take place on or off the Galeras?
How many different parcels of land do you use? Where is the parcel? What do you use the parcel for? Why do you use the parcel for this activity?	How much land do people have? How do people use their land? What characteristics of the land drive different land uses?
Do you grow fruit and vegetables? What do you grow? What is the main purpose of this crop? What are the most important crops for you in order of importance	What is the diversity of crops grown? What crops are people most dependent on for subsistence? What crops are people most dependent on for income?
Do you raise animals? What animals do you raise? Why do you keep these animals? What is the main purpose of this animal? What are the most important animals that you keep?	What is the diversity of animals reared? What animals are people most dependent on for subsistence? What animals are people most dependent on for income?
What so you receive from Galeras? What do you use these things for? How frequently do you use these things?	What benefits do people feel they gain from Galeras?
In your opinion what could be the potential for future generations living in your community?	What could be the economic opportunities for people in the future?

Interview questions to explore 'hazard '	**Data inferred**
What is needed for a good quality of life on Galeras? In the last ten years have you had any problems accessing these things? What was the cause of this problem?	What has been the cause of problems for people in the last ten years?
In the last ten years have you experienced any other problems in maintaining a good quality of life? What was the problem? What was the cause of the problem?	What has been the cause of problems for people in the last ten years?

Interview questions to explore 'vulnerability'	**Data inferred**
What is the quality of life for people on Galeras?	What are the bad things people experience living on Galeras?
What are your main monthly expenses? What are the main expenses in order of importance? Do these three principal ever change?	What are people's costs related to?
What is needed for a good quality of life on Galeras? In the last ten years have you had any problems accessing these things? What were the consequences of not having access?	What things are people dependent on? What 'needs' is access disrupted to? What is the impact when people cannot access the things they need?
In the last ten years have you experienced any other problems in maintaining a good quality of life? What was the problem? What was the cause of the problem? What was the consequence?	What things are people dependent on? What 'needs' is access disrupted to? What is the impact when people cannot access the things they need?
In regard to what you think the potential is for future generations living in your community: What is necessary to reach this potential? What are the potential future opportunities dependent upon?	What are positive economic futures dependent on?

Interview questions to explore 'resilience'	**Data inferred**
In regard to any problems you have had accessing the things you need for a good quality of life during the last ten years: How did you cope with this problem?	What strategies are people able to enact when they have a problem?
In regard to any other problems you might have experienced in maintaining a good quality of life over the last ten years: How did you cope with this problem?	What strategies are people able to enact when they have a problem?

3.8 The pilot study

In order to test the efficiency of the interview questions and the ability of the volunteers to carry out the interviews and translation, a pilot study of ten household questionnaires was conducted in the community of Obonoco, selected due to its location on the flanks of Galeras. Two volunteers and I conducted each interview, translating and transcribing as will be described within this chapter. On the completion of each interview a discussion was had within the group to identify any ambiguity or misunderstanding. Discussions were also had in relation to each volunteer's translation skills with constructive criticism given for how individuals could help improve the process. Corrections were made to the questionnaire after each individual trial and the process repeated. It was found that on average each interview took between 45 minutes and an hour to conduct allowing an approximate time to be given to each interviewee when requesting their participation.

3.9 Transcribing and translation

In order to meet the research aims of the study within the resource and logistical framework of the case study a principal research assistant was recruited (Kari Williams, Florida) as well as a team of 15 volunteer data collectors from various English language schools in Nariño. Volunteers were selected based on a set of criteria, specifically; experience of working as an English translator, an ability to convey complex ideas in English and experience of community work or research. Volunteers worked a shift system dependent on their availability and the research activities being undertaken. Before the community engagement was undertaken a one-day training workshop was provided, introducing volunteers to the research project, methods, and research ethics. Whilst unpaid, volunteer's expenses were reimbursed and refreshments provided.

All interviews and community focus group meetings were conducted in Spanish, the local language. A number of external expert interviews were conducted in English at the request of the interviewees. Each interview consisted of myself or my research assistant (Kari Williams) and one or two translators. For the focus groups, depending on the size, up to four volunteers were used to both provide translation and to record data. LeCompte and Goetz (1982) praise the use of internal validation within research, regarding it as strength during prolonged periods of participation in the social life of a group as it helps to ensure the quality of observation and concepts that are recorded.

It was decided early on in the research that the presence of a recording device in the interviews would negatively influence the quality of the interviews and that therefore they would not be able

to be used. People were outspoken in their mistrust of the government, and this appeared to translate over when asked if they minded interviews being recorded. This was also the case on occasion when people were asked to sign their permission for their interview scripts to be used in the write up. Therefore to allow both parties to remain comfortable and relaxed it was decided that only detailed notes would be taken and that when an individual did not want to sign their name that one of the translators would provide a witness signature. Although I spoke intermediary Spanish it was inevitable that without a recording device data would be lost, however it was felt this was more acceptable than interviewees not engaging.

Collecting data in a non-native language and then presenting the information in English presented a number of dilemmas in how to maintain the validity of the responses provided given the level of influence that the translators had on the information being relayed (Temple, 1997). These challenges were approached in a number of ways:

1. The volunteer training provided detailed information on the purpose of each research question and the type of data that it had been designed to collect.
2. Questions were asked firstly in English by myself in order to maintain a sense of direct interaction. A translation was then given. Clarity of the question was given by the translator to the participant if required. Responses to each question were translated back directly and notes made by myself. Where clarification was required the translator was asked during the interview. My level of intermediate Spanish also allowed for notes to be written and to ensure all details were being translated back. Where gaps were apparent a prompt was given.
3. After each interview a review of the data recorded was carried out in order to explore any areas needed further detail.
4. Continuous training and reviews of each interview were given to volunteers to ensure the process of translation was as efficient as possible.

3.10 Interpreting the data

In order to identify trends, patterns and contradictions within the data all transcript questions were first analysed for emerging themes which were narrowed down into a set of primary codes (Bryman, 2008). These primary codes were then used as a base for a frequency analysis of each transcript. This identified not only common answers but also outliers, both of which were discussed. Where necessary a secondary coding was undertaken to identify broader themes (Bryman, 2008).

A mind mapping software program called Mindview was used to organise the data and link the frequency analysis with supporting qualitative quotes. Using the software primary themes could be inputted to form a series of nodes on which narratives of interlinks quotes could be added. This method allowed for the entire data set to be visualised within the one place and linkages identified between the different narratives.

In order to understand 'Hazard' at Galeras and the disruptions that had occurred to people's quality of life, parallels were drawn to and influence taken from the Sustainable livelihoods approach developed by Chambers and Conway (1992). 'Necessities for a good quality of life' as were referred to in the interview question, were identified as drawing parallels with what Chambers and Conway (1992) described as the livelihood system, 'a means of security, the basic needs of - food, water, shelter and clothing – of life'.

The Sustainable Livelihoods model (figure 3.4), developed by DFID in the 1990's, provided a tool to better understand people's livelihoods and what may cause disruptions to them (Cannon, 2003). Therefore using this same model and its terminology provided a framework for analysis for this research. Data gathered from the interviews in regard to 'necessities' for a good quality of life were used to provide context to what the livelihoods model identified as 'livelihood resources'. These were used to describe what was needed for 'positive livelihood outcomes' (DFID, 2000). In addition, data gathered from the interviews in regard to 'problems' in accessing those necessities, were used to provide context for what the model identified as 'vulnerability context'. This was used to describe what features of the external environment have a direct impact on people's ability to access those resources (DFID, 2000). Therefore in using the livelihoods model analysis could be undertaken not just of the standalone data sets but the way in which they interact within the greater 'sustainable livelihoods' system.

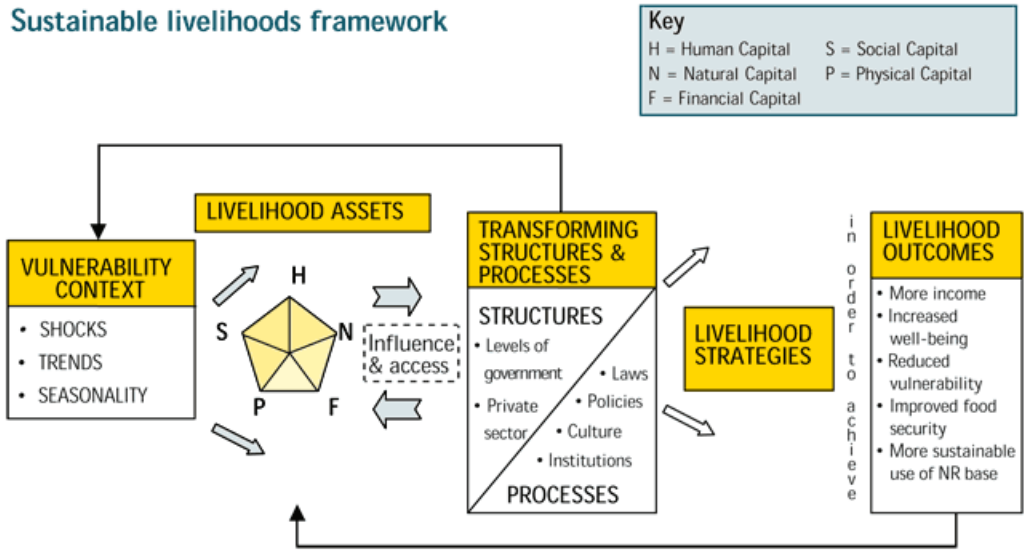


Figure 3.4. The Sustainable Livelihood Framework (DFID, 2000)

In discussing 'livelihood resources' and 'vulnerability context', coding classifications used by the Sustainable Livelihoods Framework were used. Resources were coded as one of five different capital; natural, social, human, financial and physical. A sixth capital, 'political capital', was added in light of the expected impact of the declaration of disaster on people's responses. This was to represent what Braumann (2000) refers to as the influence that 'policies, institutions and processes' may have on poverty levels. The Vulnerability context was coded as shocks, seasonality or trends. Table 3.5 outlines the definitions used to guide the coding of both livelihood resources and vulnerability context.

Table 3.5 Summary of livelihood resources and vulnerability context

Livelihood Resources		
Social Capital	Social resources: interactions between individuals, membership of formalised groups and relationships of trust (DFID, 2000)	E.g. Kin networks, group membership, socio-political voice and influence
Financial Capital	Financial Resources: available stocks and regular inflows of money (DFID, 2000)	E.g. Savings, debt, gold, jewellery, income, credit, insurance
Human Capital	Human Resources: skills, knowledge, capacity to work and good health (DFID, 2000)	E.g. Household members, active labour, education, knowledge and skills
Natural Capital	Natural Resources: stocks and flows of ecosystems goods and services (DFID, 2000)	E.g. Access to land, forests, water, grazing, fishing, wood products and biodiversity
Physical Capital	Physical Resources: basic infrastructure and physical goods (DFID, 2000)	E.g. Livestock, equipment, vehicles, houses, irrigation pumps
Political Capital	Political Resources: Structures, processes and relationships between structures and processes (Brauman, 2000)	E.g. Rights and access
Vulnerability Context		
Shocks	Shocks can destroy assets directly as in the case of floods, or indirectly such as in forcing people from their homes and disposing of assets prematurely as part of coping strategies (DFID 2000)	E.g. Human health shocks, natural shocks, economic shocks, conflict, crop/ livestock health
Trends	Trends may, or may not, be more benign, though they are more predictable. They have an important influence on rates of return t chosen livelihood strategies (DFID 2000)	E.g. Population, resources, national / international economics, governance, technological
Seasonality	Seasonal shifts in availability of stocks and flows (DFID, 2000)	E.g. Prices, production, health, employment opportunities

In order to identify the level of disruption to people's livelihood resources that had occurred over the previous ten years, a matrix was used to analyse the frequencies of shocks, trends and seasonality events. An analysis of frequency was made in order to identify which combinations had resulted in high, medium, low and no levels of disruption.

3.11 Reporting the data

Although selected as a sample of the population, those interviewed were not viewed as representative of the whole population and no statistical analysis was undertaken. The value of their narratives was to allow themes within the data to emerge, which could be generalised to theory (Bryman, 2008). Although both Bryman (2008) and Guba and Lincolns (1995) stress the importance of revealing 'multiple accounts' of the social world, importance was also placed on the analysis of the single outliers within the data.

The reporting of each data set – value, hazard and vulnerability took the same format. The frequency distribution of the answers was provided, followed by a discussion of both the highest frequency answers as well as the outliers. Themes of discussion were supported with quotations used to explore the small-scale variances within the individual responses.

Primary discussions were then backed up by data from the community expert meetings and community focus groups. Finally data from the expert interviews was used to provide an independent view of the issues raised in an attempt to provide context and further detail.
All interview scripts were coded so that interviewees could remain anonymous. Where codes are absent, these represent responses from within the household interviews data. Quotes used from community expert interviews, community focus groups and expert interviews are identified using a series of codes as identified tables 3.6, 3.7 and 3.8.

Community expert codes are a combination of the first three letters of the theme they represent and the first three letters of the community name: e.g. HeaMap is the code for Health representative in Mapachico. Community focus group codes consist of a combination of the community name abbreviation and CFG (community focus group) e.g. MapCFG is the code for Mapachico Community Focus Group. External expert codes consist of a combination of an abbreviation of the theme they represent and the organisation that the individual represents e.g. EdUoN is the code for Education representative University of Nariño.

Table 3.6 Community expert interview codes

Health	HeaMap	HeaGen	HeaNar	HeaLF	HeaCon	HeaMap
Faith	FaiMap	FaiGen	FaiNar	FaiLF	FaiCon	FaiMap
Agriculture	AgMap	AgGen	AgNar	AgLF	AgCon	AgMap
Education	EdMap	EdGen	EdNar	EdLF	EdCon	EdMap
Emergency services	EmMap	EmGen	ENar	EmLF	EmCon	EmMap
Leadership	LeadMap	LeadGen	LeadNar	LeadLF	LeadCon	LeadMap

Table 3.7 Community focus group codes

Map	**Gen**	**Nar**	**La Flo**	**San**	**Con**
MapCFG	GenCFG	NarCFG	LFCFG	SanCFG	ConCFG

Table 3.8 External expert codes

	University	**Government**	**Private**	**NGO**	**Independent**
Education	EdUoN	EdGov	EdPri	EdNGO	EdInd
Culture	CulUoN	CulGov	CulPri	CulNOG	CulInd
Business	BusUoN	BusGov	BusPri	BusNGO	BusInd
Economics	EconUoN	EconGov	EconPri	EconNGO	EconInd
Agriculture	AgrUoN	AgrGov	AgrPri	AgrNGO	AgrInd
Water	WatUoN	WatGov	WatPri	WatNGO	WatInd
Environment	EnvUoN	EnvGov	EnvPri	EnvNGO	EnvInd
Faith	FaiUoN	FaiGov	FaiPri	FaiNGO	FaiInd
Transport	TraUoN	TraGov	TraPri	TraNGO	TraInd
Health	HeaUoN	HeaGov	HeaPri	HeaNGO	HeaInd
Welfare	WelUoN	WelGov	WelPri	WelNGO	WelInd
Emergency Planning	EPUoN	EPGov	EPPri	EPNGO	EPInd

3.12 Positionality and reflexivity

In social science research Bryman (2008) argues that it is essential to acknowledge the influence of the context of the study and the people within it on the methodology used. This was particularly relevant to the study of the Galeras communities where a great deal of sensitivity was required

given the scenario surrounding the Declaration of Disaster and the relocation program, which has in part already been discussed in this chapter. It is also important to reflect and acknowledge specifically upon the positionality of myself and the research team and the influence this had on the subjects of our study (Sultana, 2007).

As a blonde, western female accompanied by another blonde western female field assistant, it was always apparent to ourselves and the community that we were very much 'the outsiders', not belonging to the different groups being studied (Bartunek and Reis Louis, 1996). We were neither from communities living on Galeras, Colombian, indigenous nor from farming backgrounds. Although the rest of the research team were from the same municipality and spoke the same language, differences in ethnicity, education, class and the fact that they were from the city and not Galeras made them outsiders too. This led in turn to a number of occasions throughout the four month period, of experiences of discomfort, tension, fear and distrust, not only felt by myself and the team but also it appeared by the community members themselves when liaising with us. Over time it became apparent that these feelings were not just driven by our western, white profiles but by our perceived roles as 'the scientists' or worse 'the volcanologists'.

The situation at Galeras during the time of the fieldwork was one of great tension. Ten years had passed since the original passing of the declaration of disaster and people were still living with the prospect of having to be moved from their communities. In objection to this some members had hired a team of human rights lawyers to represent them and in addition had also stopped engaging in community meetings with the government and associated organisations. As a result favour towards the volcanologists, disaster managers and anyone associated with them appeared considerably low and in some cases a clear disdain was apparent.

In conducting research in the communities of Galeras, many community members assumed that you must be interested directly in the volcano or be associated with the relocation program. On meeting people, many individuals' first lines of conversation were based on persuading the research team that the volcano was not dangerous. Sometimes however this insightfulness manifested into anger, which was at times quite intimidating such as at the Nariño community focus group meeting where one individual began shouting 'what are you going to do for us?'

Originally aligned with the University of Nariño, it quickly became apparent that many of the Galeras community members were fed up with the way in which researchers from the institute had conducted research but failed to present back the research findings. Respondent fatigue, a well documented phenomenon where participants become tired of being interviewed either in a singular interview or by multiple different researchers (Ben-Nun, 2008) was also identified within

participants as a result of other research teams having come to Galeras to discuss their perceptions of the dangers of the volcano. In order to deal with the mistrust and anger that had developed from this it was essential to maintain neutral and to assert independence from the other institutions and volcanologists. The primary researcher was thereafter identified as a PhD student in environmental management from the University of York in England and all research assistants identified as being research assistants to a PhD study being conducted by the University of York in England. When asked if we were working in collaboration with the University of Nariño or any other institute we affirmed that although we had had discussions with them this research was being conducted independently.

Honestly and openness with the public remained at all times a key focus, as the first responsibility of the research was towards the research participants (O'Reilly, 2012). It was essential that participants were given the choice at all times whether to engage or not with the research. Therefore in order to allow participants to make the most informed decision it was ensured that they were provided with as much information about the research as possible and that all questions that they asked were answered in a truthful manner. The only exception to this rule was when questions were asked regarding another persons responses. At these times it was highlighted that all responses were anonymous and therefore could not be discussed.

The research was described as a study of people's lives living on the volcano, what benefits were gained and what challenges they faced. Many times in response to the description of the study people began to argue the safety of the volcano and the wrong beliefs of the volcanologists and risk managers. In these scenarios we aimed to remain neutral in our discussions and highlighted our independence from other scientists working in the region. However the association that the public made of the research team working in collaboration with volcanologists and risk managers at times also presented a number of challenges. On one occasion during the scoping trip the indigenous leader of Genoy asked myself and another researcher to sign a document saying that we believed the volcano to be safe. Our decline to sign the paper was again met with frustration by the leader, which threatened to destable future opportunities to talk with him. In this case we had to argue that we were not volcanologists and therefore were not experts in the activity of the volcano.

As the research group was under considerable scrutiny at all times, we endeavoured to take every opportunity to present a positive image and build trust. We always tried to show an appreciation of people's time, organising our work around their schedules and not over staying our welcome. We also spent a lot of time within the communities outside research times, taking part in community activities and celebrations, eating in local restaurants, buying from shops, using public transport, and attending council meetings in order to give people the opportunity to get used to us and give

them the opportunity to ask us questions. In addition when we were invited to events we always tried to attend. At no point did we become ‘insiders’ during our research but we eventually appeared to be largely accepted and at times embraced.

3.13 Summary

This chapter showed the rationale and the challenges faced in the design of this research in order to generate and collate the data required for the research questions. Chapters four, five and six will now present the empirical findings of the data.

Chapter Four:

The ecological and socio-economic context of social vulnerability in Colombia

A coffee plantation on the slopes of the Colombian Andes (Britannica online, 2015)

4.0 Introduction

As was outlined in chapter one, the contextual characteristics of a region are important in determining the influences of social vulnerability from which risk can emerge, as the social, economic and political aspects of a region influence the choices that communities have to build their livelihoods. This chapter examines the contextual characteristics of Colombia, the country of location for the empirical research of this study. This chapter will examine the countries natural environment, its people, their livelihoods and economy, the infrastructure, social and environmental issues, the impacts of natural hazards and the Colombian strategy for managing risk.

4.1 Climate and resources

Colombia is situated in the northwest of South America between latitudes 12°N and 4°S, and longitudes 67° and 79°W. It is bordered by Venezuela, Brazil, Ecuador, Peru, The Caribbean Sea and The Pacific Ocean (World Bank, 2010). The country is divided up by the Andes mountain range, which enters Colombia from Ecuador and splits into three sub-chains know as the western, central and oriental cordilleras. The 'Cordillera central' is the highest range rising to 5,800m (McCourt et al, 1984).

Due to principal differences in elevation across the country, climate and precipitation vary significantly. The country divides into four main climate zones; the tierra caliente, (hot land) below 1,000m in elevation where temperatures range between 24°C and 38°C; the tierra templada (temperate land) between 1000 and 2,000m where temperatures fall between 17°C and 24°C and the tierra fria (cold land), between 2000m and 3000m where temperatures range between 12°C and 17°C. Above 4,000m is the tierra helada (ice land) where there is near permanent snow and ice (World Bank, 2010). There is very little annual variation in these temperatures, but there are two distinct seasons of high and low rainfall (Condesan, 2012).

Colombia ranks 4th in the world for the largest amount of available surface water; its high precipitation rate a product of its geographical location in the equatorial zone and in the Intertropical Convergence Zone (Guitierrez and Dracup, 2001). Rainfall is heaviest on the West cost and in the Andean areas of the country where rain and dry seasons alternate every three months (Condesan, 2012). In the Northern areas only one long rainy occurs from May through to October. The wet season brings some of the highest rainfall in the world (Condesan, 2012) on average 3000mm annually compared to a global average of 900mm (Guitierrez and Dracup, 2001). In lowland areas close to the Pacific rainfall greatly exceed the country's average, annually

receiving around 7600mm (World Bank, 2011). As a result of such high precipitation the volume of water runoff is six times greater than the world average water supply, with Colombia having around 1000 permanent rivers compared to the whole continent of Africa of which only has 60 (Vallejo, 2011); its largest being the Cauca, Guarucate, Caqueta and Magdelena (Guitierrez and Dracup, 2001).

Defined by the many variations in climate, topography and precipitation, Colombia divides into six main ecosystems; the Andes mountains, the Amazon rainforest, tropical grassland (llanos), the Pacific and Caribbean coastal regions and the oceanic islands (Etter et al, 2006). Over fifty million hectares of forestry exist in Colombia, with the area of continuous forest, one of the largest in the tropics, covering 49% of the country (Achard et al, 2009).
Categorised as 'mega-diverse', Colombia is one of the most ecologically diverse countries in world (Bueno et al, 2011); its ecosystems home to 15% of the worlds species including; 51,220 species of plants, 1,821 species of birds, 623 species of amphibians, 467 species of mammals, 518 species of reptiles, and 3,200 species of fish (World Bank, 2011).

Colombia is also a source of an abundance of minerals and other geological materials. It has one of the largest coal reserves in the world (Huertas et al, 2012) as well as reserves of petroleum, oil and natural gas (Eia, 2015). Other minerals present include gold, silver, nickel, copper, uranium, platinum and iron (CIA, 2015). Colombia is also renowned for having one of the world's richest and purest deposits of emerald (Ottaway et al, 1994).

4.2 People

Colombia has the third largest population in Latin America with approximately 46 million people recorded in 2013 (Alvarez-Berrios et al, 2013). The highest population densities are located in urban centers distributed throughout the Andean regions and along the coastal areas (Condesan, 2012). Over the last 60 years urban populations have increased from 4.4 million to 34.7 million and today 30 cities have populations of 100,000 or more (CIA, 2015). The largest populations are found in the cities of Bogota, Medellin, Cali and Barranquilla (The World Bank, 2011). A main contributor to this growth has been the significant numbers of people being internally displaced (IDPs) from rural areas because of conflict, estimated to account for approximately 6 million people, one of the largest populations of IDP's in the world (UNHCR, 2015).

The population of Colombia is, after Brazil, the most ethnically diverse country in the Americas. This is due to its rich cultural heritage of conquest from Europe and the Middle East and other

Latin American countries, as well as the introduction of African slaves in the 1800's (Hudson, 2010). Originally inhabited by the Musica, Quimbaya and Tarona indigenous groups, today 1,450,000 descendents of those groups, 3.5% of the general population, live in 567 reserves throughout the country (IWGIA, 2015). In 1991 the political constitution of Colombia recognised the fundamental rights of the indigenous peoples of Colombia and the ILO Convention 169 was passed (IWGIA, 2015).

4.3 Livelihoods and economy

In 2014 Colombia was calculated to have the third largest economy in Latin America and the fastest growing major economy in the western world behind China, with growth mainly driven by construction (17.2%), services (6.3%) and agriculture (6.1%) (Anon, 2014). Employment was mostly in the service industry (62%) but also industry (21%) and agriculture (17%) (CIA, 2015). Unemployment in 2014 stood at 9.2%, one of the highest in Latin America (CIA, 2015). Despite its fast growth, economic development has been constrained by inadequate infrastructure, inequality, poverty, narco-trafficking and civil security issues (CIA, 2015).

Historically Colombia has been a rural agrarian economy (De Janvy, 1981). As a result of its diverse climate and topography, the cultivation of a wide range of crops has been possible (OECD, 2015). It produces the vast majority of its domestic food requirements, including corn, yucca and plantains and supplies the export market with a number of commercial crops including coffee, sugar and bananas (OECD, 2015). Traditionally, agriculture has been undertaken by small-scale farmers up in the higher slopes of the Andes in temperate climatic zone. Despite there being large amounts of highly fertile flat valley floors available, these have traditionally been used to graze dairy and beef cattle (Reinhardt, 1988). This has left only the more rugged, upslope terrain for cultivation. As a result of only small-scale plots being available and the rugged topography meaning machinery cannot be used, productivity levels have been constrained (Rodriguez, 2011)

Throughout the 20th century many farmers were persuaded by the government to leave their 'small and inefficient' farms and move to the urban areas, resulting in rapid urbanization. At the start of the 21st century only 22.7% of the workforce remained in agriculture, with many having re-established themselves in the growing construction and service industries (World Bank, 2011). Those that remain in farming face a number of challenges which have led to continuing reductions in employment and an increase in levels of poverty. Agricultural policies regarding access to land, markets and agricultural services have been criticized for favoring the large-scale producers who only employ a few workers. (Heath and Binswanger, 1996, World Bank 1994). Credit policies have

also been accused of discriminating against small-scale farmers with only a third in the 1990's able to obtain loans (Heath and Binswanger, 1996).

Earnings have also continued to decrease for farmers since they began to grow cash crops and engage with market economies (Heath and Binswanger, 1996). Coffee, grown at altitudes between 1,300m and 1,800m, has always been the most important commercial crop grown in Colombia; in 2004 it accounted for approximately 40% of the land used for permanent crops. However, fluctuating market prices plus a severe drought in 1992 had led to a continuing decrease in production, resulting in Colombia's share of total exports dropping from 40-65% in 1986 to 8% in 2000 (Heath and Binswanger, 1996). Despite this, Colombia still remains the world's single largest coffee grower, providing 13-16% of the world's total production.

Other significant non-agricultural economies of the last decade include mineral export and construction. Colombia's main export, petroleum, accounts for 45% of the countries total exports, it is also the world's fourth largest exporter of coal and the fourth largest oil producer in Latin America (CIA, 2015). The construction industry is currently going through a period of escalation, growing at a rate of 20% annually due to the government's investment in transport infrastructure. Projects include the building of extensive additional road networks, the development of a railway system, the improvement of port facilities and the expansion of Bogota airport (Francisco Polo, 2014). More recently there has been a significant development and steady growth of the tourism sector as a result of decreases in levels of violence across the country. In particular, ecotourism has begun to prosper, taking advantage of the rich and varied ecosystems and biodiversity that the country has to offer (Ramírez, & Pinzón, 2015).

4.4 Infrastructure

Colombia has historically faced a number of challenges from weak infrastructure due to both constraints placed on it by its geography and the lack of funds available to be able to cover the significant costs involved. Colombia's mountain terrain has greatly impeded the development of the countries transport systems (Nations Encyclopaedia, 2015). Although expansion of a range of infrastructure is currently being undertaken, up until recently significant time constraints were placed on those travelling by road due to the need to negotiate its various mountain ranges and the significant lack of paved routes available. Whilst highway links are comparatively well invested in linking the ports of the Atlantic coast with the border countries of Panama and Venezuela, the smaller road networks, particularly within the rural areas, have not been able to adequately provide

for peoples needs. Out of a total of 70,000 miles of roads only 14000 miles are paved (Nations Encyclopaedia, 2015).

As a result of the poor land networks, domestic air travel within Colombia has developed at a rate significantly higher than in neighbouring countries. Whilst a journey by road from the capital of Bogota to the city of Medellin takes 24 hours, a flight in comparison covers the same distance in half an hour. There are 1,101 airports across Colombia receiving both passengers and cargo, ten of which are international (Nations Encyclopaedia, 2015).

Yet whilst the mountainous terrain has been a serious constraint to transportation and communication it has enabled, along with the countries high density of rivers, the advance and expansion of Colombia's hydroelectric power network. Despite Colombia being South America's largest coal producer the large majority of its electricity, 63%, is generated by hydroelectricity (Nations Encyclopaedia, 2015). This is due in part because of the severe impact of the country's civil conflict on the energy sector in the past thirty years. Many attacks have been made on oil and gas pipelines; electricity transmission towers and other infrastructure, which has caused repeated power outages in many areas of the country (Fossil Energy International, 2003). Potential energy options also include wind power, solar and geothermal, although the economic feasibility of wind power and the technology development required for the extraction of geothermal energy are currently being debated (Fossil Energy International, 2003)

The weaknesses of the energy sector have had a direct impact at the household level. In rural areas, particularly in small communities, people have had to deal with the many difficulties faced by not having access to gas pipelines or mains electricity. Although hydroelectricity has provided access to electricity where there was none before, problems with installation and a lack of servicing and repairs has meant that power is often unpredictable and only accessible for a small number of hours a day. This in turn has led to further problems for education, where power outages have often led to lessons being cut short, and health care services where a lack of refrigeration has meant essential vaccines have not been able to be stored (USAID, 2014).

4.5 Social and environmental issues

Despite being categorized as an upper middle country by the World Bank (2011), with an annual GDP of US $234 billion, Colombia is recognised as a relatively poor country, ranking 98 of 187 in the Human Development Index (HDO, 2013), and with one of the highest levels of inequality. Although poverty levels have dropped in recent years, 56% of the population is still classed as

living below the poverty line (World Bank, 2011) with 17% classed as living in extreme poverty (UNDP, 2011). In rural areas where three quarters of the poor reside (World bank, 1994), inequality rises, with an average of 74.99% of people living in poverty (UNDP, 2011). Development levels are, however, on the increase. Standards of health have reportedly improved significantly in the last thirty years with the introduction of health subsidies, and average life expectance is now estimated at 75 years (CIA, 2015). Education now receives some of the highest public spending and 92.3% of people over 15years are now literate (CIA, 2015).

One of the greatest challenges to development has been the civil conflict and resultant forced migration, which has taken place across the country. Since its independence from Spain in the 19th century, Colombia has been a site of multiple periods of civil conflict due in large part to a history of unresolved land issues and an unequal distribution of natural resources (Ibáñez and Vélez, 2008). The current period of conflict began in the 1960s with an insurgency of left wing guerillas. In response, Colombian landowners and members of the armed forces established paramilitary groups in opposition (CJA, 2014). In the 1980's the growing cocaine trade provided funding to the illegally armed groups allowing them to expand. A 'triangulated war' between the guerillas, paramilitary and government forces followed, forming what has today become one of South America's longest running conflicts (CJA, 2014). To date over 70,000 civilians have been killed and more than 3 million have been displaced (CJA, 2014).

The impacts of the conflict have been widespread across the whole country. In 2005, 94% of municipalities were either expulsion or receptor sites (Ibáñez and Vélez, 2008). Direct impacts on communities have differed between those in urban and those in rural areas. Whilst those in urban areas have reportedly suffered more murders, those in rural areas are said to have experienced more armed confrontation, massacres and forced displacement (Ibáñez and Vélez, 2008). These high levels of violence have limited rural development in many places, especially in areas where large armed groups are located (Condesan, 2012). Many farmers have stopped cultivating traditional crops, moving to marijuana and coca plants in order to secure higher incomes. Some have moved into the production of cocaine in order to increase their income even more (Heath and Binswanger, 1996). Government programs to destroy illegal crops using aerial fumigation have also had a significant impact on farmers, destroying assets, impeding income, and causing a range of health impacts as a result of the inhalation and digestion of the chemicals used (Reyes and Bejarno, 1998). The intensification of conflict and between farmers and armed groups and violent land appropriation and forced recruitment of children into illegal armed groups, has resulted in one of the world's largest populations of displaced people (Reyes and Bejarno, 1998). Nearly 7% of the countries total population (VSCR, 2006) has moved, 41% of which are women and 36% children (Ibáñez and Vélez, 2008).

The conflict and its associated drug production have also had a large impact on the environment. Displacement, the inability of the government to be able to enforce environmental policies, land acquisition and aerial fumigation, has all led to the destruction of large amounts of the countries natural resources. This has not only had a negative impact on the functioning of the natural ecosystem but also on the large amounts of people dependent upon them for livelihoods strategies. The forced displacement of large number of indigenous farmers from the Andean slopes has led to the loss of their traditional small scale, more sustainable, cultivation practices (Heath and Binswanger, 1996). These have been replaced by: deforestation and illegal logging, single cash crop plantations, and marijuana and coca cultivation, all of which have put a large amount of pressure on the fragile slopes (Posner, 1981). Each year an average 2000 km^2 of forest, the majority primary, has been lost to deforestation along with the high levels of biodiversity associated with them (Mongabay, 2006). At least 73% of this has occurred within the Andes ecosystem with an estimated 100,000 acres or more in total having been allocated each year to grow coca, marijuana and opium (Iyyer, 2009). Paramilitary organisations have also been associated with the expansion of large-scale palm oil and sugar cane production grown on technical plantations, which have been accused of exploiting land belonging to Afro-Colombian communities (Iyyer, 2009). Having collectively become the largest landowners in Colombia, the drug traffickers have transformed 20% of the Amazon rainforest into cattle ranches, which require large amounts of herbicides, pesticides and fertilizers, which in turn pollute the rivers and streams through runoff (natureVest, 2015).

Deforestation has also been caused in part by government policies. In the early nineties the National Planning Department (DNP) allocated $250 million for a large-scale infrastructure development program named Plan Pacifico. Although supposedly promoting sustainable development (Brechin et al, 2003) it was largely developed to raise revenue from the export of natural resources in order to develop the economy (Iyya, 2009). In recent years ambitious expansion of the countries infrastructure network has been undertaken involving the construction of road and rain links, hydroelectric and energy plants and the installation, of oil pipelines, a large majority of which has occurred within the rainforest (WWF, 2015).

Despite its many environmental and social impacts, deforestation has once occurred led to the further deterioration of the environment, which has creased a number of hazards to both human life and assets. The removal of trees and their root systems has increased the risk of soil erosion and landslide events and has affected the water table which helps to regulate local climate processes that control flood and drought cycles. In areas where forest cover has been lost, rapid runoff has caused rivers to rise leading to the flooding of villages and cities flooding (Iyya, 2009, Mongabay, 2012).

4.6 Natural hazards and risk management

Colombia is distinguished by its diversity of geology, hydrology and climate. But while this diversity has been the opportunity for many people's livelihoods to develop, it has also been the threat to them as well. Colombia has one of the highest recurrence rates for natural disasters in the world with an average of two a year, second only to Brazil in the South American sub-region (Charveriat, 2000). It has the tenth highest economic risk to three or more hazards in the world, the product of its physical characteristics and the location of many of its people and economic assets being in the mountainous areas of the country; 84% of the population and 86.6% of its assets are located in areas exposed to two or more natural hazards (World Bank, 2010). In the past 30 years Colombia has experienced 6 major earthquakes, 4 volcanic eruptions, annual large-scale landslides and recurrent extensive flooding (World Bank, 2013). Over the past 40 years the impact of natural disasters has killed more than 100,000 people, affected more than 14 million and led to losses of US$7.1 billion (World Bank, 2013). The regularity of disaster recurrence and Colombia's socio-economic conditions have led to a continuous state of risk accumulation presenting a challenge for the countries sustainability, delaying its progress to reach its social welfare goals (World Bank, 2011).

The regularity and rise in the number of disasters has been due to increasing levels of vulnerability caused by unplanned urbanization, inadequate environmental management and a lack of adherence to building codes in areas exposed to hazards (World Bank, 2013). Climate change has also in part exacerbated some of the trends (World Bank 2013). The large increase in people moving into the cities over the last fifty years, from 39% in 1950 to 73% in 2010, has led to extensive areas of unplanned urban growth (World Bank, 2010). These areas often lack basic social services and have established poor rates of unemployment (World Bank, 2010).

Twenty eight percent of Colombia is exposed to high levels of flooding, predominantly in the mountainous areas, low-lying watersheds and along the coast (World Bank, 2010). The floods that occurred between 2002 and 2009 had the highest number of deaths and greatest economic impact of any events preceding them, with a total of 2.9 million people affected and a cost of US$10 million (World Bank, 2013). In La Nina periods flooding increases, such as between 2010 and 2011, when 3.5 million people were affected, the majority living in the lowest income quartiles (World Bank, 2013). During this event an estimated 3,250,000 hectares were affected (World Bank, 2013). A combination of heavy rainfall, varied and dramatic mountain topography and deforestation often leads to landslides during and post flooding (World Bank, 2011). Landslides are the most frequently occurring disasters in the Colombia (Dilley et al 2005), with 31% of the

territory exposed to high and medium scale events (OSSO, 2011). Colombia has the highest landslide rate in South America in terms of fatalities per year per square kilometer (World Bank, 2011)

Climate change has been reported to have exacerbated flooding and landslides in Colombia, with an increase in weather events such as El Nino and La Niña having had serious impacts on the countries agriculture. The La Niña event that occurred between 2010 and 2011 impacted an estimated 3.5 million people, the majority living in the lowest income quartiles (World Bank, 2013). During this event an estimated 1,324,000 hectares of agricultural land were affected (World Bank, 2013) resulting in losses of approximately £8.6 billion, the greatest impact to the agricultural sector by hydro-meteorological phenomena experienced in Colombia (The World Bank 2011). The National Federation of Coffee Growers reported 190,580 hectares of crop damage to 221,567 coffee producers (The World Bank 2011). In addition to crops, livestock were also affected. 1.5 million cattle could not be moved away from the flooding and suffered nutritional deficiency as a result of damage to their pasture (World Bank, 2011).

Positioned on the boundary of three tectonic plate margins, the Nazca, Caribbean and American, Colombia is a site of much seismic and volcanological activity. Approximately 36% of the territory is exposed to high seismic activity (OSSO Corporation, 2011) yet due to population distributions, the majority of Colombia's population, including all major cities, are said to be located within areas of high or very high seismic activity (World Bank, 2010). The greatest earthquake to have occurred in Colombia happened in Armenia in 1988, registering 6.4 on the Richter scale. It affected 18 towns and 28 villages and resulted in the death of 1000 people. Due to the large numbers of old buildings in the region, built unplanned and without building code regulation, about 60% collapsed (Lora-Suarez and Marin-Vasquez, 2002).

Located within the Ring of Fire, Colombia is the location of 15 major volcanoes, six of which are classed as very active; Nevado del Ruiz, Galeras, Dona Juana, Purace, Tolima, Huila. In 1985 Colombia suffered what Voight (1990) described as the worst volcanic mudflow in historic time due to an eruption of Nevado del Ruiz, causing an estimated 25,000 people deaths in the town of Armero and 7,700 people made homeless. Vought's (1990) damage assessment described large-scale devastation encompassed all roads, bridges, telephone lines, power grids and aqueducts in the area. Damage was also incurred to 50 school, 2 hospitals, 5,092 homes, 58 industrial plants and 343 commercial establishments. The local agricultural economy was also heavily impacted with a loss of 3,400 hectares of agricultural land, 60% of the regions livestock, 30% of its grain and rice crops and half a million bags of coffee. The total financial costs of damage were calculated in excess of a US$1.5billion (Charvéria, 2000).

In the last decade Colombia has been described a ‘leader’, ‘pioneer’ and ‘role model’ in risk and disaster management in Latin America (World Bank, 2011), having established what the UNISDR (2013) describes as a ‘cutting edge’ institutional and legal framework for Disaster Risk Reduction. Its success, the World Bank (2011) sets out, is anchored in its investment in; structural measures, risk assessment, early warning and emergency response, institutional support and financial and fiscal measures at the national and municipal levels. In their 2014 World Development Report entitled “Risk and Opportunity – Managing Risk for Development”, the World Bank (2014) outlined Colombia’s history of risk management measures as well as their current approach.

The report identified Colombia’s long history of organising and designing risk management measures, starting in 1988 in the aftermath of the Nevado del Ruiz disaster with the creation of Law 46 which established a national disaster plan and the National System for Disaster Prevention and Response (SNPAD). *The laws main purpose was to ‘define responsibilities and functions for all stakeholders involved in disaster risk reduction, management, reconstruction and recovery issues including public, private and community based organisations and also including sectoral committees such as on seismic and volcanic risks, technical risks and a hydro-meteorological network’* (Charvéria, 2000).

In 2012 Law 1523 formed a new National Policy and National System for Disaster Risk Management in response to the Hyogo Framework for Action (IFRC, 2012), representing what the World Bank (2014) referred to as a ‘paradigm shift’ in which disaster risk management was recognised as part of the development process. It focused on improving disaster response mechanisms but also on disaster prevention and preparedness, risk reduction and risk knowledge and provided stronger incentives for local governments to invest in risk reduction and to strengthen technical assistance (UNISDR, 2013). The plan stressed the importance of capacity building and risk reduction and the requirement of ‘full coordination’ and ‘involvement’ at department, district and municipal levels (IFRC 2012). It also recognized, for the first time in Colombian risk management policy, that ‘local communities must be engaged’ when disaster reduction plans or response mechanisms are being developed (IFRC 2012). Finally, the plan outlined special conditions that would apply in the event of a disaster, with particular powers that would relate in part to the relocation of settlements and compensation credit for affected individuals that would be applied in order to ‘assist affected areas in recovering from disaster’ (IFRC, 2012).

Since 1997 it had been a requirement of the SNPAD that land use plans be developed at the municipal level that consider the location of local hazard for the purpose of disaster prevention. One risk prevention strategy identified was to resettle any at risk population located within the

'high hazard zones' if the risk could not be mitigated by any other means such as building codes or if those other means were costlier than resettlement.

4.7 The Challenge of the Galeras case study

Mount Galeras is situated within the department of Nariño in the south west of Colombia close to its border with Ecuador. It is an andesitic strato volcano, 4270 meters above sea level (Artunduaga and Jimenez, 1997). It is located on the northern section of South America's 'avenue of the volcanoes', forming part of the Andes mountain chain which runs 8000 kilometers down the western side of South America (Kilburn and Maguire, 1997). Galeras is one of Colombia's most active volcanoes, characterized mainly by explosive vulcanian eruptions (Artunduaga and Jimenez, 1997).

During the 1990's, Galeras along with 15 other volcanoes was designated a Decade Volcano by the International Association of Volcanology and Chemistry of the Earth's Interior (IAVCEI). This was in light of its history of high activity and its proximity to over half a million people living in either small towns and villages on it flanks (80,000 people) or in the city of Pasto at its base (450,000 people) (IAVCEI, 1994). Since the establishment of Pasto 460 years ago, Galeras has had a number of eruptive periods, with an average recurrence of 60 years between each event (Cardona, 1997). During this time eruptions have ranged from weak fumerolic activity and emissions to larger explosive events, violent shockwaves, ash falls and ballistic projectiles (Cardona, 1997).

In 1988, the Sistema Nacional para la Prevención y Atención de Desastres (SNPAD) requested the Colombian Institute of Geology and Mines (INGEOMINAS) to start studying Galeras in order to establish its eruptive history and hazard zones and to produce an accurate forecast of the possibility of an eruption and its expected magnitude (Cardona, 1997). SNPAD requested the production of a preliminary hazard map to enable an assessment of other tasks in disaster preparedness such as urban planning. A hazard map with 5 concentric hazard zones was formulated by calculating hazards in a deterministic way (Cardona, 1997).

In 1989 Galeras began an eruptive crisis. Prompted by the fear of another disaster like the 1985 eruption of Nevado del Ruiz, a large national, regional and local response was mobilized. Much criticism of the response has been made retrospectively (Cardona, 1997). This included; the Mayor encouraging voluntary preventative evacuation, based on incorrect information, which resulted in high level of public panic; the national platform for Disaster Prevention in Bogota (DNPAD) unilaterally declaring an orange level warning without having sought advice and clarification from

regional and local levels, leading to disagreement and confusion as well as sensationalism in the media; and risk communication being delivered using a video of Mt. St. Helens, a different type of volcano to Galeras, generating alarm and fear within the public (Cardona, 1997).
In 1993 an unexpected eruption killed 6 volcanologists and 3 members of the general public who were in the crater taking samples during a field trip (Baxter and Gresham, 1997), raising the volcanoes profile within the international community. These were the first deaths that had been attributed directly to Galeras' eruptivity.

In 2005, Galeras entered another period of activity. As a result of continued activity a Declaration of Disaster, Decreto 4106, was declared, the first time such a declaration had been made in Colombia before a disaster had actually occurred (Dorado, 2008). In response DNPAD started a program called Processo Galeras to facilitate emergency shelter construction and to resettle those at greatest risk (Dorado, 2008). Using the INGEOMINAS hazard map created in the 1980's, 10,295 people were identified as living in the high hazard zone and 4518 identified living in the medium hazard zone (OSSO Corporation, 2010), therefore qualifying for relocation.

4.8 Summary

This chapter has outlined that Colombia is rich in a variety of natural resources, many of which have underpinned both community livelihood strategies and national economies. However, unsustainable land use practices have led to considerable environmental degradation, which in turn has resulted in increased levels of hazard exposure to resident populations. In addition, high levels of civil conflict have developed from the inequitable distribution of these same natural resources, negatively affecting employment rates, wellbeing and security. While Colombia's natural processes have presented opportunities for livelihood security, they have also threatened to eradicate them. Galeras provides one such example, presenting a paradoxical scenario, where volcanological processes have created a diversity of landscapes and resources on which many have built their livelihoods. Yet in doing so and anchoring themselves on the volcano they have exposed themselves to high levels of risk. On paper Colombia's risk management plan aims to merge policies for disaster risk reduction and sustainable development, yet its focus on relocation will aim to remove people from the location of their livelihoods, potentially increasing their levels of vulnerability. The next three chapters present the results of my research, which aims to identify people's links with their volcano and the challenges they face in living alongside it.

Chapter Five:

Deconstructing Value

A view of the landscape on Galeras (Author, 2012)

5.0 Introduction

As described in the introduction to this thesis, each of the three data chapters presented is a deconstruction of a separate component of volcanic risk, as identified in the literature review presented in chapter three. This chapter focuses on exploring the 'value' component at the grassroots level. This was explored using the following six lines of enquiry: quality of life, motivation to reside, income, land use, direct benefits and future potential. This results section explores each of these in turn, presenting the data and later in the discussion cross-referencing it to additional external literature.

The data is presented by firstly discussing the themes raised in the household interviews where the data has been quantified through primary and secondary coding and frequency analysis. Secondly it is cross-referenced with the data from the community focus groups and community expert representatives. Thirdly, when required, the knowledge and opinions of external experts are used to provide context and explanations

5.1 Theme 1: Quality of life

The first of the six lines of enquiry focused on exploring individuals' perceptions about the 'quality of life' within their given case study region on Galeras. Having asked the question, what is the quality of life of people living in Genoy, for example, the interviewing team recorded the comments made, listing them under 'positive', 'neutral' or 'negative' as they perceived them to be said, as taught in the training sessions given to all research assistants prior to the field work (see chapter three).

After transcription all responses were coded in order to group and analyse comparable answers. For this analysis, a coded response is defined as one topic being raised by the interviewee within the discussion of the question, regardless of how many individual statements on that particular topic were made. A frequency of one was recorded when each topic was raised by the respondent, regardless of how many individual comments on the topic were made. For example, if one respondent made three comments in regard to the security of the area, such as 'no robberies', 'safe', and 'no danger', this was recorded as a frequency of one under the topic of security. Collectively therefore in the quantitative frequency analysis, a frequency of five represents five individual respondents who have made comment on a particular subject.

In total, 329 individual responses were recorded, as either positive or negative, during 91 household interviews, comprising of 208 positive statements and 121 negative statements. Ten

individuals did not provide any ‘positive’ answers and 18 did not provide any ‘negative’ answers. From the initial 91 transcribed household interviews, a total of 23 coded themes emerged. Which comments were attributed to each code will be explained and explored in the discussion below.

In this analysis of ‘Quality of Life’, these primary codes were then secondarily coded as ‘Economic’, ‘Social’ or ‘Environmental’. Table 5.1 shows both the primary and secondary coding as well as their frequencies.

Table 5.1. Coding and frequency of quality of life responses from the household interviews (n=91).

Secondary coding	Aspect (Primary coding)	Positive Perception	Negative Perception
	None	10	18
Social	Tranquility	50	0
	Community	33	4
	Safety	25	0
	Health	4	2
	Public Services	4	8
	Ancestry	4	0
	Happiness	3	0
	Location	2	0
	Governance	1	21
	Education	0	1
Economic	Employment	15	26
	Agriculture	8	1
	Wealth	5	11
	Cost of living	3	0
	Economy	0	8
Environmental	Eruption	10	16
	Climate	8	5
	Land	7	2
	Aesthetics	7	0
	Water	4	1
	Flora and fauna	3	0
	Light	1	0
	Natural Reserve	1	0

As can be seen in figure 5.1, tranquility (50), community (33) and safety (25) ranked the three highest frequency 'positive' aspects described in the discussion of quality of life, whilst employment (26), governance (21) and the eruption (16) ranked the highest three frequency negative aspects. A comparison graph of positive and negative comments can be seen in figure 4.1 below. The negative aspects identified will be discussed in greater depth in chapter six which is focused on the discussion of vulnerability.

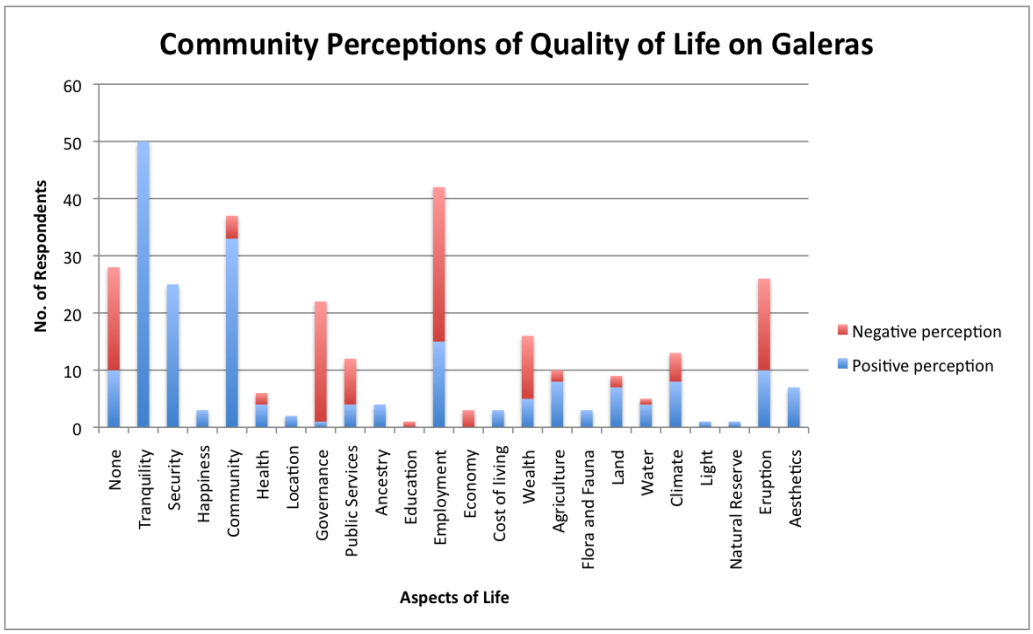


Figure 5.1. Community perceptions of quality of life on Galeras from the household interviews (n=91 interviews).

5.1.1 Tranquility

From the discussions of tranquility**,** it emerged that tranquility was not seen only as being quiet but of being 'calm'. When it was said that the '*town was quiet'* it was in recognition that people were '*living quietly'* together, without conflict, not that they were living in silence. Testimonies of living in '*a peaceful place'*, '*without complications'* were given as a result of the peace between individuals.

The perception of tranquility was also expressed by Mapachico's health representative, who regarded living in Mapachico as '*quiet'*, and in the community focus groups in both Consaca and Mapachico, where participants considered their respective towns to be '*really quiet'* and '*a peaceful place.*

In La Florida, in the community focus groups and community expert interviews, there was emphasis on the overwhelming amount of tranquility of the area, and the influence that that level has had directly on the quality of life of those living there: '*it exudes tranquility'* (LFCFG); '*there is so much peace'* (EdLF); '*the quality of life is good here because there is much peace*' (EdLF).

The leader of Mapachico was keen to highlight that when it is not peaceful this is not due to volcanic activity, as may be presumed, but due to the ongoing government relocation program that

has been in place since 2003 and the opposition that the people have to it, '*the government disturbs the peace*', '*this is usually a peaceful life'*. The conflict is fuelled by conspiracy theories that the resettlement program is not based on the risk of volcanic activity but other drivers such as the government wanting the land for tourism development and mining, '*right now discussions on resettlement seem that discussions are based on political reasons and not the volcano'*.

It appears that a conscious direct trade off has been made by many respondents between wealth and tranquility, with people recognising that they may not have as much money as those living off slope, but that they live in a much more peaceful place: '*we are poor but live in a peaceful town'* (NarCFG); and '*economically it is not optimum but there is a sense of calm'* (LFCFG).

There also appears a direct link between tranquility and the feeling of freedom, as when the community is calm people feel less constricted in what they do, *'I like it here because I feel free. I enjoy the tranquility I've had for many years'*.

The impact of tranquility on both physical and mental health was also recognised by the Nariño health representative who praised Nariño for being '*quiet',* with *'no crime',* with people with *'good health'* because of the *'little psychosocial damage',* and life *'without stress'.*

5.1.2 Community

The second highest-ranking aspect of quality of life was community (33/91), both from a point of view of community cohesion and in direct reference to the characteristics of individuals within it.

The strength of ties between members of the six communities was expressed in terms of '*good relationships*', unity, '*people are united'*, '*solidarity*' and lack of conflict between individuals; '*no problems between neighbors'*, '*life is good with the neighbors'*. The expression of a '*united community '*was further expressed in the Mapachico community focus group.

Social support was expressed as a direct outcome of the cohesion, describing the way in which individuals work as a collective: '*all working together'*,' '*we help each other,' 'people like to help each other',' most people are collaborating'*, '*support among neighbours'*. Participants in the Mapachico focus group described their community as '*people that help each other* '

The leader of Mapachico detailed how the community system in Mapachico, called '*the mingas'* works, taking on the responsibility for providing for the specific needs of individual families;

‘*mingas are the community system when you don’t have something, like water or light’, ‘if the family need water the rest of the community helps to construct pipe systems’*.

Further explanation was given by the Mapachico leader for the need for the community system, pertaining to the low levels of wealth: “*it provides where there is lacking, when you don’t have for daily bread and have difficulties, neighbours help each other”.*

The strength of community cohesion and the willingness to support and help one another is a characteristic that the communities are very proud of having built a self-reliant support network to help themselves, independent of the government or any other organisation, ‘*we depend upon ourselves’*. The Genoy leader described the network as a family, ‘*families co-exist, they have problems but they react as a family to deal with them’*.

Comments made in the Genoy community focus group provided further explanation as to how work is organised between individuals, describing a system of trade, *‘rather than money being paid for individual services, help and favours are used as currency’, ‘we trade favours, we help each other out, I pay you and in the future you help me, they pay for the work with food like potatoes’.*

Participants in the focus group explained that the system of trade not only happens for large scale projects, such as building and harvests, but also for the day to day activities such as the preparation of meals and the care of animals, ‘*they meet each other in order to cook and they share with their neighbors, nothing to pay’, ‘you take care of animals and the next day I’ll help you’.*

The personality characteristics of the community members were described in great detail through the household interviews, portraying a favorable and welcoming image of both individuals and the collective communities: *‘good people’, ‘no bad people’, ‘peaceful people’, ‘cheerful’, ‘kind’, ‘friendly’, ‘people believe in God’, ’hardworking, responsible workers’.*

The honesty and law abidingness of the majority of the community members was seen as a particular strength, that interviewees were keen to express, perhaps given the high level of social conflict and crime elsewhere in Nariño and outer Colombia: ‘*people are very respectful’, ‘they follow the rules of the state’, ‘don’t have a problem with drugs’* and ‘*they are honest’*. These qualities were also highlighted in the Mapachico community focus group, in the declaration that ‘*here we don't have bad people’.*

The community perception of the people of Galeras as hard workers was supported by the La Florida emergency services representative in their description of the people of La Florida as

‘*hardworking’, ‘responsible workers’,* and describing one individual specifically to say that *‘he's never had any government support, everything he's got is from his own sweat’.*

In addition, the La Florida agricultural representative highlighted the community’s motivation to work hard not just for their individual gain but for the good of the whole community: ‘*our people are hard working, they want to improve the quality of life for their people’, ‘they enjoy working’*.

The overall happiness of the people was commented on throughout many of the community expert interviews: ‘*happy community’* (EmLF), ‘*happy people that seek to improve their quality of life for their families*” (AgLF). Specific reference was given to the fact that despite the conflict between themselves and the government in recent years, people had remained happy: ‘*in the midst of the crisis there is still much hope and the young people are happy*’ (EdLF).

Revered throughout each of the case study communities was the fighting spirit of the community members in relation to standing by what they believe in: *’the people are fighters’, ‘fight to recover the indigenous identify’, ‘fight to defend our land’*. Although at the time of the interview people felt there was the need to defend themselves against the relocation program, suggestion was made that these recent battles were not the first the people had encountered, and that their ‘*fighting spirit’* was a due to a history of conflicts as ‘*historically this has been a revolutionary place*” (LeaGen).

Interestingly, both the leaders of Genoy and La Florida respectively, explained that although their fight against the relocation program had been hugely detrimental, their continuing conflict with the government had actually had a positive consequence, as it had led to the communities strengthening their relations with one another: ‘*they have been punished for their decisions, now we are being punished because we don’t want to move, this makes a strong society’*, ‘*La Florida is a good example of a good fight with the government and the unity of the people continues to challenge this*”.

In Genoy this strengthening had led to the reforming of the Cabildo, the indigenous administrative council. The Cabildo leaders considered this to be a great benefit to the community, in that it had given them focus, encouraged them to organise themselves and represent themselves with a collective voice: ‘*the Cabildo helps change the mindset and helped them to improve solidarity to make the decisions to defend the land. The Cabildo has given them the opportunity to participate’.*

5.1.3 Safety

Issues of safety on Galeras would perhaps be presumed to have a negative impact on the quality of life of community members, as it is common to hear volcanoes referred to as threatening life and as the cause of complete devastation. Despite this the perception of 25/91 household representatives was that the communities of Galeras were in fact places of great safety and security in comparison to many others off slope.

Across each of the six case study sites householders repeated the message that none of the social issues present in many others areas of Colombia, and particularly in other parts of Nariño, were indeed an issue on Galeras. Not only was there a lack of guerilla activity but also a lack of localised crime, violence and gang activity: '*here it is safe, not dangerous', 'don't have danger',' don't have violence', 'no conflict between the community,' 'don't have gangs', 'the town is secure', 'here there is no guerrilla', 'no need for police or army'*

Safety was a theme mirrored in both the community focus groups and across many of the community expert representative interviews, *'the life relating to security is good'*, '*here we haven't bad people'*, '*there's no danger, there's security'* (Maps) *'this is a very secure region', 'no violence'* (LeaNar) '*no violence and this is why we like living here', 'we don't have violence between people in the city and between population*' (NarCFG), '*it exudes tranquility, no danger', 'no problem with guerilla', 'no violence, no conflict, no problems with gangs' , 'the common characteristic is a house with open doors, no problem with insecurity'* (LFCFG), '*no crime'* (HeaNar).

Many of the respondents interviewed raised the point that not only did they perceive there to be a high level of safety and security felt across the case study communities, but that it was indeed by comparison far more dangerous to live elsewhere, including the nearby city of Pasto, '*we don't have violence between people like in a city and between population*', (NarCFG), '*young people here are not violent, in the city are violent, not gangsters here '* (EdCon), *'they don't have fear about people here, but fear the people in the city because they are violent and can hurt us'* (LeaNar).

In regard to moving away from Galeras, the perception of many appeared to be that other places were more dangerous, 'I*n Pasto there is more frequent crime, in Mapachico such things are not as frequent. The people living in other communities have said don't move because clothes could get stolen or cattle get stolen'* (LeaMap).

A result of this high level of safety and security not only did people want to stay living there but also other people were reported as being drawn to the region, *'many people outside of the city want to move here. According to some cities this is a place with a society that helps each other. No problem, no drugs and alcohol' (MapCFG).*

Despite its perceived insecurity and danger, respondents recognise that they still need to visit the city and therefore distance between where they live and the city of Pasto is in many respects a double-edged sword, respondents wish to be distanced enough away from it so that they are not at risk of crime, but close enough that they can easily access services and work opportunities. For those living in Mapachico, their proximity to the city was thought to be ideal, '*the good thing here is it next to the city, we can go without problems but not live in the city'*.

In the La Florida community focus group, the safety of the children was of key significance in the overall assessment of security of the community, *'the children are free from violence, they can go anywhere they want', 'children still remain on the streets to play'.*

As with the discussion of tranquility, reference was also made to the compromise being made with wealth, this time suggesting that security was more important than wealth, *'Life is not economically optimum but there is a sense of calm, 'There are basic needs that are unmet but we have a good life'* (LFFG).

Surprisingly only one person from the total 91 interviewed mentioned the volcano in their discussion of security, '*the only risk is the volcano, no more, just when the volcano explodes there is risk',* (MapCFG). This statement also highlighted that risk is not a permanent state, but a state of permanent flux. However, despite the danger it presents, with the '*potential to kill and devastate'*, people also see the volcano in a positive light, '*people do see it as a something magical'*, (HeaNar).

In stark contrast to the normal perception of volcanoes, the Consaca leader hailed the good quality of life on Galeras to in fact be attributed to the volcano, '*the life is because of the volcano',* rather than the bad of which it is more commonly argued as in the literature and media (see introduction and literature review).

5.1.4 Contradictions within community perceptions

In addition to the highest-ranking themes, it is important to note that amongst the discussions there were a number of contradictions within the community perceptions. These contradictions can be

seen in figure 4.1 where there appears near equal amounts of positive and negative answers for certain themes. These contradictions are listed below.

5.1.4.1 Work and wealth

Although people commented that their opportunities for well-paid work were poor, it was recognised that there was in fact '*much work'* for the majority of individuals including the 'young people'. These opportunities were either on the mountain itself or in Pasto; '*there is work in the city, work in the community', 'there is work in the fields'.*

The work available is in a number of different domains; *'most people work in agriculture', 'peoples lives are food and vegetable businesses', 'there is much work and handicraft making'.* There was also entrepreneurial activity with individuals creating employment opportunities, *'we work our own businesses', 'people take advantage of the resources'.*

Although there were a lot of different options for work, people appeared to stay in the same job throughout their lives, *'I like my work since childhood, the same work for 13 years', (NaCFG).* This meant however that if their line of work disappeared they did not automatically switch to something else, even if there was an available option, leading them to comment on their subsequent unemployment or poorly paid job.

In the discussion of employment, it arose that although poor wages and unemployment are a problem on the mountain, and that to work off slope in Pasto may be a more viable option, there were other factors that were prioritised, reasoning why people chose to stay and work on the mountain. In the Nariño focus group the decision making was discussed in depth, with motivation driven by safety and family, '*the work here in Nariño is difficult, but we have other good things and we have no violence which is why we like living here', 'in the past we work in the community, with kids and adults, for that reason people didn't go to cities'*.

5.1.4.2 Poverty

The low levels of overall household wealth were attributed mostly to the poor level of working wage. Yet although wealth was low, the consensus was that people had in general a sufficient enough amount of money to live on, due to a number of factors listed below. For these reasons people did not perceive the community members to be living in poverty although they did perceive them to have certain needs, "No poverty, just neediness" (HeaNar).

The first factor was that the overall cost of living in the Galeras towns and villages was low in comparison to the city of Pasto, due largely to the cheaper service costs. In the Sandona focus group one participant reasoned, 'we have to pay services but it is cheap'.

Water was a particular focus of many discussions of cost of living, highlighting the fact that it is either gained free from the rivers and garden aqueducts; "the water is free here', 'the families have their own reserve for the water', 'the families never have to pay for their water' (LeadMap).

The second factor keeping the cost of living relatively low was many people's ability to produce their own food. The Sandona focus group explained that having the opportunity to grow food was of great advantage to the community members, and often led to people on the mountain being wealthier than some off slope, 'in contrast with the city the life is good here because the farmers have the opportunity to grow their own food, so poverty is less here than in the city'.

However, although a large amount of the community members did cultivate their own crops for food, '*helping them to survive for free'* (SanCFG), there are some people on the mountain that rely on purchasing what they need. This means that food security for these people is reliant on income, therefore leading to individuals going without if they don't have enough financial resources. Yet even in these circumstances there remains positivity within the community and an appreciation of what they do have. In Mapachico, the community focus group reasoned that although '*sometimes no money to buy food, we have a house'. .*

The third factor was that although work is low paid, there was a diverse range of options available, meaning that when one is weak they could change to another, *'the artesanias are poor, but not extreme because they have several different activities. They prefer to grow coffee more than handicrafts because coffee gives more',* (SANFG). Likewise when the coffee crop failed there was also a choice to do something else, *'when people don't work with coffee they can weave"* (SanAg). As there is a diversity of different income opportunities available, individuals often balance a number of different initiatives at the same time in the hope that one will be successful.

In general the perception of wealth, and subsequently poverty, appeared to be that it is not directly attributed to money but more the access to the things that the community need, such as food, shelter and electricity. The Nariño education representative described his perception of the situation in Nariño, '*poverty is not common, everyone has enough things to live'.* The psychologist from the University of Nariño also felt this was the case, '*they have enough'*.

The final viewpoint that arose contributing to the discussion of wealth was that people live a lifestyle that matches their level of wealth; they are used to and good at adapting to what they have, '*this population lives according to the economy*', '*we live according to our economic situation*' (NarCFG).

To summarise the economic situation, one householder made this case, *'here people live very well, due to cheap services, very economical life and with a little work they have all they need to survive. Despite low incomes people get ahead'.*

Being able to secure '*everything we need*' on the mountain (LeaMap) comes across as being one of the main reasons as to why the communities are so strong in their objection against the governments relocation program. They fear that the things that they value are not the same as those that the government values, and will not be replicated in the areas they would be moved to if they relocated, '*it doesn't matter to the government that it is an ancestral place', (MapCFG) 'we can't live in Pasto, there's no work, no animals, no space*' (LeadMap). The difference in perceptions, of what is important, between the communities and the government appears to drive the ongoing conflict between the two.

5.1.4.3 Health and food production

Just as it was surprising to learn Galeras was generally perceived as a safe place, the finding that living in the area was considered to be good for your health was also unexpected.

Although health did not register as being of specific priority to householders in the discussions of value, the health representatives of Nariño, Consaca and Mapachico were keen to stress the benefits to health that living on Galeras offered, a combination of peacefulness and tranquility, increased physical exercise (due to agricultural activities and walking in steep sloped areas), the natural environment and organic food production, all qualities of which individually had been raised independently by many of the community members during their interviews. '*Everything is better for your health, tranquility, security, clean oxygen, it's healthy living'* (HeaNar), '*fresh air, contact with nature, cultivation without chemicals*' (HeaMap) and '*it is good because there is little psychosocial damage, without stress', 'health is better because there is access to many foods*' (HeaCon).

The poor state of the provision, or complete lack of these same qualities in other locations off slope appeared quite distressing to members of the Mapachico community focus group, where one member described how she didn't like to go to the city (Pasto) as she found it *'traumatic'* and that

she felt 'sick' when she went *'because of the air quality'*. Another member of the same discussion argued that '*the most important thing is to live here*', in reference to the relocation, so as not to lose access to all that they appreciated on Galeras.

Surprisingly, only 8/91 household representatives interviewed mentioned agriculture and the ability to grow their own food as being one of the positive aspects of quality of life. This was perhaps relatively low given that all 6 case study sites were rural where the majority of households have either their own parcels of land or at least a small garden in which to grow food. This was explained by the Genoy health representative who stated that whilst many people grow their own crops, the reality is that they simply cannot afford to eat them, choosing instead to sell their produce at market, "*we produce lots of different things but don't consume them'* (HeaGen). This the representative said had in turn led to rising cases of malnutrition as people only '*eat the things that aren't good enough to sell'*. The Genoy Health representative also added that although communities can grow many different crops, often they don't know how to and so only eat the products they are used to*, 'they have everything for living here, they don't realise it, they only eat rice and potatoes'.* The issues concerning food production and malnutrition were repeatedly raised in the discussions of vulnerability, which will be reported in chapter six.

5.1.4.4 Galeras, friend not foe

The discussions of safety and health have already highlighted the paradox that is Galeras, somewhere potentially so dangerous that in fact it provides a refuge to many, and seemingly as a result, to be ironically perceived to be actually greatly boosting their quality of life.

Analysis and coding of perceptions, specifically related towards the volcano, again highlighted this dichotomy of beliefs between the communities, with 10 representatives identifying the volcano to have a positive impact on quality of life and 16 as having a bad impact.

The community focus group in Mapachico captured what many believed, that Galeras is a '*friend'*, but that sometimes they, '*should be careful because if he is in movement something could happen'.* It is greatly believed throughout the communities that this '*friend*' has never hurt them and will not do so in the future. In turn they reasoned that the only people who have been hurt by the volcano were indeed not community members but volcanologists who had not asked permission to go into the crater of the volcano and were subsequently killed as a punishment.

In 2006 when Galeras erupted after many years of quiescence one of the members of the Mapachico focus group witnessed the explosion, describing herself as *'terrified'*. The participant,

however, explained that since, *'those things have happened frequently"* and that they feel the *'volcano is a friend to them and they feel accustomed'*.

Another member of the Mapachico focus group continued to further explain how people have become accustomed to the volcanic activity, *'for some people it is something strange, but for the elders they have seen the volcano erupt many times, it's something quite normal for them'*. In addition, the size of the 2006 eruption appeared to have set a precedence for what is perceived to be dangerous; of a more recent smaller eruption one interviewee said '*the volcano is not dangerous, the things that happen now is nothing*'.

An interview with an agricultural representative at the University of Nariño, described why perhaps many people believe that the volcano is not dangerous as it *'represents patrimonial environment', the volcano itself being part of the community'*. In the same way that tranquillity between the different members of the community was described, the representative explained that it is the *'respect that exists for Galeras which is the reason the volcano doesn't hurt them.*

Participants of the Genoy focus group expressed further how the volcano is part of the community and subsequently that the community is also part of the volcano. This interdependent relationship begins with the tradition that when a child is born, the family buries the placenta in the earth, *'creating an immediate connection between the baby and the land'.*

Focus group participants continued to explain further that within each house in Genoy and Mapachico there is '*La Tulpa'*, a three stone formation in the middle of the kitchen floor, where the bottom two rocks represent the resistance and the power of the mountain and the top rock represents the cosmos. The custom of the community is for the women to give birth around the Tulpa. When the baby is born they bury the placenta in the ground and in this moment they acquire a relationship with the land, '*because of this we are indigenous'*, "*for this reason the tulpa is sacred, it is our skin'.* Through this ceremony the child is blessed.

Perceptions of the volcano were far stronger for some than just a friendship. These people (predominantly the indigenous in Genoy and Mapachico) saw the volcano as a God (AgREPAlcalde), one that has protected them and their people throughout history. The Genoy leaders described the concept in greater detail, "*It's the Father, it's the protector"," there is the tangible part that you can touch, what you can receive ad there is also a historical view".* They described how the volcano had protected them over the centuries with its eruptions, *"the volcano protected them from everything, lava coming from both sides, from this moment the volcano became the protector".*

In reference back to the conflict between the communities and the government over the relocation plan, the Genoy leaders identified that one of the key problems was due to the two sides having a '*vision of the volcano that is different*'. The terminology used in dialogue between the two groups was therefore also completely different in many cases: *'it is impossible to describe Genoy without the landscape', 'this is not just a mountain it's more than that. It is the Father, the Protector'.*
An independent cultural representative described the belief system in greater detail, explaining how the indigenous community see Galeras as a spirit, *"For them the volcano is like an ancestor, a Grandfather, a sleeping relative'*, '*the things we identify as inanimate objects are alive*', '*their perception is that the volcano is a living thing, a living person, and every 100 years the volcano God wakes up'.*

The representative also described how the '*reawakening*' of the volcano in 2005 had helped to strengthen the indigenous belief system, recalling how coincidently at the same time as the eruption a group of petrogliphs had been discovered. The people believed that the coincidence was the 'grandfather' (the volcano) waking up and reminding them of their past. This point she believes was the beginning of the '*culture reconnecting with their past'.*

5.1.5 Secondary coding of quality of life data

After the initial coding of the interview data which identified all the individual aspects perceived as contributing to a good quality of life, a secondary coding exercise was applied to identify aspects as either; economic, environmental or social; the results of which can be seen in figure 5.2.

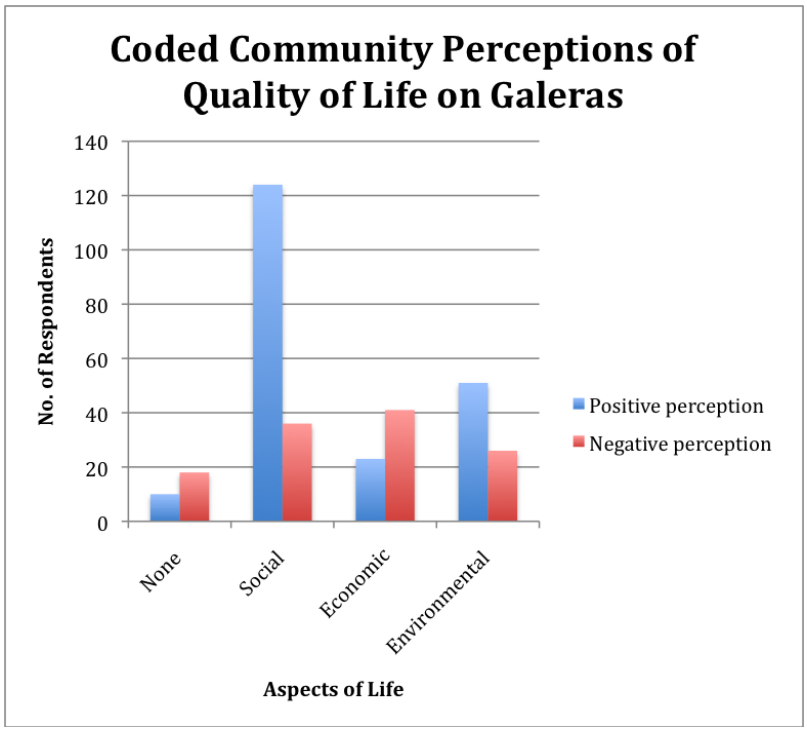


Figure 5.2. Secondary coded community perceptions of quality of life on Galeras (n=91 interviews).

These results show that social aspects of life were clearly of the highest priority in discussions about quality of life, these included tranquility, community, safety, health, public services, ancestry, happiness, location, governance and education

By secondarily coding the primary codes into environmental, social and economic, an important theme emerged, that collectively, environmental aspects contributed significantly to the positive discussions of quality of life including: the eruption (10), climate (8), agriculture (8), land (7), aesthetics (7), water (4), flora and fauna (3), light (1) and natural reserve (1). In total, environmental factors equated to 49/ 91, which in comparison was nearly equal to the highest frequency singular aspect of tranquility (50/91) that was raised as contributing to the good quality of life. A quotation from the Genoy Leaders summarises this collective value of the entire environment and the impact it has on the population, *'it is impossible to describe Genoy without the landscape, it is thanks to the place they live that the people are who they are'*

5.2 Theme 2: Motivation to reside on Galeras

Of the 91 individuals interviewed, 71 were still residing in the same community in which they had been born. Of the 20 that had moved, 14 had only migrated from elsewhere on the volcano, whilst only 6 had come from different locations in Colombia.

When asked '*Why do you live here?'* the 71 locally born residents gave a total of 256 responses (average of 3.6 per person), whilst the 20 migrants only gave 30 responses (average of 1.5 per person). The migrants were also asked their reason for moving to the area in the first place. All responses were then primarily coded. Only one individual did not provide an answer.

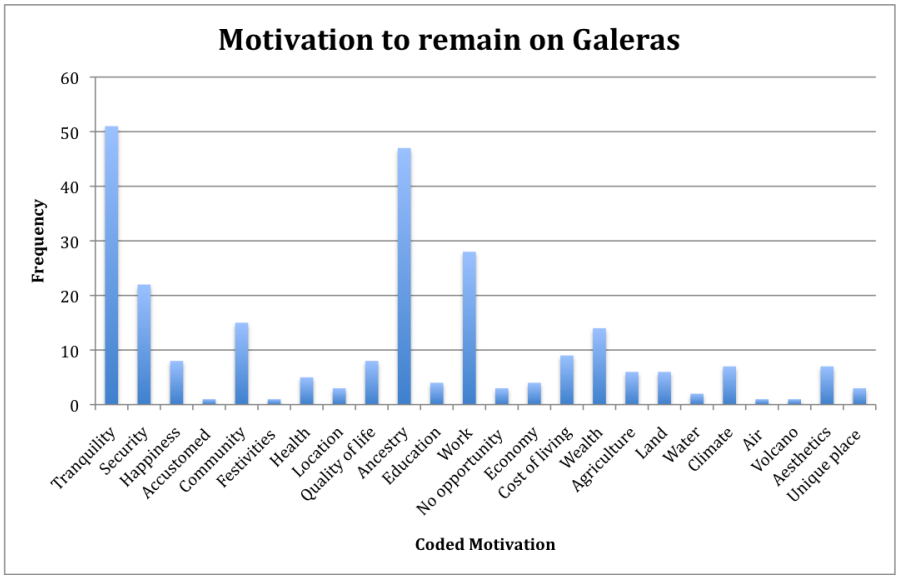


Figure 5.3. Motivation to remain on Galeras (n=91 interviews).

As can be seen above, motivation to remain residing on Galeras was again driven predominately by 'tranquility (51/ 71) as in the discussions on quality of life. In comparison, the second and third drivers were different, being ancestry (47/71) and work (28/71).

5.2.1 Tranquility

As in the discussion of 'quality of life', tranquility was referred to in two ways, the first as the absence of noise '*quiet without noise '* and the second to describe the state of calmness within the community, '*live in peace*", "*the atmosphere is nice".*

Once again, reference was made to the comparative lesser levels of tranquility in the nearby city of Pasto, '*we live in peace, more peaceful than in the city'*, and the potential impact that living so close to Pasto could have on the communities on Galeras, "*it's tranquil despite the risks of the city*".

5.2.2 Ancestry

The importance of ancestry as a factor motivating people to remain living on Galeras rated a close second to tranquility. Discussions divided into two main themes, the belonging that individuals felt to the place in which they were born, and their connections to their family in the same community.

"*I was born here*", "*it's my birthplace*", "*we're from here*", "*I grew up here*", "*I have a long history here",* "*it's my homeland*", were phrases used to describe their 'nativeness' to the region and their belonging to the community.

A sense of ownership of the land was identified, "*my blessed land*", "*it's my land*". However, in addition, as was identified in the discussions of quality of life, it was stressed how this ownership was two-fold; that they the community did also in fact belong to the land, "*we belong to this place*". This belonging was often highlighted by the use of the term "*roots*", used to describe the way in which the people were both established from the mountain and have since become embedded into it, "*roots are here*", "*roots that bind the soil*", "*we are rooted to the earth*". The cultural representative from the University of Nariño, explained the idea of 'roots' further, how '*people are rooted in the land and custom because all family group grew up there',* '*the children grew up with their parents'.*

The decision to reside also appeared heavily dependent on the location of other family members, "*my family is here*", "*for the family*", "*because our parents live here*", "*grandparents here*". From the discussions had, it appeared to be a tradition that a family would generally remain all together in the same community that they were born. The main exception to this appeared to be when an individual, usually a woman, got married to someone from outside the community and moved to be with the family of their spouse.

Before the relocation program it was common practice that one set parents of a married couple would allocate part of their land to building a house for their children. However, with the introduction of the 'no new build' policy, designed to stop people moving to the area, this tradition is no longer allowed. This prohibition has led to higher populated houses, a factor that will be discussed in greater depth in chapter six.

People's preference to stay in their communities on Galeras was also driven by the necessity for members to care for their relatives, "*there is a union of help in the families', "I care for my aunt".* The University of Nariño cultural representative noted that this duty of care begins at birth, *'since babies help parents'.* This in turn was the reason identified by many for going out to work, including the Nariño leaders*, 'We work for our families', 'work just for feeding our families'.*

Another interesting and important factor to highlight was that in the discussions of the importance of living close to family, there was little to no distinction made between those members living and those of whom were deceased.

As the communities are where their ancestors are buried, this in turn has strengthened peoples argument/wish to stay, as they too wish to die and be buried in the same place, "*people want not only to live but to die – there is a choice and it is important to die where your ancestors did, the grandparents want to die here and not in another place*" (LeadMap).

Another group that factored into decision-making was the youth of the community and the need to provide for their future, "*it's our children's heritage*", pertaining to the notion that where they live provides everything that they need for this purpose.

The local government cultural representative once again explained the relationship between the Galeras communities and the mountain, as had similarly been raised during the discussions of quality of life. However, this time more reference was given specifically to the way in which the interaction between the volcano and the indigenous community underpinned their culture, *'when people interact with their land and territory, it is a cultural manifestation'*.

The cultural representative continued to elaborate that the volcano was both a religious and cultural symbol, viewed by the indigenous people in the same way '*that the Catholic people look at the Virgin (Mary)'*.

An independent cultural representative further explained that the community in fact envisaged the volcano as a living member of their family '*the volcano is like an ancestor, a grandfather', 'the volcano is a sleeping relative' 'the rocks are alive' the things that we identify as inanimate objects are alive'.* The perception of the mountain as one of the family was also identified by a local government Cultural Representative who repeated the concept, *'the volcano is part of the family',* and one of the Genoy leaders, *'Tita Galeras is like the father'.*

The independent cultural representative continued to explain that the notion of the volcano as a member of the family was basis of the people conceptualization of their territory, *"My Father, My Grandfather, My land".*

5.2.3 Employment

In contrast to the discussions on quality of life, where employment failed to rank as a high influence, it appeared as a key motivator for people wanting to reside on Galeras. Although it was acknowledged that accessing work can be difficult for some and salaries are low, the general consensus was that in there is some form of work for everybody, "*there is lots of work", "more opportunities for work*", "e*asy to work", "I've worked here for 15 years, I work here with my husband*".

Further discussion revealed that there is a diversity of opportunities for work available if one option fails, *"if you can't find work in construction you go to the fields", "if you don't have work in construction they work in handicrafts".*

One of the migrants that had moved to Sandona also expressed this point of view*, "For me it's good living here, it's been easy to move to Sandona because it's easier to get a job, it's ok because I have a part time job and the sugar cane - if one is bad I have the other".*

5.2.4 Security

Having ranked the third highest frequency theme in the quality of life discussion, security (22/71) once again featured highly as a motivator to reside on Galeras, "*there is security for the family", "it's safer", "no dangers", "nothing has ever happened to us that is bad*". Once again, there was only a small focus on the potential danger from volcanic activity, "*the volcano does us no harm*"; and instead the focus remained highly on the lack of crime and violence in the area: "*don't have violence", "never violence", "no robberies", "no crime", "free from bandits", "no paramilitary", "no guerilla*".

The discussion of potential threats also emphasized that community members see access to alcohol and drugs, due to the association with the city, as a threat to their children, but one of which isn't prevalent in their community, "*young people don't have problems with alcohol and drugs".*

The feeling of security once again within these discussions implied freedom, suggesting a form of oppression from the levels of crime and violence elsewhere, *"freedom, I feel free".*

5.2.5 Community

Although community ranked second in the discussions of quality of life, it only ranked fifth in the discussions of motivation to reside (15/71). Tranquility, ancestry, employment and security all ranked much higher. The discussion of community, however, only sought to repeat what had already been described previously, that the cohesion between individuals and the personality of the community members were both of very high regard in the decision to live on Galeras.

The strength of the community was expressed by the comparison made of the community to a family, *"feels like family", "all the people live in one family",* "*all the people know each other", "everyone looks after one another*".

In turn, the Cultural representative of the University of Nariño described how this cohesion has led to the organisation of the community and the political organisation of the indigenous groups of Genoy and Mapachico forming the Cabildo.

5.2.6 Cost of living

Although only mentioned by a small number of people, comments themed under Cost of living (9/ 71) provide an important insight into the discussion of motivation to reside that perhaps may underpin many of the other discussions. On Galeras the cost of living is understood / expressed to be far lower than in the city. Although households may have lower overall wealth in comparison to those in Pasto, it was generally believed they have enough to live comfortably:

"*We might not earn much but it goes a long way because things are cheap. To have what I have elsewhere you would have to have a lot of money"*

"Life is very economical, everything is cheap. In the city rent and services are more expensive. Here we have cheaper public services, water, light services and electricity are cheap, only $25 for water a year."

To further emphasis the low cost of living in the area, one respondent made the point that Galeras provided '*the best land for poor people to live*'.

In the discussion of motivation to reside, the question, "Why do you live here?" was posed. This was designed as a neutral, open question, allowing respondents to answer in one of two ways, depending on their preference, either why they chose to stay or indeed why they chose not to leave.

These sub questions to many may appear the same, however, there is in fact a great difference as it highlights peoples overall preference about whether or not they would prefer to leave and not just what they liked about the area.

Of the 91 respondents who responded, only 4 suggested they would prefer to live elsewhere, explaining that circumstances prevented them from moving elsewhere: "*No opportunity to move", "because haven't had the opportunity to move to another place", "no money to improve our lives", "no money to leave to live in the city", "we don't have a good quality of education therefore we can't work in other cities".* The majority of respondents however responded only with reasons why they chose to stay.

A secondary coding of all primary codes as social, economic or environmental, emphasized that precedence was once again being given to social aspects (64%) over economic (25%) and environmental (11%) motivations.

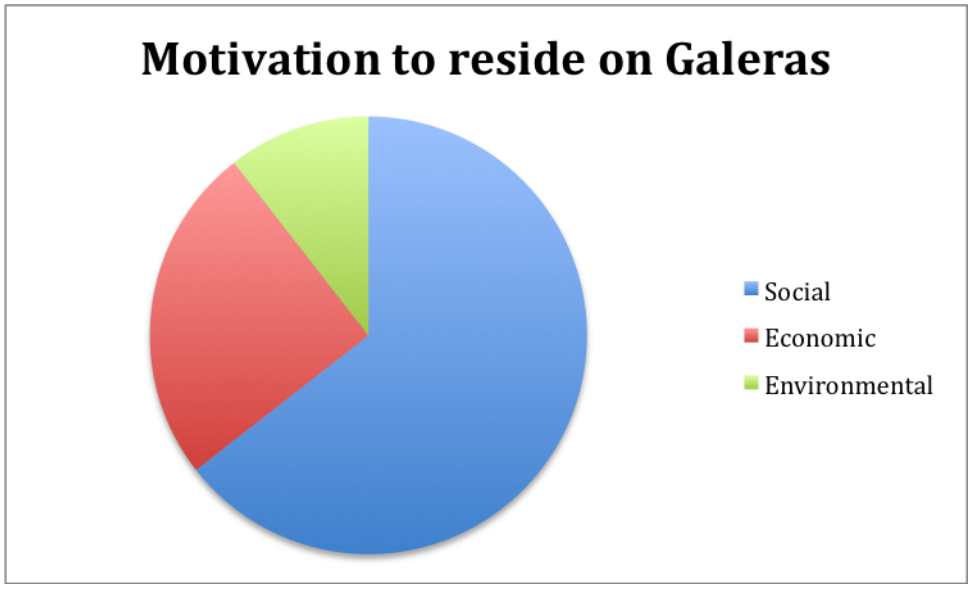


Figure 5.4. Secondary coding of motivation to reside on Galeras (n=91 interviews).

5.3 Theme 3: Income sources

The 91 households represented in these interviews were home to a total of 447 individuals. When asked how many people within the household were responsible for at least one income source, 179 individuals (40%) were identified, an average of two per household. Two households were

recorded as not having any income sources. Responsibility for income was distributed somewhat unevenly across gender: 121 male and 207 females.

In total 228 individual income sources were recorded. These were coded into 29 different types (see figure 5.5). The four highest frequency income sources were agriculture (49/228), livestock (48/228), cooking (21/228) and handicrafts (19/228). Income sources were also identified as either 'On Volcano" or "Off Volcano", dependent upon where the activity associated with the source of income was carried out. A classification of 'other' was given for income sources that did not have a location; e.g. when they didn't come from an activity but from a direct payment such as a pension or a social security payment.

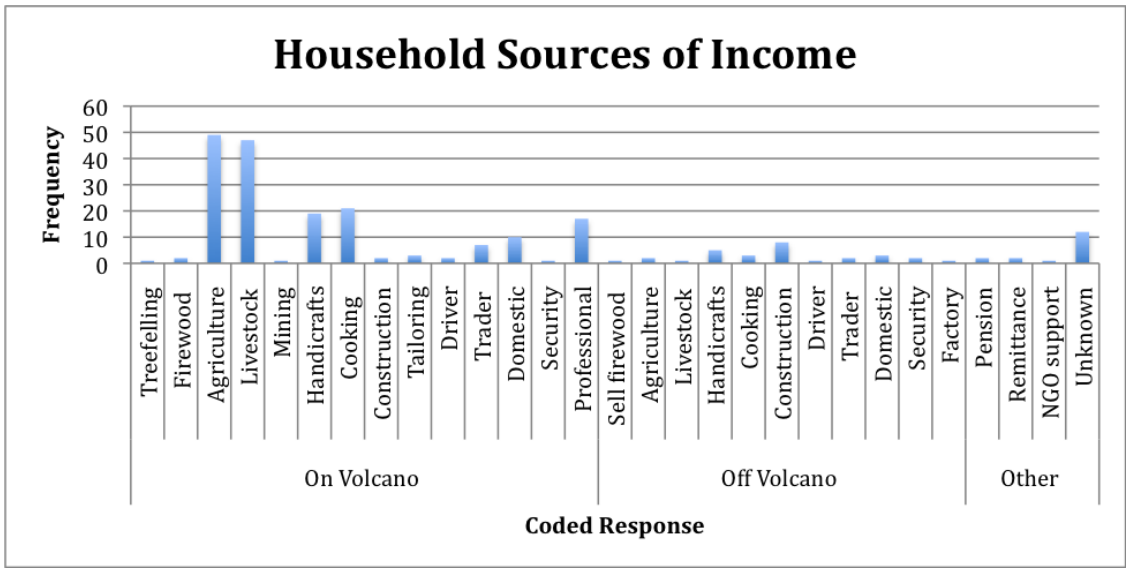


Figure 5.5. Household income sources. Income sources were further categorized as being obtained either "On Volcano" or "Off Volcano" (n=91 interviews).

5.3.1 Location of income source

Of the 228 individual income sources, the majority, 183 (80%) were obtained on the volcano, in comparison to only 39 (17%) off the volcano. A further 16 (7%) were classed as 'other' meaning they weren't location dependent, these included pensions, remittances and non-governmental support.

5.3.2 Secondary coding of income sources

Secondary coding of these data was again completed, classing each income source by their sector of the economy: primary, secondary or tertiary. Of the jobs located 'on the volcano', 55% (101/183) were primary, 'making direct use of natural resources', 23% (43/183) were secondary, 'creating a product' and 22% (40/183) were tertiary, working within the service sector (see figure 5.6).

Primary income sources were predominantly agricultural cultivation, the growing of crops to sell, and livestock rearing such as pigs and cattle to sell. This category also included the mining of aggregates and tree felling. Secondary income sources were predominantly cooking food to sell in cafes, restaurants or on street stalls, and the making of handicrafts from the fique palm and other natural resources. Secondary income also included construction and clothes tailoring. Lastly, tertiary income sources were predominantly professional, including being a teacher or a lawyer, domestic, which included housekeeping and being butlers, and private security.

5.3.3 Relative importance of income sources

When asked what the most important income source was to their household, agriculture ranked the highest (22) followed by livestock (10), cooking (7) and handicrafts (7) (see figure 4.6). Of those income sources identified as most important, 74 % were located on the volcano.

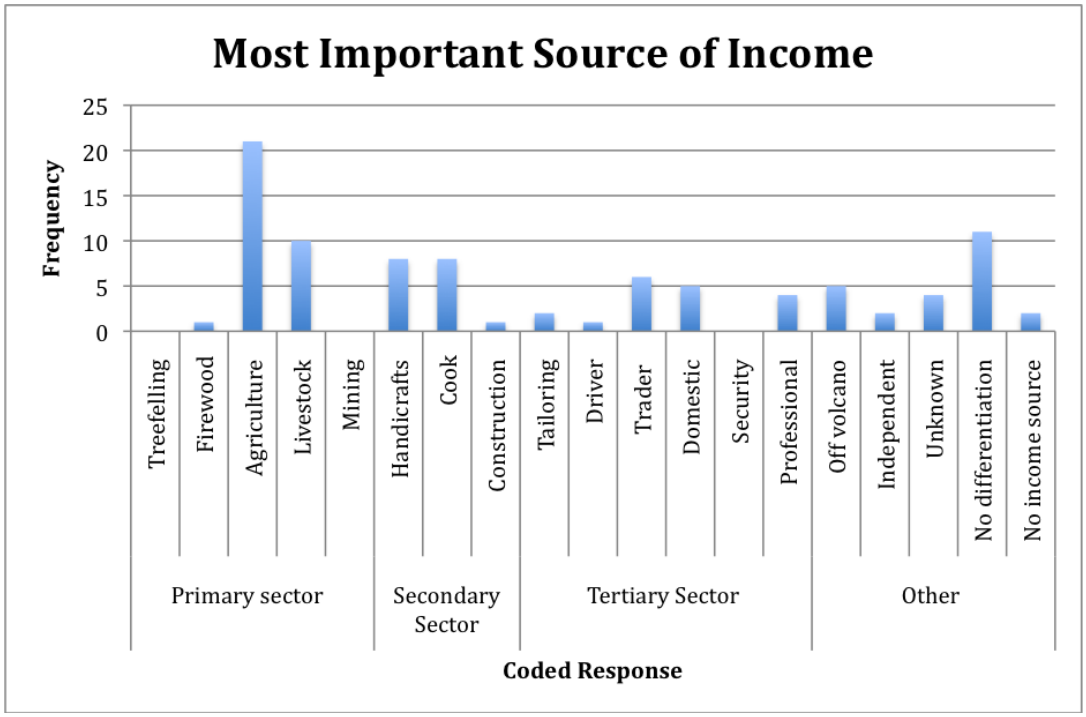


Figure 5.6. Relative importance of income sources, further categorized as to whether those activities were primary, secondary, tertiary or other (n=91 interviews).

5.4 Theme 4: Land use

Of the 91 household representatives interviewed, 60 (66%) replied that they possessed one or more 'parcellas' of land, a 'parcella' being the regional word used for a 'piece' of land of no specific dimensions, the equivalent to a 'field' in England.

In total, the 122 individual plots recorded were owned by the 60 households, an average of 2 plots per family (among those who did own land), although ownership ranged up to 12 parcellas. Across all of the plots 46 different land uses were recorded; these were coded into 12 different use categories. Figure 5.7 shows the distribution of different land uses between households across the 6 different case study sites.

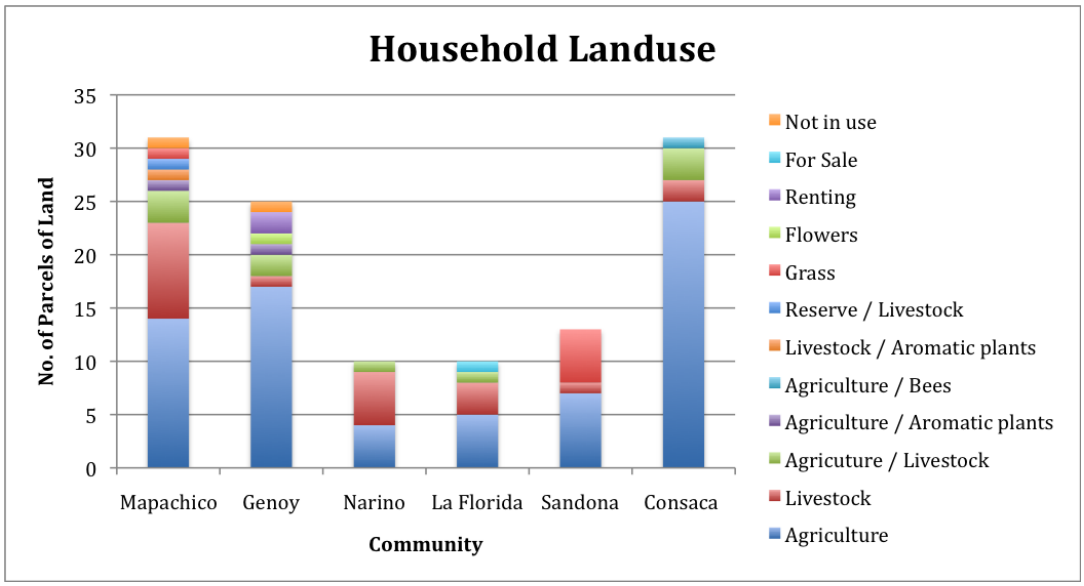


Figure 5.7. Patterns of landuse among those households interviewed in the different communities on Galeras which owned "parcellas" of land (n=91 interviews).

As can be seen above, the three highest frequency cumulative land uses across all 6 sites were agricultural crops: 61% (74/122), grass (for feed for grazing animals): 18% (22/122) and mixed agricultural crops and livestock: 8% (10/122). Other uses included; growing flowers to sell, keeping the area as a natural reserve, growing aromatic plants for medicinal purposes and for bee

apiculture. A number of fields were not in use, as they were either for rent or sale or being left clear to aid soil recovery.

5.4.1 Land use motivation

When asked what the reasons were to use each parcella of land for its designated purpose, seven themes emerged; climate, soil, water, location, space, grass, tradition, ease and exchange. 5 respondents failed to provide an answer for their land use choice.

When asked why each parcella of land was used for the strategy recorded, a wide range of different motivating factors appeared to drive decision-making, as can be seen in table 4.2. These factors can be described as either environmental variations in the land such as climate or water, or, reasons driven by function such as failure of primary crop choice or proximity to services. Whilst some strategies only seemed to be driven by one or two motivators, others appeared more complicated, with a multitude of factors to take into consideration.

According to the interviewees some agricultural strategies required a range of different environmental conditions from the land. The cultivation of corn for example was said to require; a location 'lower down' the mountain for a colder climate *'16 degrees',* fertile soil, and '*acidic soil'*. Decision-making was also based on the fact that it was the '*only suitable land'*, close to a water source and so '*didn't need water from the tap'*, that one family had '*only one field'*, and so no other choice was available, and that one crop was grown when the usual had failed for example corn was '*grown when coffee is bad'*.

Livestock grazing as a strategy was in part driven by climate, as the grass for the pasture for the cattle required a specific temperature range. However when the climate was not appropriate for the primary strategy choice, because either grass or other plants didn't like the temperature, this land was relegated for guinea pig grazing. Livestock also required fertile soil for the pasture grass and an area with lots of water availability, '*over a hundred water sources'.*

Table 5.2. Stated reasons for using land for different purposes among the 6 communities interviewed around Galeras.

Characteristics / code	***Characteristic variations / quotes***	**Land use**
Climate	*Temperature*	Agriculture, animals, **Mapachico**
	Dry summer	Yucca, oranges, platano **Genoy**
	Hotter	Sugar cane, platano, coffee, lulo, avocado, **Genoy**
	Hot	Sugar cane, **Sandona**
	Colder (16 degrees)	Corn, **Consaca**
	Drought (bad climate)	Flowers, Genoy / guinea pigs, **Nariño**
	Appropriate climate	Potato, beans, **La Florida**
	Agroclimatic zone for good production	Pasture glass, **Sandona**
		Agriculture, **Consaca** / small species, **Consaca**
	Favorable climate	Corn, beans, **Consaca**
	Climate is beneficial	Coffee, **Consaca**
	Climate is good 22degrees	Sugarcane, **Consaca**
	Climate is better	Plantain, citrus, **Consaca**,
Soil	*Fertility / soil is fertile*	Peas, wheat, carrots, corn, lima, beans, potatoes, grass for horses and guinea pigs, **Mapachico** / lemon, peaches, aromatic plants, tomatoes, cattle, **Genoy** / coffee, **Consaca**
	Soil is not fertile	Straw, **Mapachico** / cattle, **Nariño**
	To loosen the soil	Peas, **Mapachico**
	Soil is suitable	Aromatic plants, chard, cabbages, carrots, corn, **Mapachico**
	Versatility of the soil	Peas, **Mapachico**
	Good soil / good earth	Vegetables, corn, peas,

		hortalizas, potatoes, **Genoy**, / fruit, vegetables, **Nariño** / beans, La Florida / plantain, **Sandona**
	Good soil for grass	Cattle, **Genoy**
	Soil is appropriate	Agriculture, **Nariño**
	Only ground suitable	Corn, potato, beans, peas, chard, **La Florida**
	Soil has good nutrients	Coffee, **Sandona**
	Soil is beneficial	Coffee, plantain, lulo, fruit trees, bees, **Consaca**
	Soil is acidic	Coffee, corn, **Consaca**
Location	*Distance from the house*	Straw, potatoes, **Mapachico**
	Easier to spray	
	Lower down	Corn, **Genoy**
	Next to / closer to the house	Pigs, **Genoy** / cows, La **Florida** / sugar cane, **Consaca**
	Closer proximity to the power supply	Cows, **La Florida**
	Closer to the house for milking	Cows, **La Florida**
	Furthest away	Beef cow, **La Florida**
Space	*Large space*	Bamboo, **Genoy**
	Only have one field	Corn, **Nariño**
Water	*Close to water*	Vegetables, **Mapachico**
	Don't need to be close to the aqueduct	
	Don't need water from the tap	
	Over a hundred water sources	Corn, lima beans, **Mapachico**
		Cattle, **Genoy**
Grass	*Good pasture*	Cattle, **Mapachico** / small species, **Consaca**
Tradition	*Always had*	Chickens, rabbits, **La Florida**
Ease	*Easy to transport*	Sugar cane, **Consaca**
Exchange	*Temporary crop*	Blackberries, **Nariño**
	Grown when coffee harvest is bad	Corn, **Consaca**

The decision-making behind where to place livestock was also driven by location, specifically the proximity of the field to the house and to the electricity supply. Dairy cattle needed to be grazed closer to the house to enable milking, whilst beef cattle, not needing an electricity supply, could be grazed further away. For those with a choice of parcels, if dairy cattle were closest to the house then other animals or crops not dependent on electricity, fertilisers, pesticides or water could be raised further away. Being closer to the house is *'easier to spray (crops) with fertilizers and pesticides'* and to access water *'if there weren't any natural sources available'.*

5.4.2 The changing land use profile

As can be seen in figure 5.7 the profile of land use changed both within the case study areas and across them as they circumnavigated the volcano, suggesting that land conditions also varied, providing a range of individual and often unique niche environmental conditions and opportunities for food production. The Consaca leader summarised this change when he said, *'From Pasto to here different landscapes, different people, different crops'.*

External expert interviews provided further insight into each of the different motivators of land use raised in the household interviews, providing explanations as to the variation in provision of the different factors.

As can be seen in table 5.2, a varying climate provided a range of different temperatures, sought not only for the cultivation of different crops but also for the grazing of different animals. The agricultural representative from the University of Nariño explained that certain crops respond to certain climates, for example, peas and potatoes do not suit hotter temperatures, whereas crops such sugarcane thrived in it. The temperature, he explained was influenced by the altitude, with lower temperatures found at higher altitudes.

The government agricultural representative commented that the region is *'in the middle of the world on the equator where there rays of the sun are perpendicular', 'as a consequence we have more light, more sun', 'in the afternoon the sun is longer', 'the quantity of light is the most important here, it helps the plants grow faster and with a better quality'.*

High quality soil in terms of both its fertility and composition was highly sought after, *'fertility of the soil is very important for a wide range of crops as for growing the grass on which to put the animals out to pasture', however 'some crops aren't so dependent on the fertility and can be cultivated in the areas that aren't very fertile such as straw'* (AgUoN)

The fertility of the soil was attributed to the volcanic activity, specifically the ash, and how it had created '*big horizons full of macro and micro nutrients and andesol making* it very black', (AgUoN), 'the earth is fertile because the volcanic ash is good for the land', (BioCENA), 'the land is rich in ash giving it high fertility and nutrients, (AgFoC)

The ecology representative at the CIAT research institute explained that the 'natural conditions of the mountain soils were good; '*able to regulate water flow', 'high organic material content', 'high porosity', 'high retention of water', 'low bulk density' and 'stores water'.* Being in the right location to receive ash fall resulted in soil of *'high fertility*', as the ash helped to retain nutrients. One informal conversation with an additional farmer to the household interviews summed up the view of many when he said, '*In Sandona they are lucky as they get the ash, we don't get the ash here (in Genoy)'.*

According to the CIAT ecologist, the presence of the ash had not only led to the fertile soil but also better tasting produce, '*because of that, the fruit tastes different'* and that because of the ash, they are '*unique in the world*' in terms of producing specific flavors in their crops.

The availability of water was another clear determinant of the decision making process. The ecologist at the University of Nariño commented that the water is '*the most important resource in this land', 'seven communities obtain water from the volcano',* and *'that people use the landscape because it is a source of water'.* Whilst many crops and animals required access to a water source, *'many of the vegetable crops required lots of water as did the cattle' (EcolUoN),* there were equally decisions made to place things due to their lack of dependency on water.

The size of a parcella of land was undefined, referring only to one single area of land. This area, similar to a UK field, ranged from a small back garden style patch to a large meadow. The natural topography varied across the mountain, changing from case study area to another. As the topography varied, so did the size and shape of the parcella. In Mapachico the topography was steeper and rockier, due to the presence of old lava flows; here the parcella size was small, with very limited flat land to cultivate. As a result people often preferred to raise small animals, '*in Mapachico and Genoy, there are more animals because the land is smaller'* (CulAl).

In comparison, at La Florida very large areas of flat, wide-open space was available on which to graze cattle. A geology representative from the University of Nariño explained that these expanses of land were a product most likely of pyroclastic clouds collapsing and flowing down the mountain during a historic eruption, flattening everything in its path.

The size of the parcella was said to be specifically important for the growth of both bamboo and coffee, with bamboo preferring *'large open spaces'* and coffee favoring '*big land*' (FedCaff), and *'broken topography'* (AgUoN). As a result of the favorable conditions, *'the production (of coffee) is bigger in Sandona and Consaca'.*

Some land choices were done as temporary measures when the primary choice failed. An example of this was that corn was being grown in Consaca instead of the normal coffee crops, because the coffee harvest had suffered an infestation of biological pests.

A final point to acknowledge that encapsulates this discussion is the notion that all land use decision making is in part driven by age old customs and tradition that have seen the knowledge presented here passed on from generation to generation.

'In other places people don't use the soil around the mountain, but in this case there are community customs passed on for many years people by people living and working on the volcano'

5.4.3 A mosaic landscape of niche opportunities

The multiple variations in environmental conditions draw attention to the fact that Galeras is not one homogenous landscape as may be assumed of 'a volcano'. From these results it is clear that Galeras is in fact composed of a highly diverse set of landscapes, which present a multitude of niche conditions, many of which are completely unique. These niche conditions are either natural ecosystems or man made environments, '*natural vegetation is a niche for volcanic areas but people use the landscape and change it'* (EcolUoN)

The key example of a crop thriving under niche conditions on Galeras is the coffee, renowned locally and promoted internationally as '*the best coffee in the world*'.

'The coffee from Nariño is the best coffee in the world, that is why we have been working with different markets and boutiques gourmet markets in Champagne, France ' (BESoDAl),

It's unique flavor and 'special characteristics make it supposedly different to other coffees' (AgFoC). These characteristics are attributed, by the local people, to the niche *'volcanic conditions'* in which it is grown and the traditional cultural practices used to cultivate it.

According to the Federation of Caffeteros representative, the environmental niche that Galeras provides for coffee growth consists of:

- A specific climatic range: '*a temperature range of 25-27 degrees found at a height of 1600m – 2000m', 'any higher and it is too cold'*
- The presence of volcanic ash: '*fertile soil'* produced by '*the small rivers from the volcano bringing the nutrients to the land'*, of which includes the ash which '*the volcano sends'*, *'acidic soil'*, ''In *Sandona, Consaca and La Florida the land is very good for the coffee'*
- Sufficient rain fall

The artisanal farming process called 'minifundios' was described as a series of '*small processes', 'worked by the whole family', producing 'not big volumes'.* The production in Sandona and Consaca was considered to produce the best coffee, '*because they have more customs'.*

Small plots are used, creating a mosaic landscape*, 'a lot of minifundios that permit the growth', 'give to the coffees the best conditions'* (BESoDAl), *'the land is small, people can look after it better', (*BESoDAl),*'when the land is too big like in Brazil nobody can take care, just amount of land not quality' (*AgCG). '*Non intensive hand production is used, making the most of land that machinery can't access'.' People are more labored, they give the coffee the treatment that it needs, from picking to drying and selling', 'people, time and skill is needed', 'the land is small, people can look after it better'.*

Shade is required to protect the coffee plants from '*too much sun'*. To provide the right level, the coffee plants are usually cultivated either amongst *'big trees'* or *'in a mix with sugar, beans and animals to provide the coffee with shade'.*

For successful coffee production, fertilisation was advocated to provide the plants with nutrition, *'twice a year, 100g of formula for each tree' (*BESoDAL). . Nariño coffee is largely not organic although a pilot certification scheme was being launched at the time of the field visit, *'Organic is better but in Nariño we don't have organic coffee' (*BESoDAL).

Due to its individual flavor, the coffee is very popular both with local people, visitors and overseas consumers, '*buyers buy the coffee for the special characteristics '* (AgFoC). Due to its distinctiveness, the price of Nariño coffee commands a higher premium than other competitors, *'coffee is more expensive in Nariño than other places' 'overpriced because of characteristics'* (AgFoC)

5.4.4 Crop profile

Cumulatively across all six sites, 221 individual crops were recorded as being cultivated across 122 parcels of land. Of these 221 crops, there were 42 different varieties including 20 different types of vegetables, 13 different types of fruit, coffee, sugarcane, wheat, natural fibres, herbs, spices and medicinal plants. The three most commonly grown crops were corn (33 households), potato (16 households) and beans (16 households).

Across all 6 sites there was a great diversity of crops being cultivated, when analysed each site appeared to have a specific pattern of cultivation of which can be seen in tables 5.3 and 5.4.

In Mapachico, the cultivation profile record consisted of predominantly vegetables (13 different varieties) and no fruit. Varieties included legumes, root vegetables and leafy greens. Mapachico is at the highest altitude of the six sites, and also experiences a colder and wetter climate, which almost certainly explains the crop profile.

In Genoy, positioned below Mapachico, the cultivation profile consisted of nearly the same amount of vegetables as Mapachico (14), but in addition 7 different types of fruit were also recorded including bananas, berries and citrus.

In both Nariño and La Florida, the focus was again mainly on vegetables, with 8 and 9 varieties grown respectively, including legumes, root vegetables and leafy greens. Only 1 variety of fruit was recorded in Nariño and 2 in La Florida. In Sandona, there were only four individuals crop types recorded including one fruit and one vegetable, however the addition of coffee and sugarcane was also recorded.

Consaca was reported as growing 8 vegetables and 13 different fruits including bananas, berries, citrus and soft fruits. In addition coffee and sugar cane were also recorded. Consaca had the hottest climate of all the sites.

In Mapachico, Nariño and La Florida, there was a large diversity of vegetables being grown, but very little or no fruit, whilst in Consaca there were both 8 types of vegetables and 11 different fruits. Some crops were only identified in one or two locations, such as coffee and sugarcane, which were only reported as being grown in Sandona and Consaca. This diversity suggested both a range in ecological characteristics but also a difference in social preferences and economic drivers.

It should be noted that although fields had a predominant use, many were also used to grow one or two individual plants of different species of which perhaps the individual didn't list some crops. It would therefore not be accurate to suggest that other households did not grow coffee or sugarcane for example, but that they simply didn't designate their whole field to a certain crop. Had the survey provided a checklist of different crops the answers might have been considerably different. However, such an approach was presumed to be too invasive, as it may have appeared to be a more formal inventory of crops grown and hence aroused suspicions among some participants.

Table 5.3. Crops grown by households in the 6 different communities interviewed around Galeras (n=91 interviews)

	CROP	Mapachico	Genoy	Nariño	La Florida	Sandona	Consaca
VEGETABLE	Arracacha		■		■		
	Avocado		■				■
	Beans	■	■		■		■
	Beetroot	■		■			
	Broccoli	■		■			
	Cabbage	■	■				
	Carrot	■	■	■			
	Cauliflower	■					
	Chard	■	■	■	■		
	Corn	■	■	■	■		■
	Cucumber						■
	Hortalizas		■				
	Joyoco		■		■		■
	Lettuce	■	■	■			
	Onions	■			■		
	Peas	■	■		■		
	Plantain					■	■
	Potato	■	■	■	■		■
	Tomato	■	■	■	■		■
	Yucca		■				
FRUIT	Banana		■				■
	Blackberry			■	■	■	■
	Granadilla		■				■
	Guayaba						■
	Lemons		■		■		■
	Limes						■
	Lulo		■				■
	Mandarin						■
	Oranges		■				■
	Papaya						■
	Peach		■				
	Strawberry		■				
	Tangerine						■
OTHER	Coffee					■	■
	Sugarcane					■	■
	Coriander	■	■	■			
	Parsley		■				
	Paprika						■
	Wheat	■					
	Linseed		■				
	Fique			■			
	Medicinal plants			■			

Table 5.4. Summary cultivation profiles for the 6 different communities interviewed around Galeras (n=91 interviews)

Site	**Vegetables** (Total 20)	**Fruit** (Total 13)	**Other** (Total 9)	**Cultivation Profile**
Mapachico	13	0	2	All vegetables, no fruit
Genoy	14	7	3	Both
Nariño	8	1	3	Mainly vegetables
La Florida	9	2	0	Mainly vegetables
Sandona	1	1	2	Coffee and sugarcane
Consaca	8	13	3	Vegetables + large fruit diversity

Corn, potatoes and tomatoes were grown in 4/ 5 of the sites. 12 of the crops including cauliflower and paprika were only recorded in one place.

5.4.5 Relative importance of land use

When asked the purpose of growing each individual crop, three options were offered; personal consumption, selling or both. The predominant reason was personal consumption (94/221) which can be seen in figure 5.8. In addition, 43/221 crops were grown for commercial purposes and 53/221 for both personal consumption and commercial. Thirty-one household representatives failed to provide a purpose.

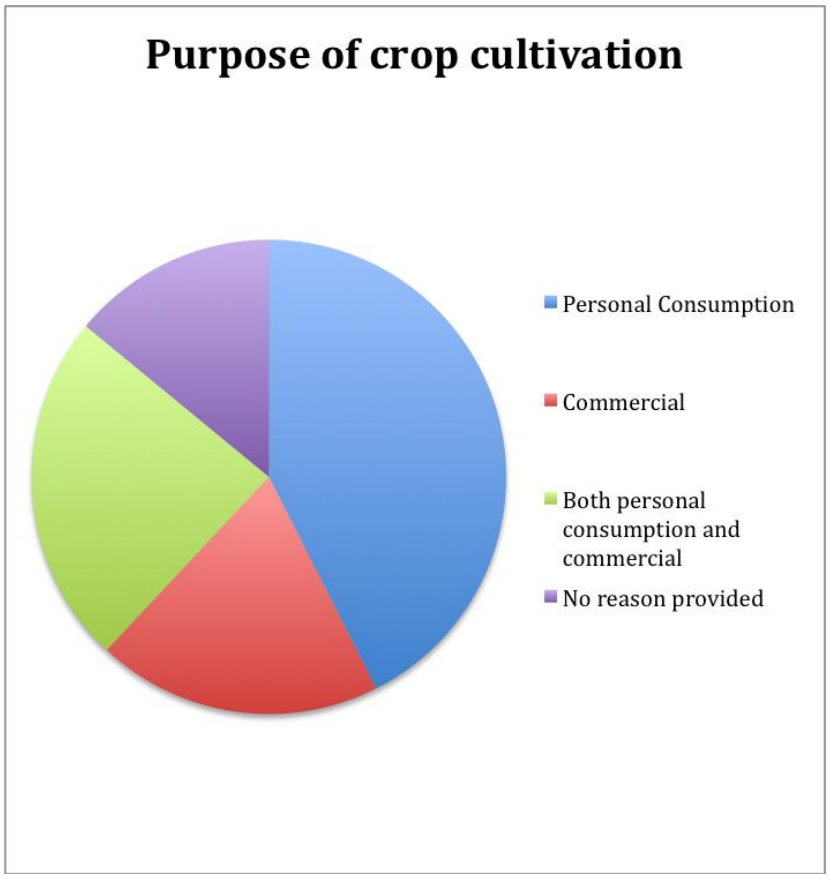


Figure 5.8. Stated purposes of growing different crops in the 6 different communities interviewed around Galeras (n=91 interviews).

The top three crops mostly commonly grown for personal consumption were corn (19/94), potato (8/94) and beans (5/94). The benefit of growing their own crops was not only recognised for supplying food for consumption but also for the household budget as money was not being spent on those products grown, '*we have a place to make our own harvest, don't have to buy anything,*' (ConCFG) For commercial purposes, the highest ranking crops were coffee (6/43), beans (5/43) and corn 5/43.

When asked 'what is the most important crop to your household?' corn, potato and coffee were ranked the highest.

The importance of the produce grown on the volcano was not only to those living on the mountain and working the land, it was also recognised that there was also a major benefit to those living down slope in the city of Pasto and other areas, '*the people are feeding the people of Pasto who don't have access to the fields, Pasto has food from the volcano'* (CulUoN), '*Selling things to the city that they don't have access to'* (FedCaff)

'To Pasto they sell fruits including mortino, chaquilulo, motilon, medicines such as frailejon for pulmonary diseases and granicillo for heart and blood pressure. Between villages there is animal commercialization in local markets' (EcolUoN)

5.4.6 Economic value of land use

From the record of crops grown it has been shown that each case study community had an individual land use profile, attributed to both environmental and social factors. The representative of the Camara de Commercial (Chambers of Commerce) highlighted the importance to the local economy of what individuals were growing in their back gardens and what they are doing with the products and added that each community had its own microeconomies.

Genoy, Nariño and La Florida – Cuisine, particularly cuy.

- '*The most important companies are little restaurants that sell many things to the people of Pasto'*
- *'At weekends people cook and sell the cuy'*
- *'People consume many things in Genoy'*

Sandona - Panama hats and panela

- '*The strength is the pajatoqiha – for the hat's*
- *'The main business is the sugar cane and the panela'*

Consaca - Coffee

- '*The coffee is the best business'*

5.4.7 Cultural value of land use

Agriculture did not register highly in the discussions of motivation to stay living on Galeras, even though 66% of households stated that they had one or more parcels of land, the majority of which were farmed. However in the discussions of land use and direct benefits, both show that agriculture is of great importance to the community

Comments made by the culture expert from the University of Nariño may provide insight in this dichotomy of results, outlining that the stronger the relationship people make with the city, the weaker their relationship is with their own land as a result. He labeled this process 'deterritorization', the loss of territorialism; '*Nowadays the people don't depend on the land, they are closer to the city', 'the city has more resources', 'the new generations are so influenced by the*

culture', 'they don't feel the territory', 'the life and society of the people on the mountain is lost', 'the culture is in the history, and customs are very important in the farm'.

An independent cultural expert described how motivation to stay on Galeras might also be spiritual, built much on what crops people can cultivate, how they prepare them, and where they store them. She explained that combined '*all of these little facets make up the indigenous identity', such as* cooking *in a certain way'* and *'storing corn in the eves of the roof so that it would keep between one year and the next'.* These practices, repeated every year, passed on from generation to generation, have become tradition.

As much as belief systems direct why and how people use their land, the independent cultural representative also highlighted that this includes areas not to use or to avoid completely, '*Spiritual beliefs are also why people won't use certain areas depending on their location'*, 'Because of the animals in the place, *the plants and animals have different importance's based on their spiritual purposes', rocks are guardians', 'for the weather can be very superstitious', 'for the belief that ghosts frequent areas of water, you can pick up bad spirits from the water'.* The representative went on to explain that this is not just a local 'relationship' but one across the whole Andean region, *'In the Andean world there is a strong sense of belonging and everything in its right place, this is tied deeply to the landscape*'.

A cultural representative from the Alcalde also explained that the previous land use of the ancestors of those living on Galeras today has had a great influence on their cultural practices; *'the Quiliiciungas were more commercial communities, selling peanuts, aji and gold', 'In other municipios the economics dynamics are very different, in Genoy they have a way of sustaining through their agriculture'.*

In summary, the culture of those living on the volcano appears to be shaped from the produce grown, the ways in which people work the land and what they do with the produce and other natural resources once they have taken it from the land. *'The organisation of society depends on the volcano, agriculturalists and the indigenous', 'their life is in the land', they value their land because it gives them activities', 'their land makes all for the life'* (CulUoN)

As the volcano is of such great value to them, to lose it would have a huge impact on their lives. This possibility was found to be of great concern to the majority of individuals living on the mountain, '*their biggest fear is not living with the volcano, it's if they have to leave their land', 'if they leave the land they have nothing' (*CulUoN)

5.5 Theme 5: The direct benefits of Galeras

After the previous discussions of quality of life, motivation to reside, income and land use, approximately half of the household representatives interviewed, 43/91, responded ‘none’ when asked what direct benefits they gained from Galeras.

Of those 48 respondents who did acknowledge either one or more direct benefits, a total of 18 different themes arose that were translated into both primary and secondary codes. As can be seen from table 5.5, water (32/43, volcanic ash (21/43) and clean air (7/43) ranked as the top three.

Although ‘tranquility’ ranked highest in both discussions of quality of life and motivation to reside, in the discussion of direct benefits gained, it only ranked 6th.

Table 5.5. Secondary and primary coding of direct benefits of living on Galeras, as perceived by the households interviewed (n=91 interviews).

Secondary codes	Primary codes
Environmental	Natural resources Vegetation Land Volcanic ash Climate Water Wood Air Unpolluted Scenery
Social	Tranquility Enjoyment Everything for life Dwelling Connection with the land Home
Economic	Agricultural workers Government help

Both the community focus groups and community and external expert interviews gave further insight into the direct gains of the volcanic activity at Galeras. During the interviews the following themes arose; water, soil fertility, the eruption, agriculture, tourism, transport, location, coffee, climate, topography, tranquility, forest, friend, economy, aesthetics, ancestry, location, security, services and health.

5.5.1 Water

Of the 43 household representatives that perceived themselves to directly gain from the volcano, 32 perceived water to be one of the main gains. Water was also a major topic discussed in the community focus groups and internal and external expert interviews. Sub themes highlighted were:

1. That the mountain directly provides the communities with natural water; '*from the volcano we have water'* (NarCFG), '*the mountains give us water'* (MapCFG) '*the volcano bears several sources of water that nourish the aqueducts'* (AgLF), from *'rivers, springs and fountains***'** (AgCon), '*this area is very hydrological'* (LFCFG), **'***The volcano is important for hydrological benefits'* (AgSan)
2. That much of that water is used for drinking, '*we drink this water directly from the sources on the volcano* '(ESLF).
3. That the water is perceived to be plentiful, '*water here is abundant*' (LFFG), '*the water here is very rich* (MAP/CR/L)
4. That because it is abundant there is no conflict between community members, '*In other places there is fighting for water*' (SanCFG)
5. That the composition of vegetation is because of the availability of fresh water, '*there is much diversity because of the water springs*'
6. That the water is free.
7. That the water is clean and unpolluted, '*the aqueduct doesn't have contamination*' (MapCFG)
8. That as a result of its perceived purity, the water is considered to be beneficial to health, '*The water improves the quality of life because it is without pollution*' (MapCFG), '*we are healthy people due to the pure water, the water here is good for our health*' (MapCFG).
9. That the water is also believed to be rich in minerals, '*the most important thing is the water with the good minerals'*, '*There are good sources of minerals in this water*' (LFFG)

As water is such a valuable commodity within the communities' lives, its protection is of high priority to many, 'we look after the water and the sources, we grow trees around the aqueduct and reforest areas' (MapCFG).

5.5.2 Volcanic ash

As seen in Chapter 2, the literature review, the fertility of volcanic soil is often cited in volcanic literature as one of the predominant reasons why volcanic communities live on volcanoes. These 6 field case studies provided ample discussion on the topic.

The fertility of the soil was directly linked to the volcanic ash: *'Many ideas from the farmers about the volcano in regard to the ash, they believe that the ash has several elements for nutrients and a lot of silicate' (*AgUoN), *'The ash fertilises a lot', 'it is a communal fertilizer* (MapCFG), *'The fertility of the land is a direct benefit of the volcano' (LFCFG). 'The volcano gives us ash, which provides the soil with minerals and nutrients' (AgLF), 'the volcano gives us ash, minerals and nutrients' (MapCF2),'* '*ash is used to improve the products of agriculture*' (AgUoN), '*the soils are rich in fertilisation'* (AgSan) ' *the fertility of the soil is influenced by the volcano*' (AgCon) '*When*

rain and ash at the same time is good because it fertilises the soil' (MapCFG), '*fertile production' (* SanCFG), '*the richness of the soils,'* (SanCFG), '*Galeras volcano explodes ash, which is good for the plants',* (MapCFG), *'This volcano when active, ash fall over the crops and it can be nutrient for the plants' (SanFRep), 'it's a blessing for the people because the volcano helps with the agriculture, providing nutrients to the plants (AgSan), 'gives us sulphur just for a little time',* (AgUoN), '*the ash generates fertile soil to cultivate coffee which is known as one of the best coffees in Colombia'* (LFgRep) .

That crops have a unique taste as on Galeras; 'The ash has a big influence when the agriculture is growing, it makes it unique in the world because the fruits taste different' (AgAl), '*That the coffee industry in particular benefits hugely from the 'unique taste', 'best coffee in the world because of the conditions'* (SanCFG), *'ash from the volcano gives different characteristics ',* 'special coffee with a special flavor thanks to the volcano'.

However although ash is highly regarded it is acknowledged that there is a threshold where gain can become loss due to the plants fragility. An agricultural representative from the University of Nariño warned that, '*soils from volcanic origin have a problem*', '*if the soil is of volcanic origin then the phosphorus, one of the most important elements, is immobilized*', '*if the plants can't get enough phosphorus then it's necessary to add it to use fertilisers with a high content of phosphorus*', '*the farmers have to use fertilizers in order that the plants can obtain nutrients*'. '*Sometimes there is a problem with the physical pressure of the ash on the crops, as when it settles onto the leaves of the plants it breaks the cells and produces microsis', as a result the plant is damaged in the cells because the ash breaks the cell wall and some of the cells die', 'The animals that eat these crops e.g. grass is possible they have problems in their mouth* (AgUoN).

The volcanic activity itself was also seen as a benefit as 'people like and enjoy the activity', 'the Consaca people like the volcanic activity, it's something to look at' (LeadCon).

The volcano is not only of local value, but national and even international value too, '*the volcano raises the profile of the municipality when it's active as publicity about the municipality is because of the volcano'* (LeadCon).

The geological process of mountain building and volcanic activity provides a geological and topographical landscape, which changes at varying altitudes. These 'foundations' combined with altitudinal change, which in itself influences climate, together presents a variety of conditions (geological, biological, hydrological) and niches that presents advantages for the settlement and colonization of a variety of flora and fauna.

"*There is a variety of topography on the mountain"* (AgCon), *'it is important because it presents microclimates'* (AgCon), "*here there is all the climates from hot to cold*" (SanCFG), '*the weather helps them to grow several crops*' (SanCFG) "*different species are grown in different zones at different heights, not only for the soil but for the temperature too*" (AgUoN), '*there is a diversity of flora, fauna and food' (AgCon), 'there is biodiversity in the products of agriculture for food' (MapCFG).*

The best example of the relationship between biological niche and society on Galeras is the growth of coffee. Coffee is a crop that thrives in very specific environmental conditions of which can be found in certain areas at Galeras. In addition, the crops success is supplemented by the addition of the fertile ash of which is said to provide its distinct flavour.

'The quality of the land improves the taste of the coffee because of the microclimate' (ERLF), '*the wind all the time brings the rain which is good for the coffee'* (AgSan) *'the formation of the canyon helps to increase the temperature in these types of zones because of the slopes of the canyon*' (AgSan), *"The volcanic soils are the origin of volcanic ash over a lot of time'* (AgSan), "ash gives several characteristics to let the coffee grow' (AgSan), *"we grow the coffee on the high steep sides'* (AgSan), 'ash from the volcano gives different characteristics" (SanCFG) *'there is a special flavour thanks to the volcano*' (SanCFG) '*It is the best coffee in the world because of the conditions*' (SanCFG), *'coffee from here is one of the best, it won an award for the quality and taste'* (ERLF) as discussed earlier.

The growth of coffee has not only become a livelihood activity but an industry within certain regions on the volcano, which in turn can be identified as a specific 'economic zone'. This relationship again highlights the ability for us to be able to model 'volcanic societies' by developing our understanding of why certain activities occur in certain locations. Chapters 5 and 6, which will discuss 'vulnerability' and 'hazard', will build on this 'system' highlighting the further relationships that suggest we can to a degree predict drivers of vulnerability by land use, which in turn links directly back to land cover and natural resources, which are themselves dependent on the geological and biological conditions formed by different volcanological processes.

The agricultural representative at the University of Nariño highlighted these 'niche opportunities' as one of the most important reasons why people within the communities of Galeras object to the current government relocation program, 'The landscape is very special here (in Mapachico)' (MAP/CR/E). Whilst the relocation package offers a substitute house in an alternative location, it doesn't offer replacement farmland, which would in fact be impossible to replicate, due to these

niches, unless people were moved to another part of the volcano, as the conditions are so unique to Galeras.

One point in particular raised in this discussion with the agricultural representative was the way in which the culture of the Galeras people has adapted to the conditions of the mountain, *"The topography on the mountain is very broken", "in other places people don't use the soil around the mountain but in this case there are community customs, many years people have been living and working on the volcano'.*

As a result of the direct link between culture and the environment, people's identity and ability to survive have become directly dependent on being located not only on a mountain or volcano but also specifically on Galeras. This ability to survive is a factor that the people argue is not recognised by the government in the relocation program. Consequently, they argue the relocation programme will directly result in a decrease in quality of life and inability to maintain community needs.

"It's very difficult to leave these areas because the government doesn't offer opportunities to improve life", "what the government offers isn't attractive', 'the people have two options and they prefer to stay' (AgUoN).

The potential cumulative loss of all that is their 'life' on Galeras due to the relocation program, is the source of a huge amount of both anger, which has resulted in high levels of conflict both between the communities and the government, and between community groups themselves, and fear, which has manifested itself in a range of mental health issues among those living on the mountain. Both of these issues are reported in greater depth within chapter six which explores the vulnerability profile of Galeras, but are attributed directly to the potential loss of all that is 'valued', as detailed in this chapter.

Agriculture is not the only industry, which has been built on exploiting these environmental niches. Tourism is thriving and growing on Galeras as people not only come to enjoy the landscape and all that it has to offer, but also experience the culture of the communities, predominantly their cuisine.

'*There are benefits of the volcano to the municipality, the orography, the diverse landscapes, tourist attractions that generate profits*" (LFAgRep).

5.5.3 Opportunities for tourism

Tourism on Galeras can be broken down into cultural tourism, religious tourism, agrotourism, sports, food, ecological and volcanic. Although people come from other parts of Colombia as well as internationally, the main tourism to the mountain is from people in nearby Pasto visiting the volcano and its villages and towns, either for a day visit, for lunch, or for a day of cycling. Many people have holiday homes, 'fincas' on the mountain, which the families visit at the weekend. Tourism is important for two main reasons, the first is that it presents community members with an alternative income source and therefore an opportunity to divert from their traditional agricultural work, *'The tourist attraction gives to the community sources of money and diversity'* (ERLF). Secondly, those livelihood opportunities can then spiral out to contribute to the wider economy as community members spend their increased wealth', '*tourism here is important because many people come to see the volcano"* (AgCon)

The plus side of heightened levels of volcanic activity, is that it appears to attract visitors despite the increasing level of danger, '*The eruption is something beautiful, really interesting to see the volcano explode', 'the eruption is a spectacular opportunity for photos and videos', 'looks like in a comic, they come to see the volcano, it's something unique'* (LFCFG).

5.5.4 Quality of air

Other perceived natural direct benefits gained were the quality of air, the beauty of the landscape and the forest.

The argument for air quality was based not only on the quality, *'here we breathe fresh air'* (MapCFG), '*here is pure air'* (LfCFG), but that again this is in some aspects a niche environmental quality that the volcano provides which cannot be easily found elsewhere, '*there* is purity in comparison to the city' (LFCFG), 'here is pure air, in the city there is no pure air' (HeaSan).

5.5.5 The beauty of the landscape

The beauty of the landscape was celebrated by individuals with a real sense of pride and satisfaction, with individuals both grateful for the beauty but also aware that the position of living on a volcano is quite unique; 'Mapachico is one of the most beautiful places' (MapCR/E), 'look, it's beautiful' (LFCFG), ' here it's beautiful' (LFCFG), 'other people admire the lifestyle of the people living around the volcano' (LFCFG), 'the volcano is something special, but *something only they can appreciate, other people don't have a volcano'* (LFCFG).

5.5.6 Forestry products

The forest hosts a multitude of resources, with the potential to provide for many different needs; '*there is a forest reserve in all this zone where you can find flora and fauna, it's a nice place for this kind of thing'* (AgSan), '*there is wood for construction and cooking, vegetable carbon for burning and calefaction to sell in the city. It is the most important resource for cooking because it's very cold'* (EcoUoN), '*there are other materials for construction such as plant fibres, Calamagrostis, to make the roof of the traditional homes and temporary homes for farmers to put their animals* (EcoUoN).

Trees are a particular commodity recognised by the communities for their role in protecting the water sources, and individuals have been taking action to enhance this resource, '*they are conscious that they shouldn't cut down the trees, this is why they have grown eucalyptus'* (MapCFG).

5.5.7 The Circumbalar road

Settlement and societies consequential development has resulted in a number of man-made features in the areas, which the communities also perceive to be direct benefits of the volcano. For example, the Circumbalar road that circumnavigates the volcano links many of the mountains communities together, including the six examined in this study. The road is used to transport both people and goods, and to the people who utilise it, the road appears to represent both freedom and productivity. It is commonly described by the community not as a transportation route but as a communication channel, as it allows people to connect with one another.

The 'paved' road is only approximately 15 years old. Before its construction the people only had a series of gravel pathways. With the introduction of the Circumbalar the villages were not only better connected with one another but also with the city. This connection with Pasto has not been solely positive as is reported in both Chapters 6 and 7 Hazard and Vulnerability, where the problems associated with the road such as the introduction of alcohol and drugs via the young people of Pasto visiting, are detailed more fully. With the introduction of the Circumbalar road people can now travel with more ease, either with their own vehicles or more commonly via public buses, taxis and motorcycle taxis; '*the advantage of this municipality is that there are connections with other communities'* (AgCon), '*all the vederas can connect with the roads'* (EdCon) '*transportation is no problem, you can go wherever you like'* (LFCFG).

With a large amount of people growing produce, the road network also allows the transportation of goods to markets, both on and off the mountain, *'producers can carry their products to market'* (EdCon).

People are also aware that the road network not only allows the export of people and goods but also input and is a direct contributor to the growing tourism industry of the region, '*here there is good infrastructure you can come here in a car'* (SanCFG)

It is not only the Circumbalar road that is of significant importance but the older network of pathways higher up the mountain that allow for the movement of produce and animals, '*we have an old road, for us it is like our production zone' (LFCFG), 'There we can grow coffee, fruits, avocado, tobacco, orange, lemon, pineapples, carrots, sugar cane, arracache and Kunh, peas, potatoes, repollo and cauliflower, oka, and cebada' (LFCFG)*

For the young people there is an additional but quite significant benefit associated with the road, that it transports them to the city for school and university, '*it is a shorter distance to university than in the past*'. (EdCon)

One key concern of the community is that the relocation program would cause the loss of this network of new and old roads, even though in theory it would be irrelevant as the people concerned wouldn't be living on the mountain anymore.

5.5.8 Other benefits

Other direct benefits of living on Galeras that fall into the category of 'social and economic' include;

5.5.8.1 Security

Security (as mentioned above): **'***In Pasto there is more crime* (LeadMap)**, '***here we can go without problems, but not in the city* (MapCFG)**, '***don't have fear about people here, but fear the people in the city because they are violent and can hurt'* (MapCFG), '*sometimes they sleep without locking the door because no one wants to steal anything*' (MapCFG).

5.5.8.2 A good economy

A good economy: '*it's an economic place to live', 'the water is free', 'electricity and housing is economical*' (LFFG), '*Services are cheaper, more economical, water and light sources aren't expensive*' (MapCFG).

5.5.8.3 Good health

Good health: '*People down slope are more sedentary; they have more problems, more illnesses. People outside have to walk more, work more; they have fewer problems*' (HeaSan).

5.5.8.4 Community

Community: '*Here we have good neighbours, if you have any problems you can ask for help', 'in the big cities people live without solidarity*' (LFFG), '*in winter when the people were sleeping, some houses were flooded, other people came to help them with food*' (MapCFG), '*when someone dies and the family need help, people give goods and the things they need*' (MapCFG).

5.5.8.5 Ancestry

Ancestry: '*My family was born here; it's tradition to live here*' (LFFG).

5.5.8.6 Social security

Social security: '*there are no natural benefits from the volcano but the health services are free*' (HeaCon), '*the health subsidiaries are the principle advantage*' (HeaSan)

5.5.8.7 Compensation

Compensation: '*it's a bonus to be near the volcano, the government only help the towns that are near to the volcano*' (HeaCon).

5.5.8.8 Symbolic reference

Symbolic reference: '*the volcano is a symbolic reference of religion, food and fertile land*' (CulAl).

5.6 Theme 6: Future Potential

The last question asked in the discussion of value was 'What do you think the future potential of your town is?' Of the 91 households interviewed only 3 people replied that they didn't believe their town had a future potential. A total of 15 themes of 'potential' emerged of which can be seen below in figure 5.9.

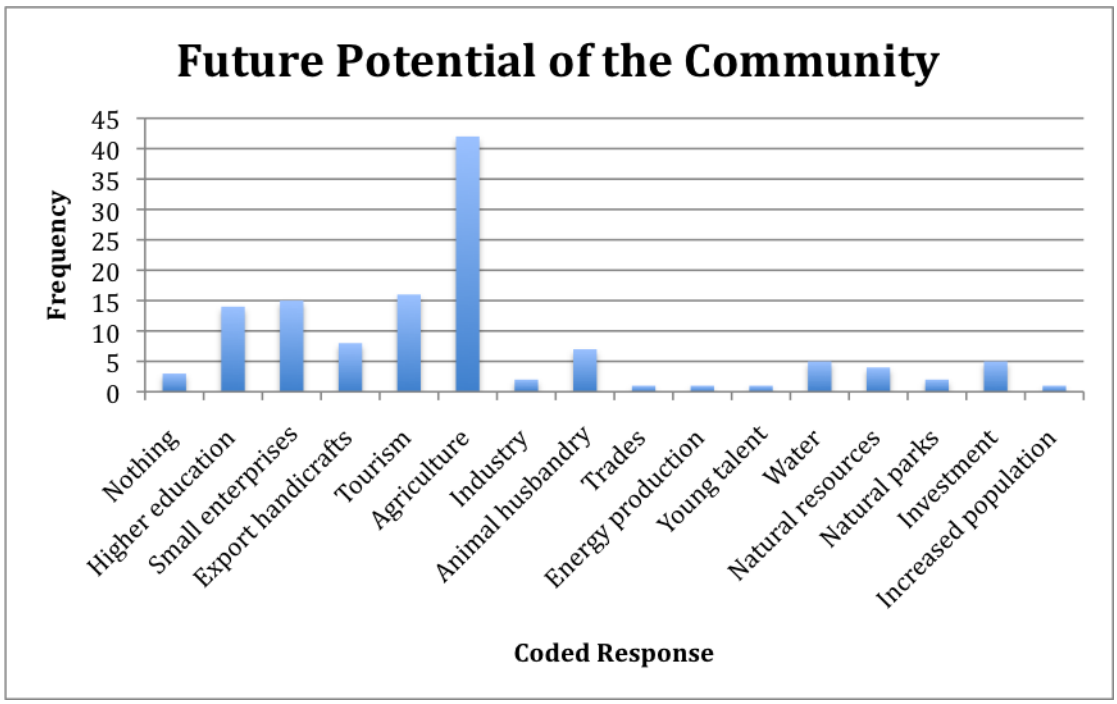


Figure 5.9. Activities perceived to hold future potential for each of the communities investigated in the household interviews (n=91 interviews)

As can be seen above, interviewees from across the six case study sites provided a diversity of ideas for the future potential of their areas, with agriculture, tourism and small business development achieving the greatest number of acknowledgements.

Figure 5.10 presents the perceptions of future potential across the six case study sites independently. This highlights in particular the commonalities between each of the six communities, where each community except La Florida identified agriculture as their greatest future potential.

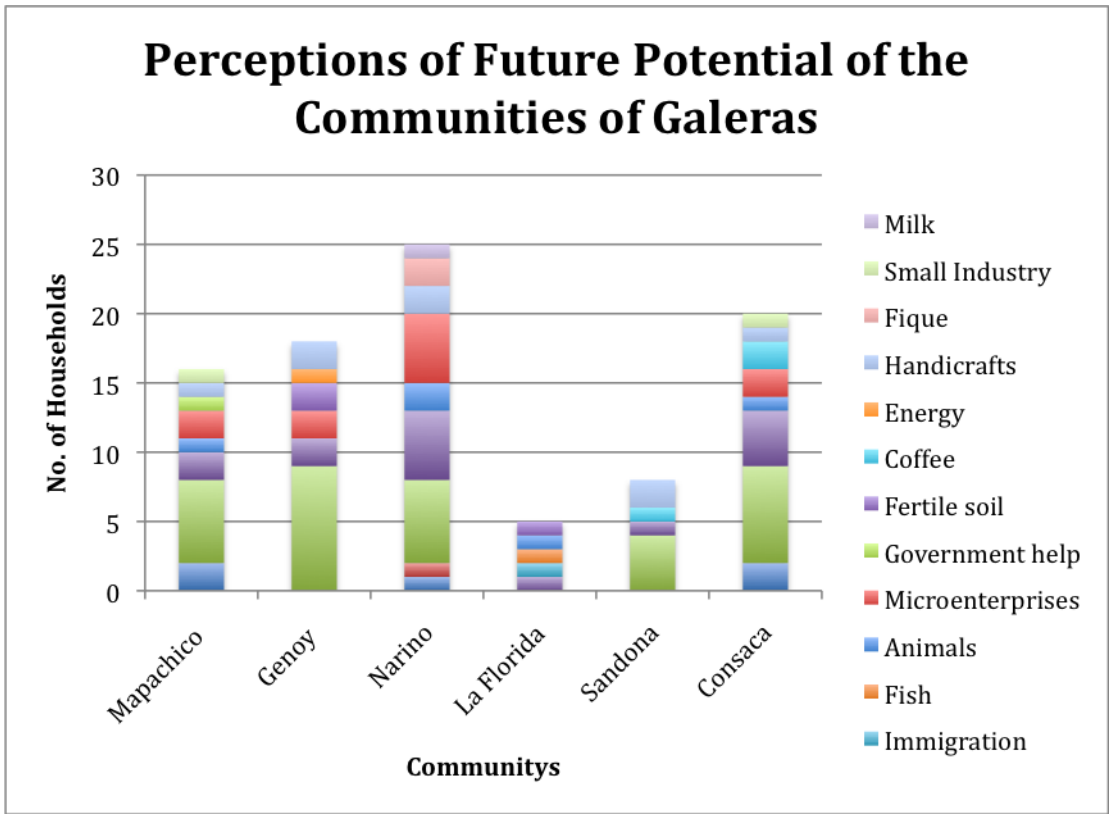


Figure 5.10. Activities perceived to hold future potential and how this varied for each of the communities investigated in the household interviews (n=91 interviews)

5.6.1 Agriculture

The potential of agricultural was the basis of 42/91 peoples discussions of future potential, '*The landscape is the potential because the volcanic ash is good for the land*' (BusGov).

Visions for the future '*exploitation of the land'* included a drive towards producing higher yields of particular crops for export, especially beans, coffee, sugar cane, brocolli and panela.

Coffee was a particular focus. An interview with an agricultural representative from Sandona highlighted that there is a growing market within the region for more coffee, '*Nariño has a big demand, people need more coffee in the area*', '*we need to expand areas of coffee crops, when we expand areas we can increase benefits'.* The representative praised the region for being suitable to meet the needs of expansion, having both the ideal environmental conditions and the artisanal agricultural techniques, '*we have the climate, the minifundios and the demand'*.

The government agricultural rep not only saw the regional potential but also international and the opportunity to become renowned as a specific global location for coffee, '*the coffee from Nariño is the best coffee in the world, this is why we have been working with different markets, boutiques and gourmet markets'.*

Despite the perceived large potential of agriculture, the agricultural representative emphasised the need for great investment to cover the costs of renovation and renewal, '*these processes will help the farms to improve their businesses', 'when they renovate crops they will increase productivity'*. In addition to investment, commitment from the younger generations is also required as it is well recognised that farming in the region is highly dependent on an aging population, '*they need young people to take some of the work because most farmers are around fifty years old'*. Investment and workers as well as other needs required to meet the potential of the area are discussed further in chapter 6 on vulnerability).

Discussions on the diversification of crops and cultivation methods were also had in the discussion of future potential, including the production of new seed varieties and the take up of new practices, '*we need to experiment on crops so that there is a greater variety*' (AgNar), "*we could use greenhouses to cultivate tomatoes*'.

A move specifically towards more organic production was considered favourable, "*Organic without chemicals',* as it gave farmers the potential to add value to their crops through certification, a processes where international recognition is given that a crop is farmed under certain regulations. At present although the majority of farming techniques are artisanal (significant in the certification process), a large amount of chemical pesticides are used. This means that organic certification, which would reap higher sales prices, would not be possible at present. There is, however, a pilot scheme in place to certify a small number of the coffee plantations in Sandona and Consaca, encouraging people to '*take care of the environment'* and '*manage the soil' (AgSan).* Many of the farmers interviewed hoped to join the scheme in the future, as the benefits were greatly understood in terms of profit, however, joining costs were of significant concern, an issue again explored further in chapter 6 on vulnerability.

The agricultural representative at the University of Nariño described how value could be added to coffee production in numerous ways other than certification, as many of the processes involved could be tweaked. Each of these changes could in themselves alter the flavour of the coffee, '*we can add value to the coffee with different processes, solar, spray, hot air, microwaves, freezers'.*

Diversification of livestock was also seen as a viable option for the future but was again largely dependent on outside investment in order to help farmers purchase animal stock, '*they could in the future raise livestock such as pigs if they wanted, if they were helped'* (AgNar).

5.6.2 Tourism

Tourism ranked as the second highest for future potential (16/42), specifically with a focus upon 'ecotourism' and 'ecological tours', to take advantage of the surrounding natural environment. '*We need to focus on tourism activities*' (AgCon)

The volcano itself provides a unique setting both for its mountainous landscape and volcanological features and processes. In addition, when the volcano is at an increased state of activity an additional set of attractions are present associated with eruptive explosions exhibiting gas, ash and lava.

An interview with a tourism representative from the Alcalde in Pasto explored the relationship between the volcano and tourism in the region and her views on how it should be encouraged and supported. She explained how Galeras was one of the three main points of focus in the present Mayor of Pastos tourism plan and that ecotourism was *'one of the most important things'.* The representative went on to add*, 'People come to the region specifically to see the volcano and therefore tourism, as an industry, should be encouraged', 'tourism is important in the area because people come to see the volcano'.*

Others in indirect agreement with the government tourism representative said*, 'the people in other places enjoy this landscape. People come from far away to enjoy and receive a warm welcome' (EdMap), 'Galeras is a tourist corridor, it is very important because people from the outside would like to see the volcanoes'* (LeadMap).

The volcano has become the basis for tourism so much that it is used in the logos of some tourism agencies, '*when some people work in tourism they use the image of Galeras. For this reason the volcano is important' (TourGov). As a result of the ever increasing number of visitors to the area, money is spent in small businesses providing services including 'restaurants, shops and thermal spas' (MapCRL), 'tourism is important because it generates income for the businesses in the municipio'.*

The development of tourism in the future would build upon an industry of which contributes significantly to the regional economy, 'the economics in Nariño is mostly due to tourism' (EcoandbusAl).

Tourism on Galeras takes advantage of everything that the volcano has to offer with each feature presenting a unique set of opportunity for business and potential profit, *'The volcano is a big potential for us that is why we exploit everything'* (TourGov*), 'Tourism is an opportunity, natural, agricultural, waterfalls, ecological paths, plants and flowers' (AgGov).* In a focus group consisting of three independent tourism consultants and a representative of the travel and tourism board, a picture of the tourism on Galeras was described:

- Ecotourism: including trekking, walking and camping in the natural reserves. Visiting waterfalls, lakes, rivers and thermal pools. Looking for species of flora and fauna.
- Adventure: Rapelling, canyoning, trekking, rafting, kayaking and paragliding.
- Culture: Celebrations and fiestas, factories, handicrafts, black and white carnival and historical sites such as Bombana the site of a historical battle.
- Religion: Religious fiestas and annual celebrations, churches, Sandona cathedral, specific sites for pilgrimage.
- Sport: Cycling, walking, kayaking, rafting.

The future potential of tourism was raised across all branches of interviews and predominantly focused on the wish of the communities to develop ecotourism and to introduce specialised tours of the volcano.

Views on ecotourism included*; 'ecotourism is one of the most important things'* (TourGov)*, 'the future potential is the development of ecotourism'* (EPLF), *'In some areas of the natural reserve ecotourism is important when the volcano is safe'* (EcoUoN) *and 'I think it's a big opportunity for ecotourism in the future, the landscape is beautiful to see',* (BusInd).

Views on introducing specialised tours of the volcano included*; "We can do tours around the volcano"* (EPLF), *'it's very nice to use the volcano, you can travel through different places and return to the city"* (AgUoN), *and* '*walking on the side of the volcano to visit the sanctuary'* (LeadCon).

5.6.3 Small enterprises

The development of small enterprises was deemed as having the third most future potential (15/42), predominantly setting up businesses to sell the local handicrafts in order to generate work, *'Ideal for the future is small businesses from their crafts'* (CulInd).

Repeated here was the discussion of how adding variety to products already being produced and sold on the mountain was also seen as an opportunity. In Sandona a key cottage industry is the handcrafting of Panama style hats, made from the fique palm. The agricultural representative from the University of Nariño explained that each variation of the hat, for example each different colour, each different pattern, each different style is a different product and gives the buyer both a choice and an option to buy more than one item, '*we can make hats with different colours to obtain more products and more value*'.

5.6.4 Water

Although water did not rank highly in discussions of future potential at the household level, within the community focus group meetings and expert interviews it was a hot topic in terms of its value to bottle and sell.

One of the leaders of Mapachico described how the previous year people from Pasto had shown interest in bottling the water because the water in Pasto was not good for drinking, yet the people of Mapachico had objected, '*It's our water*'. The government representative for business and economics expanded on the topic describing how a Californian company had proposed a bottling plant.

5.6.5 The community

Although the communities of Galeras recognise that there is much potential for the region, they also acknowledge that without willing and able people, those potential opportunities cannot be realised. Therefore it is essential that people be trained to partake in the activities needed, in skills such as agriculture and business and that there are people present to do the work, as one of the major societal problems identified (and explored in greater depth in chapter 6 on vulnerability) is that many young people only want to live and work in the city and not on the mountain.

The ability of community members was realised in many of the interview discussions, as was the responsibility upon the younger generations in the future to stay in their hometowns and villages and continue to build the communities.

One concern was that although many individuals were talented in the creative sense, those specific talents did not always translate directly into jobs, both because work as artists was minimal and no other qualifications had been gained due to a lack of higher education opportunities. '*Here in Genoy there are lots of artists, musicians, storytellers, poets, dancers, but there is no chance of working as an artist'* (LeadGen). The only work for most artists it was said, to express themselves creatively, was in construction, '*when you are a construction worker you create things with your hands and become an artist because there is not university' (LeadGen).*

The education representatives interviewed within each of the case study sites praised the young people they worked with and their talents, but worried that they wouldn't get the opportunity to develop their knowledge and skills in the higher education they needed to find employment,

'The students have great ability for sports. It is our responsibility to give them the opportunity but it is difficult for us to know how to do it'. In sports it is easier to give them the opportunity to practice but for arts it is more difficult, we need to find opportunities for them' (EdGen).

'Their creativity is one of the best, they are artists. They draw very good, they are very creative' (EdMap).

'They have a lot of strength and talent in education, sports and arts. The young people have a curiosity to explore new opportunities, they need to develop their skills in a good way' (EdLF).

'There are a lot of intelligent people here. The school has good grades, the highest in Colombia' (EdSan).

The need for the younger generation to take over the farms in order for them to reach their potential was also raised, as many young people are moving to the cities in search of jobs and not working on the farms; '*The potential is in their hands'* (LeadGen), *'they need young people to take some of the work because most farmers are around 50yrs old'* (LeadGen), '*they don't want their sons to go to the city, they want them to stay here with a house'* (MapCFG), '*people should die here and not in another place'* (LeadMap).

In order for the young people to meet their potential and in turn contribute to the future of their communities, many of those interviewed identified educational opportunities as needing to be increased and improved. One of the leaders of Mapachico argued, '*they need education to meet their potential', 'we need more schools', 'we need increased levels of development, the government needs to invest in education'*.

In addition, the Mapachico community focus group expressed that their dream was to have their own native education within the communities. They want to train young people how to work the land as they fear the knowledge is being lost with so many young people leaving the mountain to work in the city

5.7 Theme 7: Places of importance on Galeras

In addition to the questions used to explore 'value' within each of the interview populations, participants in the community focus groups were asked to engage in a public participatory mapping activity to identify areas of significant community importance.

Participants were given a base map of their community and asked to annotate it with references of locations that they agreed were of significant importance. Table 5.6 shows a summary comparing those locations identified as important within each of the of case study sites.

Table 5.6. Summary of areas of significant importance within each of the six case study communities (Map = Mapachico, Gen = Genoy, Nar = Nariño, La Flo = La Florida, San = Sandona, Con = Consaca). Colours represent themes: green = environmental features, orange = identified boundaries, blue = infrastructure and red= people

	Map	Gen	Nar	La Flo	San	Con	Total
Pasture (cows)							6
Crops							5
Fique							1
Medicinal plants							2
Flora							2
Fauna							1
River							5
Natural Park							1
Natural reserves							2
Oxygen							2
Coffee							1
Aqueduct							5
Oasis							1
Thermal pools							1
Big trees							1
Birds							1
Mountain slopes (skirts)							1
Ash zone							1
Poisonous plants							1
Cold zone							2
Medium zone							2
Hot zone							2
Zone of protection							1
Ancestral land							1
Dangerous place							1
Road							4
School							2
Health centre							2
Fique Machine							1
Shelter							2
Shops							1
Restaurants							2
Town centre							2
Market							1
Football stadium							1
Feeding station							1
Cemetery							1
Petrogliphs							1
Hospital							1
Communal house							1
Church							1
Houses							1
Women							1
Basket makers							1
Mote makers							1
Sombrero makers							2

All six community focus groups identified 'pasture' for their livestock as being an area of significant importance within their community. '*This represents the food and the economy*' said one participant of the community focus group of Mapachico. Five community focus groups out of the six, minus Genoy, identified 'crops' as being an area of significant importance. *'This is a good resource because people can grow their own products', 'they have an opportunity to sell', 'for our food'* were explanations of the importance identified in the Nariño community focus group. *'Here*

we have what we need', 'this is special food, very good' justified two participants of the Consaca focus group.

Five community focus groups, minus Consaca, identified the 'river' as being an area of significant importance. *'There are two parts to collect the water'* stated a member of the Nariño community focus group.

Five of the six community focus groups (except Consaca) identified the 'aqueduct' as being an area of significant importance. *'This is the most important place because water is life', 'the aqueduct provides water to so many homes'* (MapCFG), *'we use it for drinking and agriculture'* (ConCFG).

Four community focus groups, minus Sandona and Consaca, identified the 'Circumbalar road', between Pasto and Nariño, as being an area of significant importance. Explanations included, *'For the people that drive a taxi', 'for tourism for us and for visitors', 'for work', 'for our transport', 'it is important to connect with the capital and other towns'*, from the Nariño focus group, and, '*it is important for people to exit La Florida',* and *'important for tourists'*, from the La Florida focus group.

By comparison, there was a great difference in the amount of detail that participants of the different focus groups annotated their maps with. Whilst this could have been due to a few participants who appeared uncomfortable with the task, the amount of people participating in each focus group meant that there was always at least one person who took the lead, discussing the question with the rest of the group and making the annotations accordingly.

Further analysis recognised that Genoy and Mapachico, the two indigenous communities, annotated their maps with the greatest level of detail. Whilst there were some comparisons with the other sites in the inclusion of pasture and crops, the maps of Genoy and Mapachico also included a far more specific level of detail, identifying certain locations of 'certain sized trees, specific types of birds, certain topography, species of poisonous plants, ancestral lands, dangerous places, individual climates, people with specific trades and skills, species of snakes used for antiseptic and even where the best women for marriage lived. In stark contrast participants of La Florida and Consaca were more succinct, seemingly identifying much wider zones of land use such as the town centre and natural reserve.

5.8 Summary

These results showed that not everything that is valued by the people of Galeras is of capital value, with a focus place more on the importance of those individual factors to households and the community. A loss of these items would therefore also not just be financial but would have a direct impact on people's wellbeing.

Chapter Six: Deconstructing Hazard through a livelihood lens

Protest signs against the relocation program. Found in Genoy (Author, 2012)

6.0 Introduction

The literature review in chapter two highlighted ‘hazard’ to be another of the three key components of risk equation along with value and vulnerability. It revealed that hazard was conceptualized within the literature as being a negative impact or loss, caused as a direct result of a volcanic product or process.

This chapter focuses on exploring the ‘hazard’ component at the grassroots level. It seeks to move beyond the scientists and politician’s simplistic focus of the volcano as the hazard to volcanic communities, and instead seeks to identify all hazards that threaten the things that volcanic communities value for their livelihood activities and wellbeing. This was explored by asking participants; what they required for a good quality of life, what the consequence would be of not having access to those ‘necessities’, if in the last ten years they had encountered any difficulties in accessing those necessities and if they had, what had been the cause.

The data is presented by firstly discussing the themes raised in the household interviews where the data has been quantified through primary and secondary coding and frequency analysis. Secondly it is cross-referenced with the data from the community focus groups and community expert representatives. Thirdly, when required, the knowledge and opinions of external experts are used to provide context and explanations

6.1 Hazards and the livelihood system

In exploring hazard, interviewees were first asked to identify what they deemed necessary for a good quality of life on Galeras. A total of 268 different responses were given by 91 individuals, which were coded into 45 themed groups and after, secondarily coded by their livelihood capital. Figure 6.1 shows the frequency distribution of these responses. The top five ranked responses were; employment/salary (46), physical health (30), education (20), food (19) and water 15).

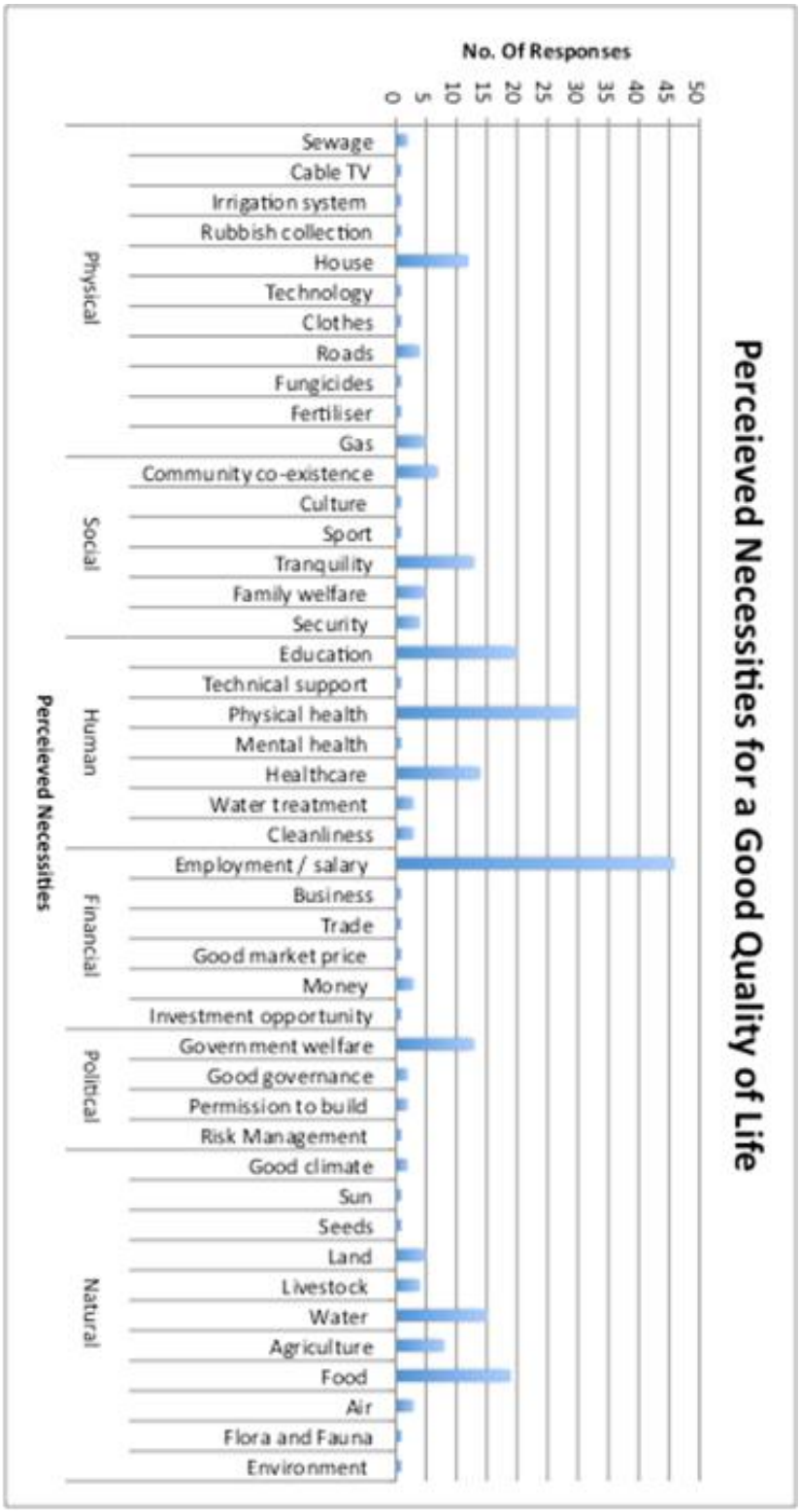


Figure 6.1. Perceived necessities for a good quality of life on Galeras, as determined from the household interviews (n=91 interviews).

By coding the needs of the communities into the six different livelihood capitals identified in the sustainable livelihoods approach (DFID, 2001), a more in-depth analysis could be carried out of the livelihood systems of those communities living on Galeras. Table 6.1 shows the secondary coding of livelihood assets into the livelihood capitals.

Table 6.1. Description of how assets identified from the household interviews around Galeras were coded as different livelihood capitals.

Livelihood Capitals	**Coded assets as identified in the household interviews.**
Social	Community co-existence, culture, sport, tranquillity, family, welfare and security.
Human	Education, technical support, physical health, mental health, healthcare, water treatment and cleanliness.
Financial	Employment/salary, business, trade, good market price, money and investment opportunities.
Natural	Good climate, sun, seeds, land, livestock, water, agriculture, food, air, flora and fauna and the environment.
Physical	Sewage, cable television, irrigation system, rubbish collection, house, technology, clothes, roads, fungicides, fertiliser and gas.
Political	Government welfare, good governance, permission to build and risk management.

The asset pentagram as seen in figure 5.2 below is a key part of the sustainable livelihood model and presents a visual representation of the livelihood assets of either a household or a collective community (DFID, 2001). The shape of the pentagram can be used, *'to show schematically the variation in people's access to assets* (DFID, 2001). The closer the line to the centre of the pentagon the less access to assets that the community has, whilst the closer the line to the edge of the diagram, the maximum level of access it has.

By charting the 'necessities' data as a radar graph the same approach to interpretation could be taken as with the asset pentagram (the only different being the addition of political capital).

Figure 6.2. Schematic representation of people's access to the livelihood assets perceived to be needed for a good quality of life on Galeras.

The Galeras community asset hexagon revealed a collective livelihood profile largely dependent on access to human, natural and financial capitals and less dependent on social, physical and political assets.

6.1.1 Access to livelihood assets 2002 - 2012

Having identified the key assets comprising the Galeras livelihood model, an accurate inventory of previous disruptions to livelihood security could then be compiled. Householders were asked, in relation to the necessities they had identified previously, if in the past ten years, from 2002-2012, they had experienced any problems in accessing the necessities required for a good quality of life. The interviewer asked the question in reference to each individual 'necessity' the individual had identified, recording a yes or no answer. On the occasions that the interviewee did not give a specific answer, an option of 'no answer' was recorded. A total of 139 'yes' answers, 95 no's and 30 no answers were recorded. The five largest numbers of disturbances to livelihood assets recorded were to employment / salary (33), healthcare (14), physical health (11), education (10) and tranquillity (8). Details of these specific impacts will be explored in greater depth in chapter six which explores the component of vulnerability, as the impact of hazard events is a key detail in understanding vulnerability at the grassroots level. This chapter focuses on identifying the source of impact. Table 6.2 (over page) shows the number of different answers recorded, whilst figure 6.3 shows the distribution of yes and no answers to each of the identified quality of life necessities.

Table 6.2. Top five ranked disturbances (shaded grey) to access to livelihood assets as identified from the household interviews around Galeras (n=91 interviews).

Capitals	Factors	Total Yes	Total No
Physical	Sewage	1	0
	Cable television	1	0
	Rubbish collection	1	0
	House	5	6
	Clothes	1	1
	Roads	2	0
	Fungicides	1	0
	Irrigation system	0	0
	Technology	0	0
	Gas	2	0
Social	Community-co-existence	2	6
	Culture	0	1
	Sport	1	0
	Tranquility	8	3
	Family welfare	3	2
	Security	1	1
Human	Education	10	9
	Physical health	11	10
	Mental health	1	0
	Healthcare	14	8
	Water treatment	0	2
	Cleanliness	1	2
Financial	Employment / salary	33	13
	Business	0	1
	Trade	1	0
	Good market price	1	0
	Money	6	1
	Investment opportunity	1	0
Political	Government welfare	3	4
	Good governance	0	0
	Permission to build	2	0
	Risk management	1	0
Natural	Good climate	1	0
	Sun	1	0
	Seeds	2	0
	Land	4	0
	Livestock	3	2
	Water	6	11
	Agriculture	5	2
	Food	6	13
	Air	1	1
	Flora and fauna	0	1
	Environment	0	0

According to the sustainable livelihoods approach (DFID, 2001) the asset pentagram previously discussed can be used to represent the 'constant change' in access to livelihood assets that community's experience. By plotting 'access' at different times, the change in shape can be analysed in order to describe the impact on the community. Figure 6.4 shows the assets required for a good quality of life and how many disturbances were experiences to those assets during the time period of 2002-2012.

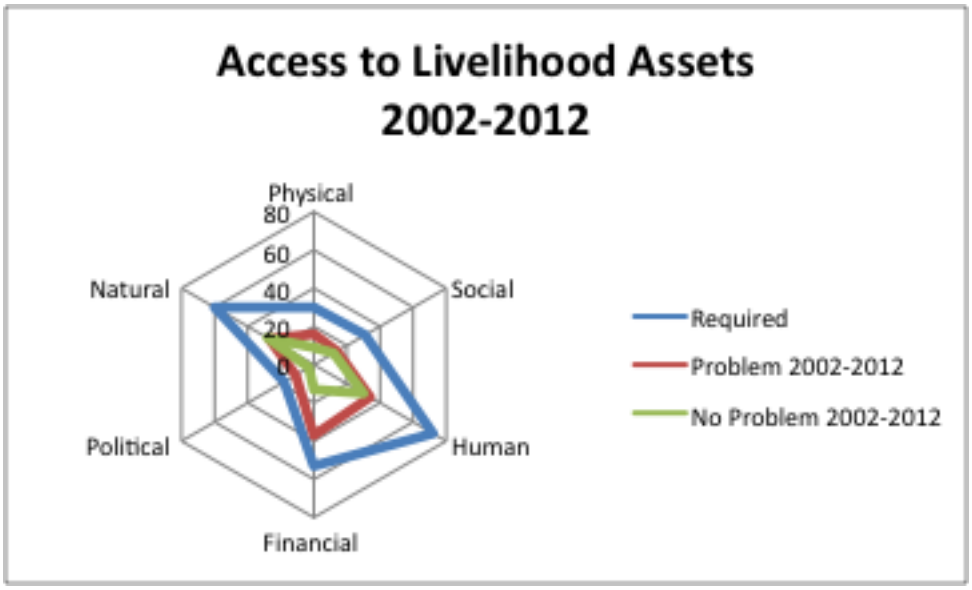


Figure 6.4. Schematic representation of access to livelihood assets between 2002 and 2012, among the communities interviewed on Galeras (n=91 interviews).

By examining the access data in the shape of the hexagon it can be seen that the greatest gaps between the 'required' line in blue and 'problem' line in red represents where the greatest levels of impact were felt to the different livelihood capitals over the ten year period. Here it can be seen that the greatest impact in total across all the communities was to human capital (education, physical health, mental health, healthcare, water treatment and cleanliness) whilst the least level of impact was experienced to political (government welfare, good governance, permission to build and risk management).

6.2 Categorising hazards to livelihood assets

Having identified the type of disturbances to livelihood assets between 2002 and 2012, the causes of those disturbances were then identified. This involved establishing what type of disturbances had impacted which livelihood assets. Data from 'necessities for a good quality of life' was cross-

referenced with data from ‘What was the cause of the problem?’ Data was also secondarily coded into both ‘livelihood capitals’ and ‘vulnerability context’ as described in chapter three in discussions of DFID’s Sustainable Livelihoods Model. The results of this analysis are displayed in a series of three conflict matrixes designed to show the impact caused by each specific type of disturbance, identified as either ‘trends’, ‘shocks’ or ‘seasonality’ (Tables 6.3, 6.4 and 6.5).

Table 6.3. (Over page) Conflict matrix of ‘trend’ disturbances to access to livelihood assets, as ascertained from the household interviews on Galeras (n=91 interviews).

TRENDS	Physical					Social					Human				Financial	Political				Natural					
	Sewage	Rubbish	House	Roads	Gas	Community	Tranquility	Family welfare	Security	Education	Physical health	Mental health	Healthcare	Employment / salary	Investment opportunities	Government welfare	Good governance	Permission to build	Risk management	Seeds	Water	Agriculture	Natural Resources	Total no. responses	No. of different impacts
Poor / no government provision	1	1	0	2	0	1	0	0	1	3	4	1	2	3	1	4	1	0	1	1	0	0	0	27	15
Declaration of disaster	0	0	1	0	0	1	8	0	0	1	0	3	0	0	0	0	0	1	0	0	0	1	0	16	6
Family problems	0	0	0	0	0	1	1	0	0	0	3	2	0	0	0	0	0	0	0	0	0	0	0	7	4
Poor private provision	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	5	2
Poor community behavior	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	4	4
Poor / no private investment	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	4	1

Immigration	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
No land	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Change in production	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	1
Bad employers	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	1
Global economic crisis	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	1

Table 6.4. Conflict matrix of 'shocks' to access to livelihood assets, as ascertained from the household interviews on Galeras (n=91 interviews).

SHOCKS	Human			Political	Natural								
	Physical health	Mental health	Employment / salary	Permission to build	Good climate	Sun	Land	Livestock	Water	Agriculture	Natural resource	Total no. of responses	No. of different impacts
Physical sickness	7	1	5	0	0	0	0	0	0	0	0	13	3
Poor climate	0	0	6	0	1	1	1	0	1	2	1	13	7
Volcanic eruption	0	0	1	1	0	0	0	0	1	1	0	4	4
Crop failure	1	1	0	0	0	0	0	0	0	0	0	2	2
Poor livestock health / death	0	0	1	0	0	0	0	1	0	0	0	2	2
Crime	0	1	0	0	0	0	0	0	0	1	0	2	2
Psychological stress	1	0	0	0	0	0	0	0	0	0	0	1	1
Chemical fertilizer	1	0	0	0	0	0	0	0	0	0	0	1	1

Table 6.5. Conflict matrix of 'seasonality' to access to livelihood assets, as ascertained from the household interviews on Galeras (n=91 interviews).

SEASONALITY	Physical		Social	Human				Financial		Natural					
	House	Fungicide	Tranquility	Education	Physical health	Mental health	Healthcare	Employment / salary	Investment opportunities	Seeds	Livestock	Agriculture	Food	Total no. of responses	No. of different impacts
Not enough money	3	1	0	4	2	0	1	0	0	1	1	1	1	15	9
No employment / salary	1	0	1	1	0	0	0	6	0	0	0	1	4	14	6
Old age	0	0	0	0	2	0	0	3	0	0	0	0	0	5	2
High costs	1	0	0	1	0	0	0	0	1	0	0	0	0	3	3
Poor market price	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1
Short term con-tracts	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1

Analysis of the conflict matrixes, summarised in table 6.6, show that the largest amount of disturbances to all livelihood capitals were 'trends' defined as:

'Factors that may or may not be more benign, though they are more predictable. They have a particularly important influence on rates of return (economic or otherwise) to chosen livelihood strategies' (DFID, 2001).

Trend disturbances identified in the data included; poor/ no government provision, the declaration of disaster, family problems, poor private provision of services, poor community behaviour, poor/ no private investment, immigration, no land, change in production, bad employers and the global economic crisis.

Different types of disturbances impacted different types of capitals. A combination of trends was identified as being the cause of impact to access to all of the livelihood capitals but particularly to human and social capitals. In comparison, shocks (definition) (including physical sickness, crop failure, poor climate, volcanic eruption, poor livestock health, psychological stress, chemical fertiliser, and crime) did not impact all capitals, only human, natural and political.

Table 6.6. Total number of disruptions to access to livelihood assets, as ascertained from the household interviews on Galeras (n=91 interviews).

	Physical	Social	Human	Financial	Political	Natural	Total
Trends	8	20	25	1	7	7	68
Shocks	0	0	26	0	1	11	38
Seasonality	6	1	11	11	0	10	39

Total no. of disruptions recorded = 145 (4 unattributed)

The highest ranking disturbance was poor/no government provision (27), a trend, which was blamed for the disruption to 15 different livelihood assets; sewage, rubbish, roads, community, security, education, physical health, mental health, healthcare, employment/salary, investment opportunities, government welfare, good governance, risk management and seeds.

The second highest-ranking impact was the declaration of disaster (16) blamed for disruptions to house, community, tranquillity, education, mental health, permission to build and agriculture.

Not having enough money ranked third (15), blamed for causing disruption to home, fungicides, education, physical health, healthcare, seeds, livestock, agriculture and food.

Interestingly, a volcanic eruption was only mentioned in 3% of responses as a disturbance to access to four livelihood assets; employment, permission to build, water and agriculture.

Table 6.7 highlights the frequencies of the different causes of disturbances whilst figure 5.5 shows the same data in graph format.

Table 6.7. Stated causes of disturbances to access to livelihood assets (the hazardscape) as ascertained from the household interviews on Galeras (n=91 interviews).

Disturbance	**No. of Responses**	**% of total Responses**
Poor / no government social support	27	18
Declaration of disaster	16	11
Not enough money	15	11
No employment /salary	14	10
Physical sickness	13	10
Poor climate	13	10
Family problems	7	5
Poor private provision	5	3
Old age	5	3
Volcanic eruption	4	3
Poor community behaviour	4	3
No / poor investment	4	3
High cost	3	2
Crop failure	2	1
Poor livestock health / death	2	1
Crime	2	1
Psychological stress	1	0.6
Chemical fertilizer	1	0.6
Immigration	1	0.6
No land	1	0.6
Change in production	1	0.6
Bad employers	1	0.6
Global economic crisis	1	0.6

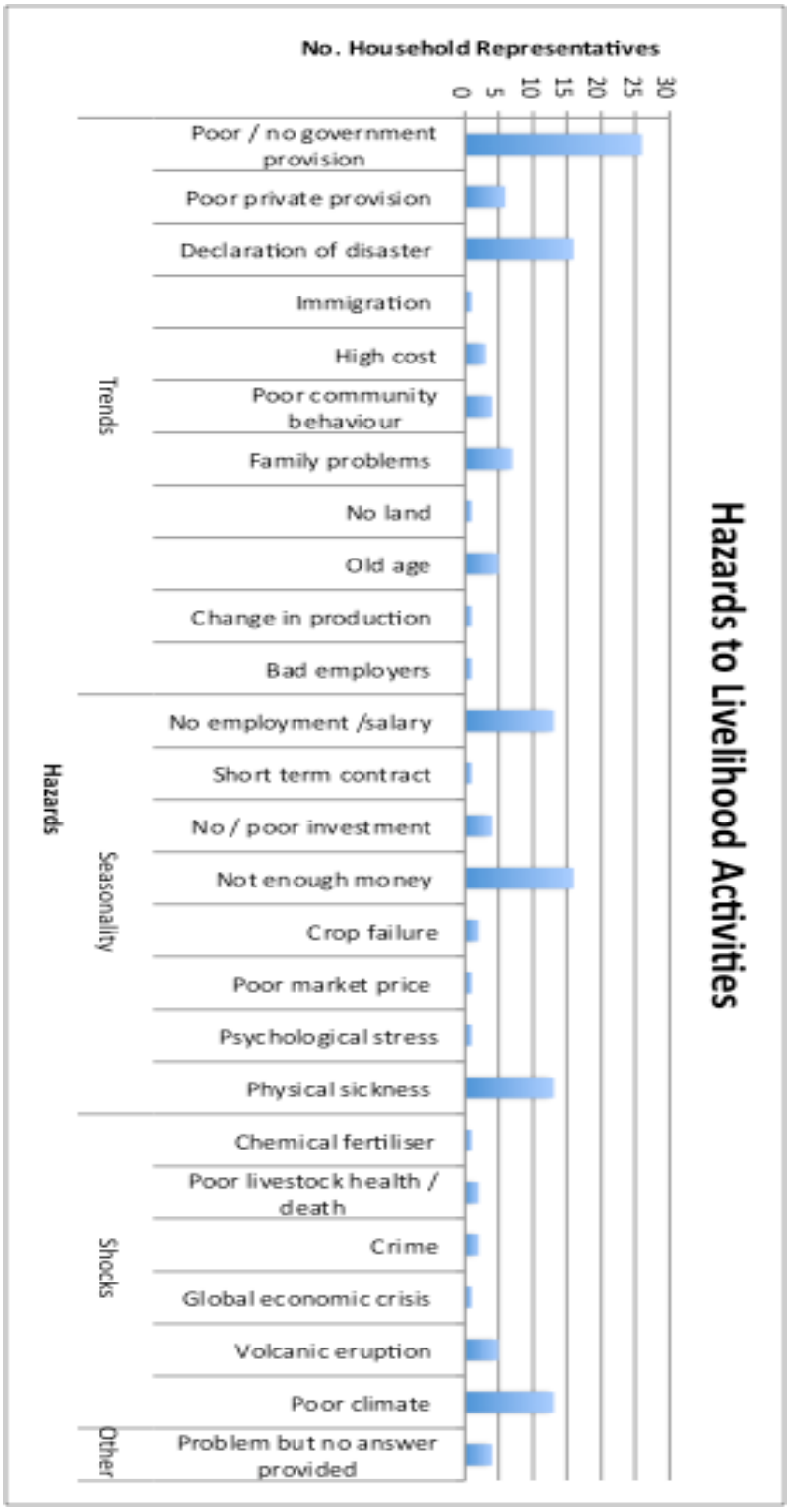


Figure 6.5. Disruptions to livelihood activities on Galeras, as ascertained from the household interviews (n=91).

6.2.1 The Galeras livelihood risk matrix

Risk matrices are commonly used during the risk assessment process to represent the varying levels of risk to an area, so that risk management strategies can be prioritised. Risk matrices are most commonly built on an axis of likelihood and consequence. High likelihood-high consequence is identified as the highest level of risk, whilst high likelihood-no consequence is identified as the lowest level.

The Galeras risk matrix presented in table 6.8 differs to the traditional likelihood-consequence model. Instead of representing likelihood (of which is unknown from the available data set), it represents the type of disturbance to have caused the impact on the livelihoods of the communities, of which is represented by the six livelihood capitals.
This matrix is not a predictive model; it identifies simply the events over a decade of time and the challenges to livelihood security that those events caused. By analyzing the different frequencies of answers the matrix identifies not risk but high, medium, low and no priority for planning and future risk assessment.

The levels of priority on the matrix were calculated by converting the number of individual disturbances of a specific type to a specific livelihood capital into a percentage. This was done by taking the total number of a particular disturbance type (trend, shock or seasonality) to a specific livelihood capital, dividing it by the total number of disturbances to that capital, and multiplying the total by 100. The full calculations can be seen in table 6.8.

- 0% is represented by a white box indicative that not such disturbance was recorded in the data to that specific livelihood capital.
- 1-25% is represented by a yellow box
- 26-50% is represented by a light orange box
- 51-75% is represented by an dark orange box
- 76-100% is represented by a red box

Table 6.8. The Galeras Livelihood Risk Matrix

CONSEQUENCE						
	Physical	Social	Human	Financial	Political	Natural
Trends	8 / 57%	20 / 95%	25 / 40%	1 / 8%	7 / 88%	7 / 25%
Shocks	0	0	26 / 42%	0	1 / 12%	11 / 39%
Seasonality	6 / 43%	1 / 5%	11 / 18%	11 / 91%	0	10 / 36%

The resulting Galeras Livelihood Risk Matrix seen in table 6.8 shows the varying comparative levels of impact that different disturbances have had on different types of livelihood capitals. This information in turn can be used to identify priorities for future risk management identifying that an immediate focus be on those areas identified in red (trends to social, trends to political and shocks to financial).

The significance of this matrix is that in areas such as Galeras where the focus for risk management efforts is primarily pinned on the levels of volcanic activity, this graph illustrates that underpinning livelihood security is a far more diverse and complex inventory of hazards.

It should be reiterated at this point that this risk matrix is neither conclusive nor predictive; it is a representation of events that have already occurred, which in turn is thought to provide a clearer picture of influences on the livelihood system. For future policy making this evidence base identifies where specific approaches are required to 'strengthen' the system. Whilst many of the 'hazards' cannot be controlled or diminished completely, efforts can be made to ensure that the livelihood system is protected from their impact. A further discussion of the need to strengthen the system will be the basis of Chapter eight, deconstructing vulnerability.

6.2.2 Mapping the hazardscape of Galeras

As was described in chapter three 'Hazardscape' is a term used to describe the spatial distribution of different hazards. It was deemed necessary to identify the variance with which the hazard inventory was spread throughout the six case study communities in order to identify, which hazards are a problem to all and which are more sites specific. This information in turn can be used to influence the strategy of future policy approaches, ensuring that a targeted, needs specific approach is used.

6.2.3 Comparing community disruptions

By looking at each of the case study sites independently it can be seen that whilst common disruptions were recorded amongst all six places, there was also the occurrence of unique disturbances occurring in only one place. Again it should be stressed that this study does not claim to be conclusive and suggest that an absence of an event within the data records means an assurance that it has never occurred or will never occur. It seeks simply to say that given the evidential testimonies of 91 households that from their perceptions, certain factors were of more influence to some individual's livelihood security than others and that this changed not only household to household but also community to community. Table 6.10 identifies the distribution of disturbances across the six study sites, highlighting areas where frequency was recorded, illustrating that each communities' inventory plots a specific profile on the graph in reference to its unique 'hazardscape'.

Table 6.10. Hazard profiles of the six communities around Galeras where household interviews were conducted (n=91 interviews)

Disturbance		Map	Gen	Nar	L. Fl	San	Con
Trends	Poor / no government provision	4	5	7		6	5
	Declaration of disaster	10	4		2		
	Family problems	1	3	1			1
	Poor private provision	1		1	2	1	2
	Poor community behaviour				1		1
	Poor / no investment			1	1		1
	Immigration		1				
	No land					1	1
	Change in production			1			
	Bad employers		1				
	Global economic crisis						1
Seasonality	Not enough money	3	3	4		2	4
	No employment /salary	2	3	5			6
	Old age		2	2			1
	High cost	2		2			
	Poor market price					2	1
	Short term contract		1	1			
Shocks	Physical sickness	3	5	6			1
	Poor climate		6	1	2	2	4
	Volcanic eruption	3		1			1
	Crop failure						2
	Poor livestock health/ death					1	
	Psychological stress		2	1			
	Chemical fertiliser		1				1

Table 6.11 illustrates the spatial nature of the impact of individual disturbances, identifying events that both occurred uniquely in one location, and others that occurred in multiple communities. Again it should be stressed that that the data is representative of the prioritised perceptions of blame of individuals for individual impact events and does not suggest that events simply did not occur in other locations. The data highlights that hazard is not homogenous to all and what may impact the livelihood security of one individual, or collectively one community, may not necessarily be the same as what impacts in other locations.

Each of the disturbances presents a story for analysis. The context surrounding the event in which they occurred gives detail as to the current levels of risk that individual households and communities on Galeras are facing.

Immigration, change in production, bad employers, the global economic crisis crop failure and poor livestock health/death were all unique disturbances recorded in one community, whilst family problems, no employment /salary, physical sickness, no government provision, poor private provision, not enough money and poor climate were all issues that four or more communities suffered.

'Change in production' was only identified as a disturbance in the community of Nariño. Across Galeras many people engage in the handicraft production of items such as hats and bags from the fique palm leaf. In Nariño many people have also traditionally made potato sacks and twine as one of their main income activities, a hazardous and laborious task involving the treatment of the palm and then the weaving involving a large wooden machine powered by a foot pedal to move the wheels. The introduction of plastic fibres onto the market has rendered this handicraft production almost obsolete and as a result left many unemployed. Whilst this change may have also affected individuals in other communities, it was only discussed in Nariño, where the event was blamed for both an individuals' current unemployment within a household interview and a community's high level of unemployment as a whole in the community focus group.

In comparison poor climate conditions were mentioned in five of the six communities (except Mapachico). Longer summers and lack of rain have not only resulted in an impact to agricultural production but had in turn led to loss of jobs for those working on the farms.

Table 6.11. Spatial analysis of perceived disturbances in the different communities around Galeras where household interviews were conducted (n=91 interviews). G=Genoy, M=Mapachico, N=Nariño, LF=La Florida, S=Sandona, C=Consaca.

Type of disturbance	No. Communities	Communities
Immigration	1	G
Change in production	1	N
Bad employers	1	G
Global economic crisis	1	C
Crop failure	1	C
Poor livestock health / death	1	S
Chemical fertiliser	2	G,C
Poor community behaviour	2	LF,C
No land	2	S,C
High costs	2	M,N
Poor market price	2	S,C
Short term contracts	2	G,N
Psychological stress	2	G,N
Declaration of disaster	3	M,G,LF
Poor/ no investment	3	N,LF,C
Old age	3	G,N,C
Volcanic eruption	3	M,N,C
Family problems	4	M,G,N,C
No employment / salary	4	M,G,N,C
Physical sickness	4	M,G,N,C
Poor / no government provision	4	M,G,N,C
Poor private services	4	M,G,N,C
Not enough money	4	M,G,N,C
Poor climate	5	G,N,LF,S,C

6.2.4 Cascading hazards

As the cause of each disturbances were analysed, the qualitative data identified a number of links between the different events. Figure 6.6. shows a systemic diagram of causality whilst the narrative below provides a description of how many of the elements were linked.

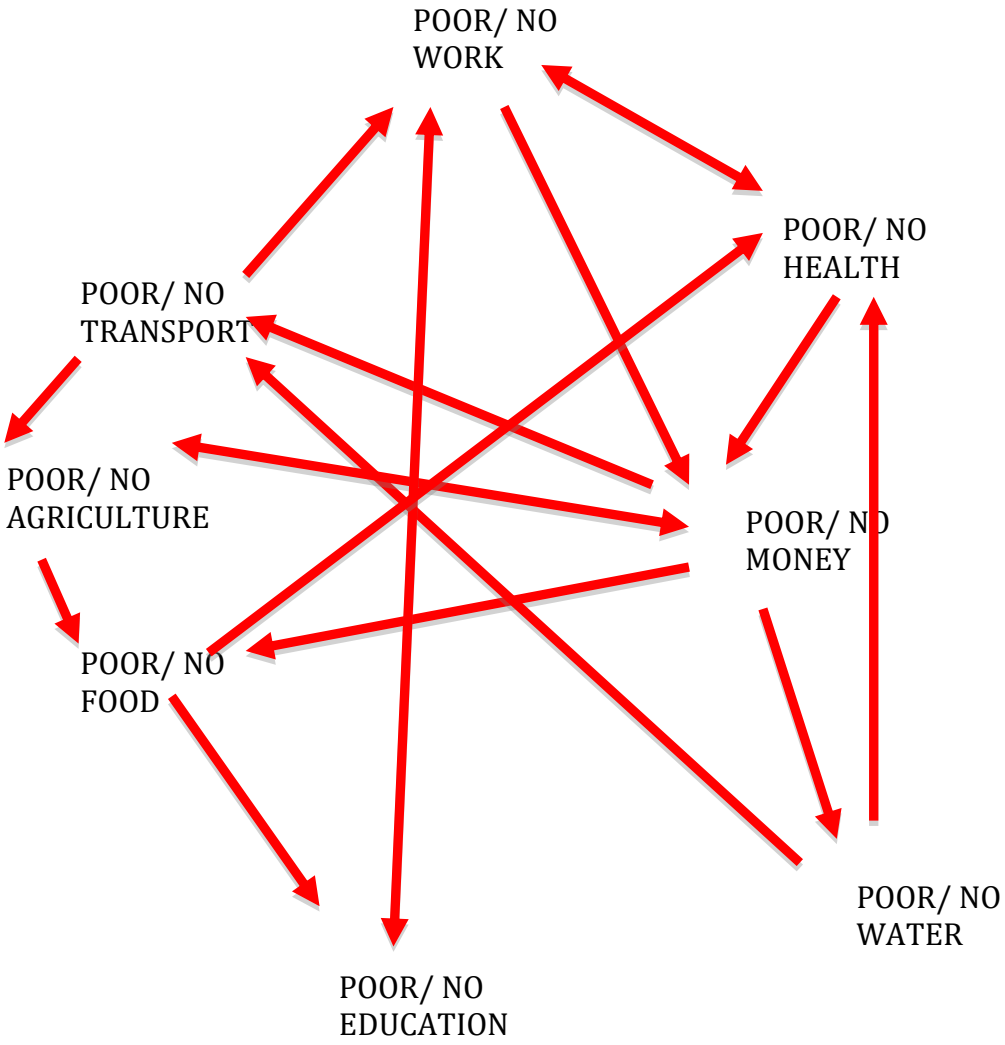


Figure 6.6. Systematic story of causality

When asked to identify what their household expenses were, food (82/91) was rated the highest and agricultural inputs third highest 24/91. This was because people could not afford to eat what they grew needing to sell it for income instead. Although there was a lot of variety of agricultural products grown, the biggest health problems for many people were identified as diabetes and hypertension caused by a high sugar bad diet. This was because people could only eat a small variety of what they grew, mainly high sugar crops of corn and potatoes, and the two highest ranking substance crops. These illnesses mean that people cannot go to work and their medication costs increase. If people need treatment that is not available on the mountain it means travelling to the city, which means a high cost of transport. If there is no money to buy food or only poor quality food is available then children do not function properly at school and their education suffers.

6.2.5 Localised hazardscapes

Further analysis at the community level showed the spatial variation of different causes of disruptions that had impacted each community, as shown in table 6.12 Here it can be seen that each individual community had over the ten year period in question experienced a different profile of events. Whilst some events were more generic, having impacted more than half of the communities, others were more localized, having only affected less than half of the communities.

Generic disturbances (3-6 communities): Climate change, Not enough money, Poor private service provision, Physical sickness, No employment / salary, Family problems, Volcanic eruption, Old age, Poor / no investment, Declaration of disaster

Localised disturbances (1-2 communities): immigration, change in production, bad employers, crop failures, poor livestock health, chemical fertilizer, poor community behavior, no land, high costs, poor market prices, short term contracts, psychological stress.

Table 6.12 Community hazardscapes

	M	G	N	LF	S	C
Poor climate		■	■	■	■	■
Not enough money	■	■	■			■
Poor private service provision	■	■	■			■
Poor / no government provision	■	■	■			■
Physical sickness	■	■	■			■
No employment / salary	■	■	■			■
Family problems	■	■	■			■
Volcanic eruption	■		■			■
Old age		■	■			■
Poor / no investment			■	■		■
Declaration of disaster	■	■		■		
Psychological stress		■	■			
Short term contract		■	■			
Poor market price					■	■
High costs	■		■			
No land					■	■
Poor community behavior				■		■
Chemical fertilizer		■				■
Poor livestock health / death					■	
Crop failure						■
Global economic crisis						■
Bad employers		■				
Change in production			■			
Immigration		■				

6.3 Summary

This analysis showed that a wide variety of disturbance events had affected livelihood resources during 2002-2012. Volcanic activity was only attributed by the communities to be the cause of a very small number of these events.

Chapter Seven: Deconstructing Vulnerability and Resilience

A landslide on the Circumbalar road between Consaca and Sandona (Author, 2012)

7.0 Introduction

As described in the introduction to this thesis, each of the three data chapters presented is a deconstruction of a separate component of volcanic risk, as identified in the literature review presented in chapter three. This chapter focuses on exploring the 'vulnerability' component at the grassroots level. It first seeks to identify income and expenditure within the households Secondly it identified the generic livelihood system of the Galeras communities and the components of it that need to be maintained for a good quality of life. Thirdly it identifies the different potential threats to those necessities. Fourthly it explores the coping strategies that the community utilises to deal with disruptions. Finally it explores what the communities perceive to be the future potential of their communities and what that future depends on.

Whilst some of the same data is used within this chapter as in chapter five, it is analysed in order to answer a different question. Whilst 'hazard' sought to identify the source of the disruptions, 'vulnerability' seeks to explore the variance of impact within the communities.

7.1 Identifying income and expenditure

In identifying the different sources of income to households participants were asked, what their household's main sources of income were, who was responsible for each income source and where that income source was located (i.e. where that work occurred). The 91 households represented in these interviews were home to a total of 447 individuals. When asked how many people within the household were responsible for at least one income source, 179 individuals (40%) were identified, an average of two per household. Only two households were recorded as not having any income sources. Responsibility for income was evenly distributed across gender, 121 male and 207 females / ages. In total 228 individual income sources were recorded, of which were coded into 29 different categories as can be seen in figure 7.1. The four highest frequency income sources were agriculture (49/228), livestock (48/228), cooking (21/228) and handicrafts (19/228). The location of each income source was also identified as either "On Volcano" or "Off Volcano", dependent upon where the activity associated with the source of income was carried out. A classification of 'other' was given for income sources that did not have a location as they came not from an activity but from a direct payment such as a pension or a social security payment.

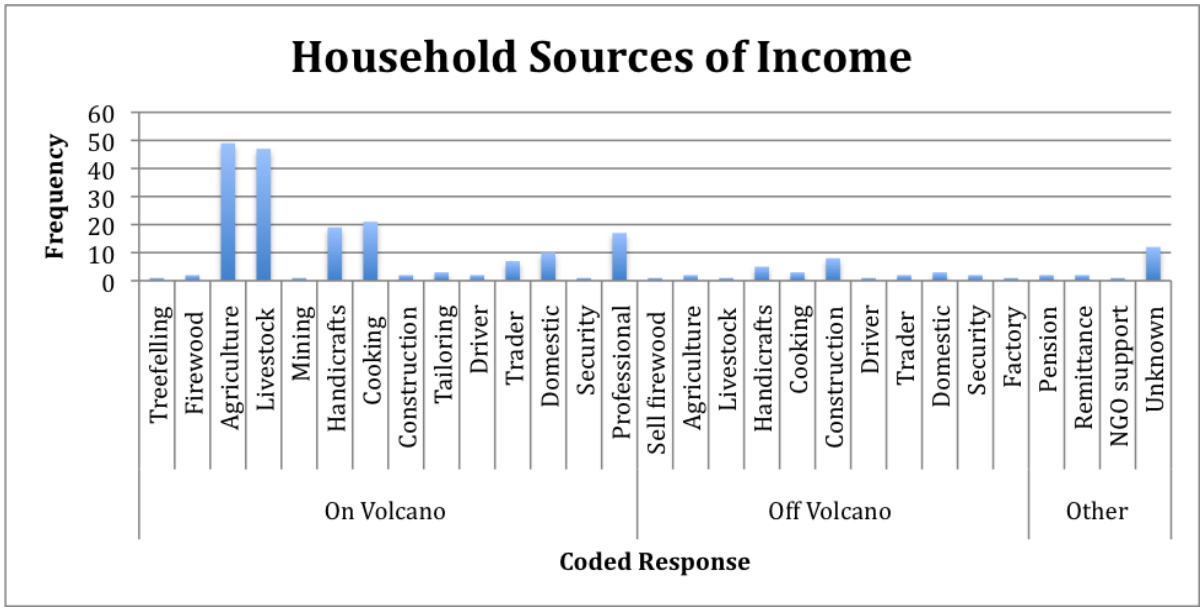


Figure 7.1. Sources of household income (n=91 interviews).

Of the 228 individual income sources, 80% (183) were reported as being located on the volcano, in comparison to only 17% (39) that were located off the volcano. A further 16 (7%) were classed as 'other' meaning they were not location dependent, these included pensions, remittances and non-governmental support.

Secondary coding was also completed, classing each income source by which sector of the economy they represented; primary, secondary or tertiary. Of the jobs located 'on the volcano', the greatest amount, 55% (101/183), were in the primary sector directly extracting natural resources, 23% (43/183) were secondary, creating a product, and 22% (40/183) were tertiary, working within the service sector.

Primary income sources were predominantly agricultural cultivation, the growing of crops to sell, and the rearing of livestock such as pigs and cattle, either to sell live or for specific animal products such as meat. It also included the mining of aggregates and tree felling. Secondary income sources were predominantly cooking food for selling in cafes, restaurants or on street stalls, and the making of handicrafts from the fique palm and other natural resources. Secondary income also included construction and clothes tailoring. Tertiary income sources were predominantly skills based including teachers, lawyers and domestic staff (see figure 7.2).

When asked, what the most important income source was to their household, agriculture ranked the highest (22), followed by livestock (10), cooking (7) and handicrafts (7) as can be seen in figure

6.2. Those income activities located on the volcanoes were perceived by the majority (74%) as being most important to their household as can be seen in figure 7.1.

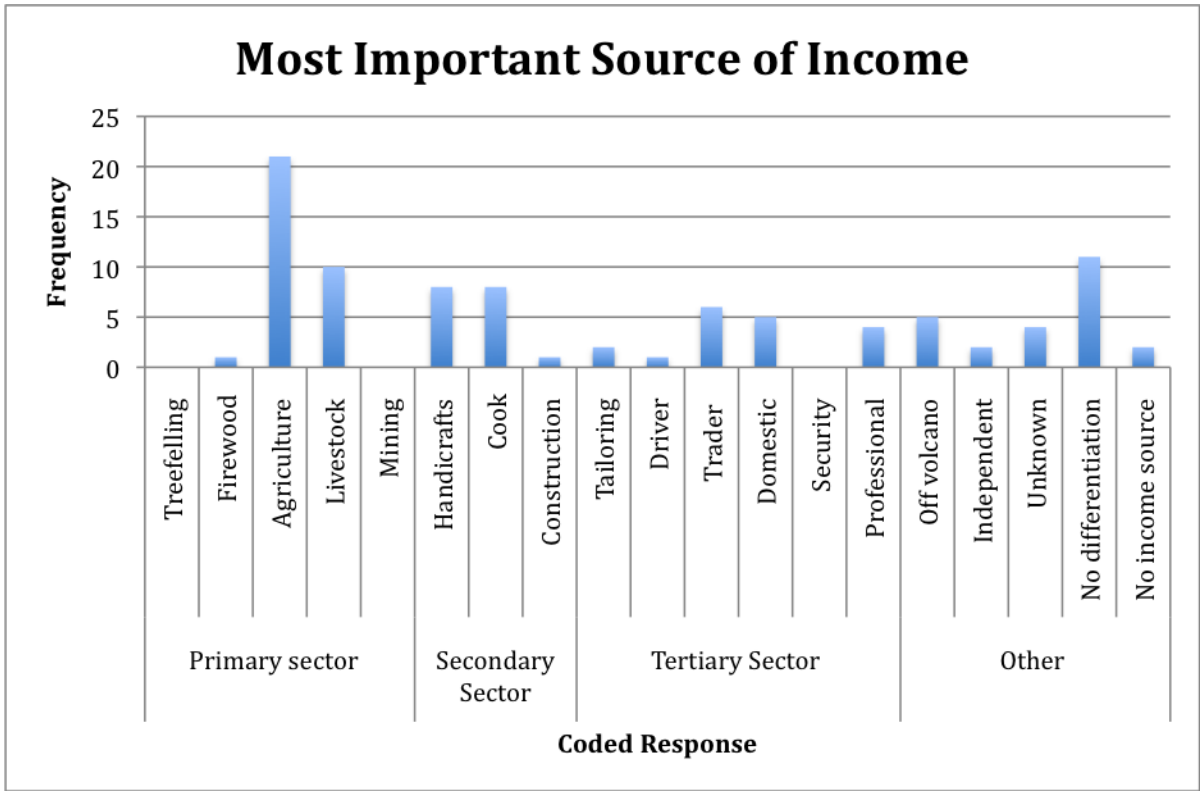


Figure 7.2. The most important sources of income to individual households in the 6 communities studied around Galeras, as determined from the household interviews (n=91 interviews).

7.1.1 Monthly expenses

When asked to identify what the individual factors of their monthly expenses were, all 91 household representatives provided one or more responses. A total of 304 individual expenses were reported, which were coded into 22 different categories, shown in figure 7.3. The six highest ranking expenses were identified as; food (82/304), public and private services, which included water and electricity (76/304), agricultural inputs, including fertilisers, seeds and pesticides (24/304), clothes (22/304), and education and healthcare (20/304). Although ranking less significantly, it is also worth noting that; transport (12/304), labour (10/304) remittances (10/304), debt repayment (9/304) and rent (5/304) were all mentioned as being an expenses incurred by at least five households.

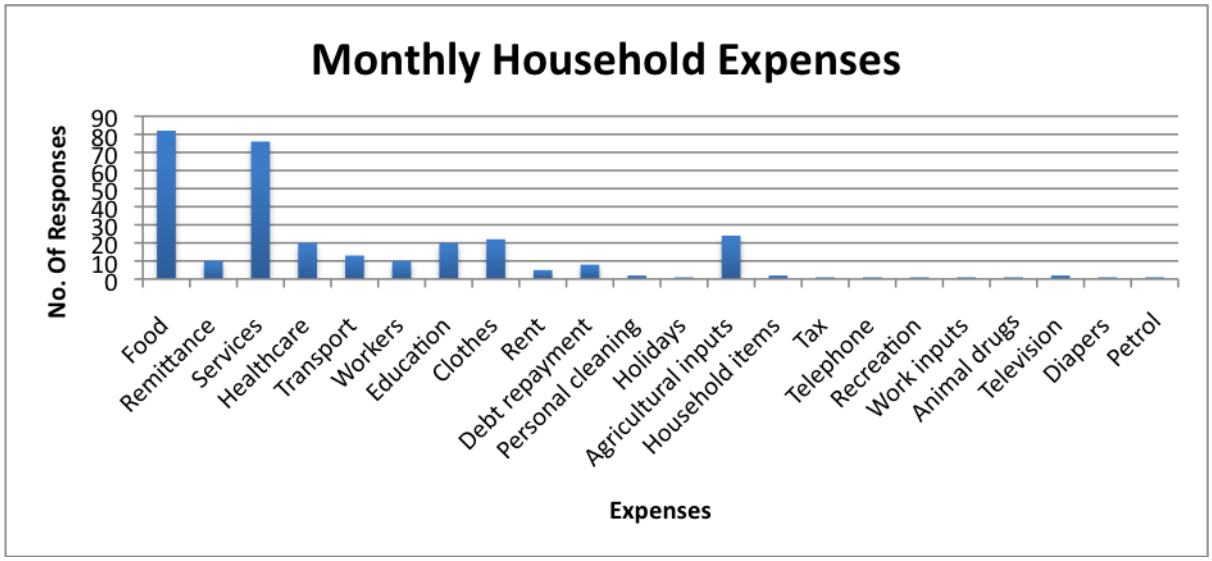


Figure 7.3. Monthly household expenses in the 6 communities studied around Galeras, as determined from the household interviews (n=91 interviews).

When asked to rank which three expenses formed the greatest part of the household budget, respondent's ranked food (75), public services (60) and agricultural inputs (20) the highest.

Acknowledging that expenses are not always constant, householders were asked if their expenses ever changed and if so what was the cause of the change. In response 38 /91 respondents said that their monthly expenses are subject to change as seen in figure 7.4. The predominant cause of change was healthcare costs (20 / 38) as a result of needing to pay for medication or the cost of seeing a specialist when either they or members of their family were sick or injured. Healthcare costs also included for some the transport costs to visit healthcare facilities in the city. Other reasons for change included Christmas and the need to buy gifts and extra food, replacing appliances such as fridges and freezers when they failed, household repairs, and replacing clothes when old. Seasonal labor to work on the farm, the need to buy food after a failed harvest and the event of a family death and incurring funeral expenses, also changed altered the budget. Three individuals also highlight that their spending behaviour changed when their income was less and they during such time they had to re-evaluate their priorities, meaning that some items were no longer affordable to them so they went without.

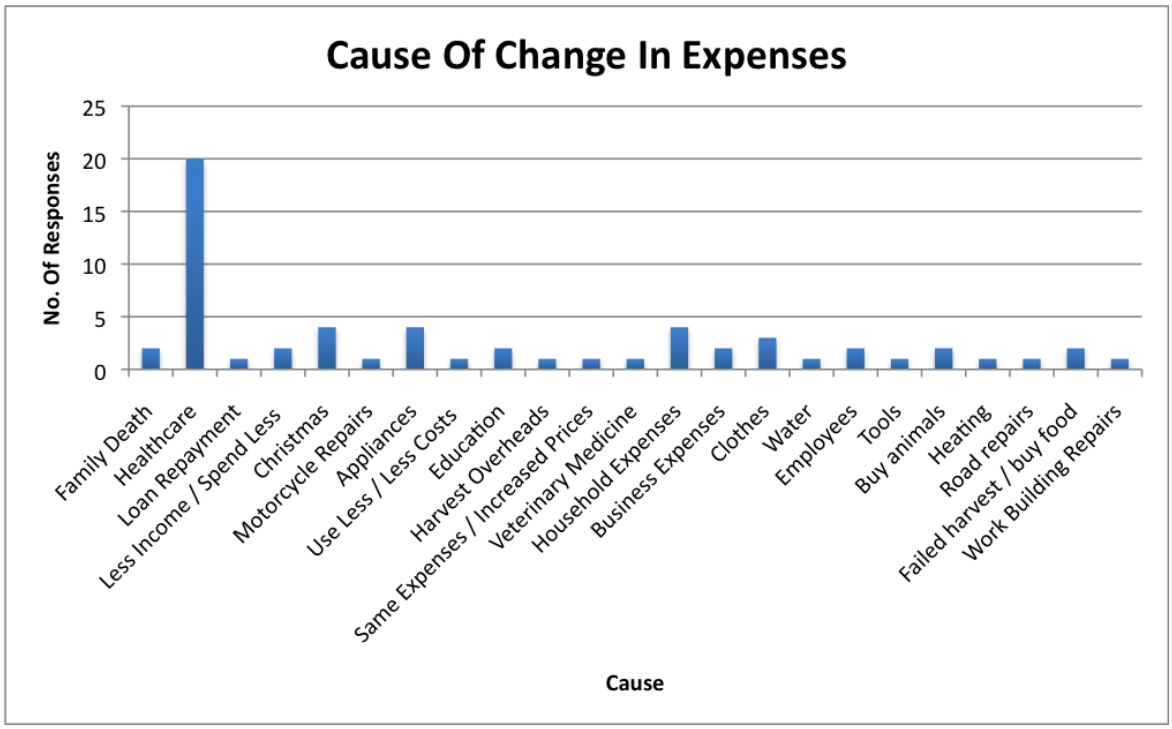


Figure 7.4. Factors responsible for causing changes in household expenses, as perceived from the household interviews in the 6 communities studied around Galeras (n=91 interviews).

7.2 Identifying 'necessities' for the functioning of the Galeras livelihood system

The second part of this analysis sought to identify what things were perceived as necessary to the functioning of the Galeras livelihood system. The analysis focused on the answers to two of the household interview questions; *"What is necessary for a good quality of life for you and your family?",* and "*What are the consequences if you do not have access to these things?* Displaying the components householders believed to be underpinning their livelihoods, figure 7.5 shows the components recorded and coded into 45 different categories. Table 7.1 lists a full breakdown of the various consequences perceived to be caused as a result of not being able to access their different needs.

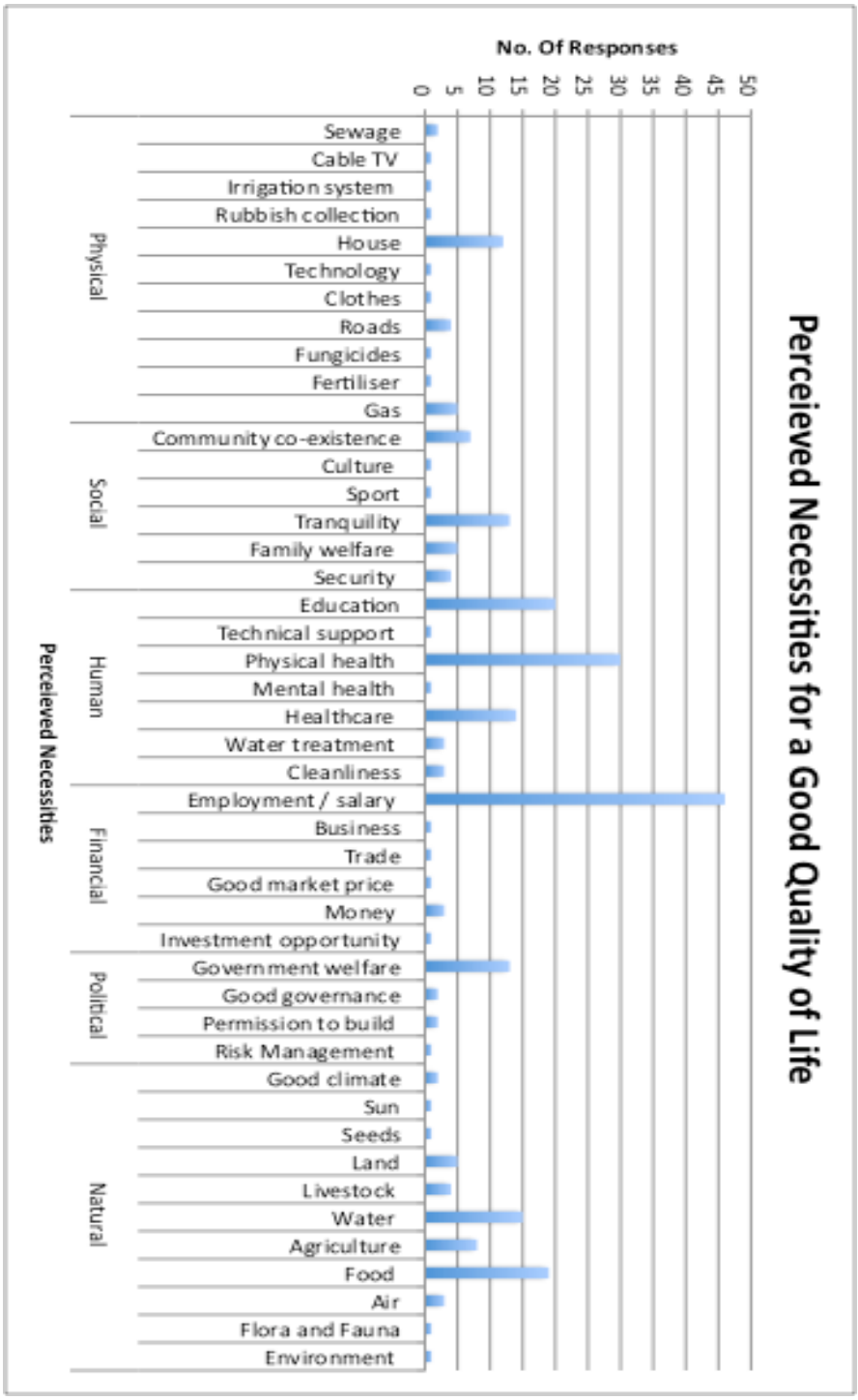


Figure 7.5. Components perceived to be necessary for a good quality of life on Galeras, as determined from the household interviews in the 6 communities studied (n=91 interviews).

7.2.1 Theme 1: Employment

The main component that respondents perceived to be as vital to a good quality of life, identified by just over half of the household respondents interviewed was employment (46/91). This coding included the availability of work, the need for that work to be of high quality and the requirement of a good salary. The consequences of not having access to these things divided into three key discussions.

The greatest consequence perceived was that without work and salary households would not be able to afford the things that they needed, which would mean that they would not be able to survive, *"can't satisfy our basic needs", "we can't survive", "don't have a good quality of life".* Some identified this as being placed in a state of poverty, *"poor absolute poverty".* As a result they argued that they would not have enough money to afford to pay for the things they classed as their basic needs, "can't satisfy our basic needs". These needs included; food, " we'd have no money to eat" "children lack food", "wouldn't be able to eat", "cut in eating"," can't eat", "no access to food", "endure hunger", education; "can't study", "no education", healthcare; "don't have money for medication", clothing, 'no money for clothes", "no shoes", or services, "no money for services". In addition, as a result of either not being able to pay their rent or their debts on their homes, they predicted they may lose them, 'no dwelling', 'displaced from family homes', "need to sell property".

The second discussion was that as a result of not being able to finance their basic needs, respondents perceived themselves at threat of their health suffering, both physically, "sickness", "malnutrition", and mentally; "sadness and concern" with the worst case scenario being death, "desperation and death", "sick and death", "we die", "we die without opportunity".

The third discussion was that without access to all the things that they needed, they would need to make changes to their livelihood system. The main change would be the need to seek out new sources of income, "need to look for alternative income", which may require a move from their community to find new opportunities further afield; "start to leave to work for work elsewhere", "leave the house to find another location", "look for work in Pasto". Some individuals suggested that a lack of work might eventually lead them to engage in criminal behaviour, "have to find moon lighting", "stealing to survive".

7.2.2 Theme 2: Physical health

The second highest-ranking component listed as needed for a good quality of life was physical health (30/91). The consequence of not having a good level of physical health was argued mainly

as being the inability to work; "*I couldn't work", "lack of work", "could not work on the land".* Being unable to bring money into the household,*" don't have income",* would result in '*economic problems'* for the family budget and an inability to access things that need to be paid for. Being ill would in itself also lead to additional expenses such as medication and doctor's bills placing a greater stress on the family finances as was also identified in previous discussions of household expenses.

7.2.3 Theme 3: Education

Education (20/91) was the third highest ranking component listed (20/91), and the need to send children to both secondary school and university. The consequence of an individual not accessing higher levels of education were perceived by interviewees to be detrimental to their ability to get a job and earn an income in the future, "*can't get work", "not able to achieve goals", "not able to survive without it".* A further impact identified was the impact on the mental health of individuals with many suffering *"serious moral problems"* as a result of their inability to find work.

7.2.4 Theme 4: Food

Food (19) was the fourth highest-ranking component listed. Consequences were simple; lack of food would in the short term lead to sickness, diseases and malnutrition, and in the longer-term starvation and death. A secondary impact would be that as their health suffered, people wouldn't be able to work, *'without strength to work'.*

7.2.5 Theme 5: Water

Water (14) was the fifth highest-ranking component. A lack of access to water was described as once again leading to health implications including dehydration, illnesses (including bacterial infections and gastric illnesses) and malnutrition which in turn would ultimately lead to death, "*can't live".* A lack of water would also mean an inability to carry out cultivation of crops causing a further implication of lack of work for farm laborers. No water would also mean individuals not being able to cook, as one of the key cooking practices is to boil a large majority of their food. Without water one individual summarised that there would be '*no life'* as *'everything is dependent on it'.*

Table 7.1 (over next 3 pages) The full listing of components perceived to be necessary for a good quality of life on Galeras, and the consequences of not having access to them, as determined from household interviews in the 6 communities studied (n=91 interviews).

Employment (Work, good work, good salary, economic income)	Less economic resources
	Can't satisfy basic needs, poor quality of life, low quality of life, difficult life, don't have anything
	No money to eat, no food, children lack food, Hunger, malnutrition, living off what you sow, sickness, death, die without opportunity, sadness and concern, desperation
	Poverty, absolute poverty
	No dwelling, Displacement, need to find another location
	No money for medicines
	No money for clothes, no money for shoes
	No money for education
	No money for services
	Salaries driven down lower as more people looking for work
	Need to look for alternative employment, look for work in Pasto
	Steal to survive, have to find moon lighting
	Sell property
Food	Illness, sickness, starvation, malnutrition, diseases
	Death
	Without strength to work
Water	Dehydration, illness, malnutrition, health problems, bacterial infection, gastric illness, death
	No crops / can't cultivate
	No work
	Can't cook
	Chaos
	Can't live, there is no life
Physical health / healthcare	Go to doctor, have to buy medicines
	Economic problems, death if you can't pay for treatment you die
	Family problems
	Infants suffer, concern for the children, children have to work more
	Need to ask for help
	Stress
Education	Low literacy levels
	Bad quality of life, decreased quality of life, could not achieve goals, can't get work, poverty, never get out of poverty
	Serious moral problems, bad customs, wrong in the future, no self esteem, de-motivation
	Low economy
Community co-existence	Loss of support
	Live alone, divisions, difficult to cooperate
	Bad life, stress, violence, children want to drink, bad ways
House	Displacement, live on the street
	Sickness, illness
	Poverty

Government welfare	Poverty, bad quality of life
	Difficulty finding work
	Loss of competitiveness in the market place
Tranquility	Illness, psychological illness, stress, much stress, concern for the future, depression, sickness
	Move to Pasto
Family welfare	No peace
	No happiness
	No economical support
	No psychological support
	Displacement
Services	Poor health, sickness, death
	Contamination, abandoned rubbish
	Lost refrigeration
	No drinking water , have to buy
	Cold at night
Cleanliness	Sickness, health problems
Agriculture	Misery
	Lack of money, poverty
	Displacement
	Can't live
	Loss of crops
	If production is low have to go to p/t work
Livestock	Need to buy more
	Costs of veterinary treatment
	No economic support, no income
Air	Death, illness
	Contaminated water
	Contaminated plants
Flora and fauna	Death
Money	No food
Businesses	No jobs
	People leave if there aren't any jobs
	Rise in crime
Security	Look for another place to live
	Fights
	Loss of life
	Loss of belongings
	Robberies
Culture	
Good governance	Poor equality of life
	Poor employment opportunities, unfair distribution of work
	Loss of market competition

Clothes	Same clothes
Permission to build	No answers provided
Good market price	Financial loss
Good climate	Unable to cultivate fields , crop loss, small harvest
Good investment opportunities	Poor quality of life
	Not enough money for food
	Not enough money for education
	Not enough money for clothes
	Difficult to survive
Good risk management	Disturbs peace and tranquility
	War
	Disaster
	Oppression of the poor
	Taxes
	Evacuation
Seeds	Can't sow seeds
	Have to go to the city to find work
Fungicide	Can't sow seeds
Technical support	No target crops
	No sustainability
Roads	Impossible to communicate in case of an emergency
	Many accidents
	Houses affected
	Children can not play near to the road
	Chaos in evacuation
	Forced to walk
	In the summer there's dust / rains there is mud
	Collapse when there is water
	Pay to repair

7.3 Identifying threats to the functioning of the livelihood system

The third part of the analysis examined the historic disruptions to the Galeras livelihood system during the period between 2002 and 2012. Respondents were asked to identify if between that times they had experienced problems in accessing what they had previously listed as necessities for a good quality of life. The cross referencing of necessities and access can be seen in figure 7.6 as was already discussed in chapter five.

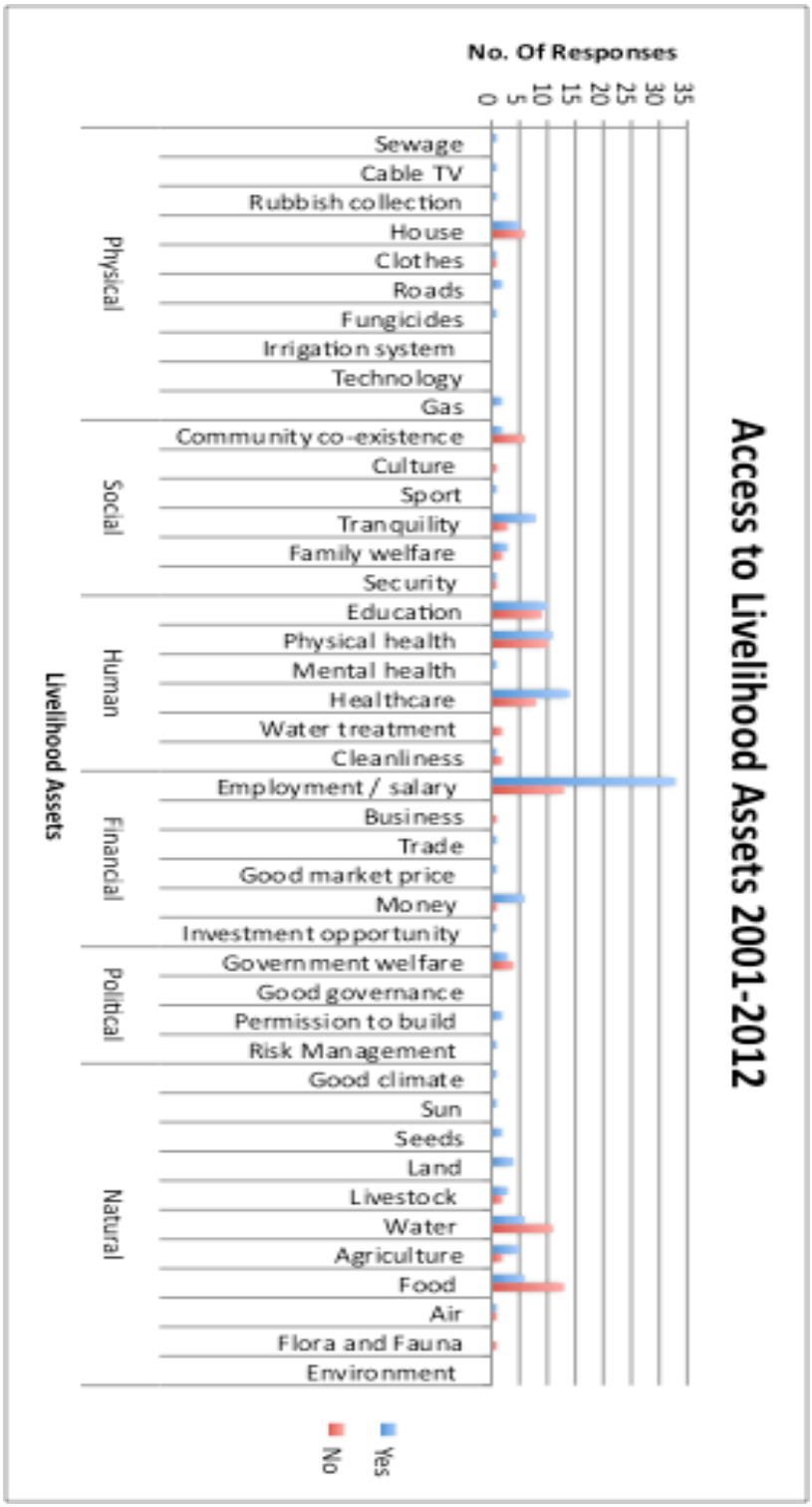


Figure 7.6. Perceived accessibility to necessities for a good quality of life between 2001 and 2012, as determined from the household interviews in the 6 communities studied around Galeras (n=91 interviews).

The data above show that the highest number of perceived disruptions to livelihood necessities were to employment (33), healthcare (14), physical health (11), education (10) and tranquility (8).

For this purpose physical health, mental health and healthcare have been analysed as separate components, however had they been amalgamated then all three together would have been the necessity with the second highest number of disruptions. Figure 7.7 shows the assets identified by the household respondents necessary for a good quality of life and how many disturbances were experienced to those assets during the time period of 2002-2012.

When asked to describe the quality of life of people living in their communities, the most common negative topics discussed were; employment (26), governance (21), eruption (16), wealth (11) and the economy and public services (8), as can be seen in figure 6.7. This graph was also used in chapter four however the emphasis was on the positive perception data.

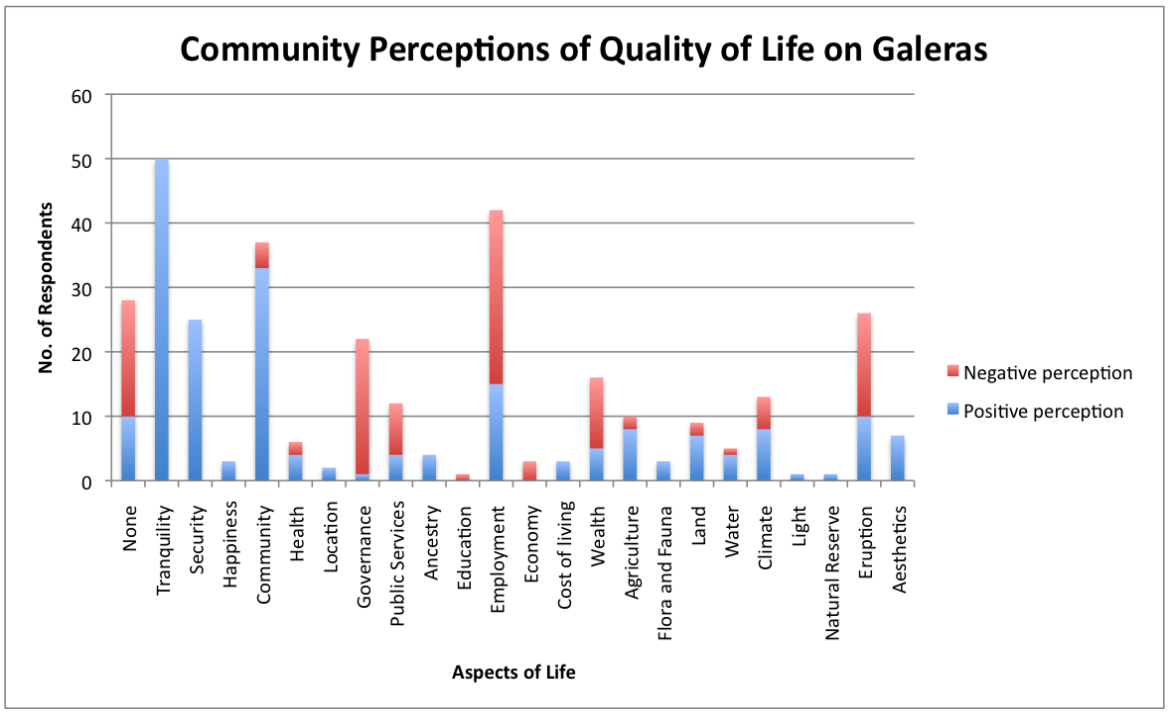


Figure 7.7. Community perceptions of the quality of life on Galeras, as determined from the household interviews in the 6 communities studied (n=91 interviews).

7.3.1 Theme 1: Employment

Discussions of unemployment focused on both the lack of jobs, *'there aren't many opportunities for work", "there are lots of people without jobs*", and the low salaries for those jobs that were available, *"salaries are too low', "I work in construction and get paid less and less'*. Highlighted were the specific difficulties for the young and old in finding work, "*older people can't get jobs*", "*there is no opportunity to get a job at 82"* as well as for the higher educated, "*People who are educated don't find work here.*

The points made in relation to the impacts of unemployment mirrored that of the previous discussions. That unemployment and the lack of income coming into the household meant an inability of households to meet their basic human needs and as a result had a direct impact on their wellbeing, "*without work we cannot satisfy our basic needs", "life is hard because of the lack of work", "the life of the people is difficult because we don't have work, the only work is fique", 'we never have the opportunity to do something better". That this lack of work and the challenges it presented to households meant that there was a growing temptation to relocate to Pasto and other areas of possible work, "the children want to live in Pasto because they saw Mapachico offers many things but they do not see too many opportunities to get a better job and quality of life'.*

7.3.2 Theme 2: Governance

Some blamed the government's risk management strategies for dealing with the volcanic activity as the reason for high levels of unemployment, outlining how the government had disallowed private investment as part of its declaration of disaster*, "It devalued our jobs because people don't invest in the town"*

Discussions revealed that the Declaration of Disaster and it's prohibition to build or invest and the subsequent relocation plan, had not only meant both a poor provision of social services across Galeras but a direct impact on the mental health of community members as a result of the perceived governments intimidation techniques to get people to move. "*They take people from here because of the volcano", "Because of the volcano they want us to relocate", "the government wants us to abandon the land", 'people are intimidated by the government', 'the government want to kick us out and in the past they have brought police', 'we fear being banished', 'fear being hassled', "the population has no fear of the vocano but they do fear the eviction", "the volcano isn't a problem, it's the government", "Processo Galeras is the worry of our community". "we have an anxiety of what our land is worth", "we are suffering because of the government", "They have changed the way of life", 'we don't want to leave here, we feel safe with the volcano', 'there is no explanation why they want to evict people, it has become a constant fear', 'this law made us scared".*

In addition to the risk management strategies, respondents also highlighted a lack of financial subsidies or other financial support from the government for the communities, *" there is no support from the government", "there is a lack of government help", the government have given us absolutely nothing", 'the government doesn't sustain us, we sustain the government".*

7.3.3 Theme 3: The volcano

The volcano itself and its activity was the third highest discussed component due to the physical damage the eruptions had caused, the psychological impact the activity has had on the people and the way in which the activity had caused the government to want to relocate them.

'We have a problem with Galeras, it affects our poor town', 'It contaminates the water', 'it gives cattle a cough', 'it kills the animals', 'ash affects the leaves of the platano, root vegetables and yucca', 'it dehydrates the grass', 'it damages the crops', were all comments on the physical damage caused by previous ash fall. In addition, heightened activity was also identified as being the cause of loud noises, fires and avalanches.

In respect to their health, respondents also told how they were personally affected by the ash fall, *'sickness due to the ash which contaminates the water and the crops and the air', ' has affected our population with diseases like colds. This particularly affects our children'.*

Psychologically the volcano was also blamed for high levels of stress within the community, caused by its potential for destruction and for its uncertainty, '*we have a fear for the volcano*', '*an anxiety for the volcano'*, '*fear of the volcanic tremors*', '*fear of disasters*', *'I feel scared when Galeras starts to erupt, when the office says it is at yellow or red level'.*

Although many blamed a number of the disruptions on the government for the way in which it had responded to the volcanic activity, others placed the blame directly on the volcano itself, *"Galeras impedes the development of projects because it's a zone of risk fear. The state does not invest in risk zones", 'the volcano caused a zone of risk', 'the volcano has caused unemployment', 'some people who work in tourism can't work when the volcano is active'.*

7.3.4 Theme 4: Wealth

Low levels of wealth were perceieved by some to be responsible for the low quality of life**,** as people labelled themselves as poor, *"we are really poor people', 'everybody is poor', we are a poor municipality', 'we don't have enough money'.* Lack of money meant that they didn't have the ability to pay for the things that they needed, *'don't have resources for the education to study',* "*worried for our house because we don't have money to maintain it in good condition*" and that they were dependent on the food that they could grow on their land, "*people live off what they can grow".*

Some people attributed low levels of wealth to the collapse of a pyramid investment scheme in 2008 that had also affected many other people across Colombia. Many individuals had invested not only their life savings into the scheme but had also remortgaged their homes in the hope of a big pay off. When the scheme collapsed and the organisers disappeared, many people were left nothing and some with debts, *"we had some problems with pyramid schemes, they stole everything we had".*

7.3.5 Theme 5: Public services

The poor provision of public and private services including roads and water were also identified as an impediment to the quality of life of those on Galeras. Unpaved and collapsing roads cause difficulties for vehicles to travel on making it difficult for people to get to different places and also to transport goods to market. Old and degrading pipelines and aquifers meant that the supply of water was often prevented from getting to people's homes and that the water was easily contaminated.

7.3.6 Theme 6: Climate change

A growing problem that the agriculturalists in the community had started to identify in recent years was a change in climate, specially longer, hotter summers of which had caused crops to fail, *"It's been a hot summer, not normally this hot which means that the crops have been drying out. There is a risk of loosing crops ".*

Table 7.2 provides a full inventory of negative perceptions discussed in regard to quality of life on Galeras.

Table 7.2 Negative perceptions of quality of life on Galeras, as determined from the household interviews in the 6 communities studied (n=91 interviews).

Codes	Sub-themes	Quotes
Government	Relocation	The volcano they want us to move / The government want us to abandon our land
	Intimidation	People are intimidated by the government / The government want to kick us out and in the past they have brought police / We fear being banished / We have bother from the government
	Fear and anxiety	I have anxiety of what my land is worth / I fear being banished / The main fear is eviction from their homes / The population does not fear the volcano but the eviction / Processo Galeras is the worry of the community / The government says the volcano is dangerous but it is a lie / People can't sleep at night, it's not the volcano that scares them it's the government.
	Wellbeing	We are suffering because of the government / They have changed the way of life / There is inequality of economic aid / We don't want to leave here, I feel safe with the volcano and I am here.
	Lies	The death of the scientists was not because of the volcano, but an error committed by the scientists / There was a bad study of the volcano to overthrow the people by the government / The government affects trade with misinformation / The volcano isn't a problem , the government is a problem / The problem is with the government and not the volcano / The government wants us to make provision for the volcano and it's a lie / They lied about the volcano
	Poor provision	The government money is badly invested / There is no support from the government / The government badly organises the shelters / There is a lack of government help / Government gave us absolutely nothing / The government doesn't sustain us, we sustain the government because we pay for the services / They give us nothing for helping us in case of eruptions / Lack of communication / There is bad administration of the local government
	Difference of	People should really know about the places on the volcano to

	opinion	know the real situation / They have a big problem with us / Maybe they want us to go and don't love the land.
Unemployment	Lack of jobs	There aren't many opportunities for work / Lots of people without jobs / Older people can't get jobs / There is no opportunity to get a job at 82 / People who are educated don't find work here / We don't have companies as there is no investment
	Low salaries	I work in construction and get paid less and less / Salaries are too low
	Wellbeing	Without work we cannot satisfy our basic needs / Life is hard because of the lack of work / Life is good but we need work / I think the people are satisfied with what they have, but they have quiet lives, their greatest need is the lack of work and lack of opportunities / The life of the people is difficult because we don't have work, the only work is fique / We don't have a good opportunity for work / Never have the opportunity to do something better
	Relocation	In the case of this family the children want to live in Pasto because they see Mapachico offers many things but they do not see too many opportunities to get a better job and quality of life.
	Food	People live off what they grow
	Fique	Before we had fique but with the plastic the work is finished here / I sell fique in Manizales because nobody in Narino wants wants to buy itbecause they prefer synthetic.
Water	Poor infrastructure	Bad plumbing / bad water treatment
	Contamination	The water is contaminated with ash and we have to wait many days to take it again
	Supply	Don't have water, deforestation is a serious problem
Volcano	Fear	Fear of the volcano / For the government alerts / There is no explanation why they want to evict the people /It has become a constant fear / Anxiety for the volcano / Fear of the volcanic tremors / Fear of disasters / They feel scared when Galeras starts to erupt / When office of volcano say it is in yellow, red / sound of the volcano is very frightening

	Uncertainty	Sudden volcanic eruptions
	Relocation	Some regions are at a high risk of danger, and they have to move from their places to safer places
	Impact on the government	They take people from here because of the volcano, / Because of the the government alerts / Galeras impedes the development of projects because it's a zone of risk fear, the state does not invest in risk zones / Since 1995 the law has affected us , people don't visit / This law made us scared / Devalued our jobs because people don't invest in the town.
	Water	Contaminates the water
	Animals	Gives cattle a cough / Sometimes ash effects the health of the people and of the cattle, the cattle get sick, Kills animals, Ash contaminates water and affects animals
	Plants	Ash affects the leaves of the platano, root veg, and yuca / Ash dehydrates the grass / The animals and plants are affected by the ash / Ash damages the products / Ashes damage the grass / Damages the crops
	Danger	There are some towns in danger / The volcano caused a zone of risk / We have a problem with Galeras, itaffects our poor town,
	Health	People are affected because of the ashes / There is sickness due to the ash which contaminates the water and the crops and the air / It has affected our population with diseases like colds, this particularly affects our children.
	Employment	The volcano has caused unemployment / The volcano has devalued our jobs
	Tourism	Some people work in tourism but maybe because of the volcano they don't work / There is no tourism for fear of the volcano.
	Dangers	Starts fires, causes avalanches
Wealth	Education	Don't have the resources to pay for education,
	Poverty	We are really poor people, we are a poor municipality, we don't have enough money.
	Crime	We had some problems with pyramid schemes, they stole everything we had

	House	I am worried for our house because we don't have money to maintain it in good condition
	Food	People live off what they grow
Security	Gangs	The formation of gangs
	Theft	Robberies and thefts
Road	Poor condition	Unpaved roads
Health	Poor healthcare provision	There is a lack of medical attention, we have to go to Pasto, one hospital is not sufficient for emergencies / One hospital is not sufficient for emergencies / Need better attention in health service
Agriculture	Difficult	Life is hard / Life is difficult.
Topography	Difficult	We don't have good terrain for raising animals
Recreation	Facilities	We lack recreation sites
Climate	Drought	It's been a hot summer, it's not normally this hot which means that the crops have been drying out. There is a risk of loosing crops

7.4 Identifying the effective responses needed to deal with disruptions to the livelihood system

Having identified the historic disturbances to the community's livelihood assets between the period of 2002 and 2012, respondents were asked to describe how they had coped during these events. Table 7.4 identifies the various coping strategies that were carried out by the community members to deal with various disruptions to their livelihood assets; these were coded into 22 different categories. The five highest frequency strategies were:

Borrow money: This involved asking a bank, a family or friend for a loan of money. It also included asking businesses for credit on items. It was used in periods of unemployment and food insecurity, when money was needed upfront to pay for agricultural inputs and when people needed to rent somewhere to live.

Stop / change practice: This involved changing from a more traditional way of doing something to a different way. It was used to deal with changes in water supply and quality when people needed

to source their water from alternative places to the aquifers. It was also used when people needed to change the way in which they farmed, changing the crops they grew, the animals they raised or farming methods used.

Travel to a different place: This involves travelling temporarily to a different place in order to access something of need or in order to do something of need. It was used to deal with periods of unemployment within the communities, periods of ill health when people needed to travel off of the mountain to the city, when people wanted to send their children to schools in the city and when people went in search of peace of quiet.

Community action: This involved the community undertaking work, which was normally undertaken by the government. It was applied in order to maintain the road network, supply water to houses and build houses. It was also used to describe the regrouping of the indigenous councils in order to contest the relocation program.

Demand and contest: This involved actively protesting and the demanding of rights and needs at public meetings with the government. It was used when people wanted to oppose the relocation program, demand better risk management solutions and demand better education provision for their children.

Table 7.4. (Over page) The different coping strategies said to have been applied by household representatives to the disruptions to different livelihood assets between the period of 2002 and 2012.

		Livelihood Assets																					
		Employment	Good governance	Good risk management	Health / healthcare	Education	Food	Water	Tranquility	Family welfare	Public services	Agricultural inputs	Agriculture	Livestock	Community	Clean air	Money	Good market price	Security	House	Government welfare	Roads
Coping Strategies	Seek support from others	■					■										■					
	Ask government for help				■																	
	Income diversification	■											■	■								
	Travel to a different place	■			■	■			■													
	Work in different place	■																				
	Work more																			■		
	Limit spending / save	■																				
	Pray	■							■													
	Sell assets												■					■				
	Relocate																					
	Send wife / children to work	■				■																
	Traditional methods				■																	
	Borrow money	■					■					■					■			■		
	Stop / change standard practice							■			■	■	■			■						
	Do it yourself	■	■		■																	
	Community action		■						■		■											■
	Demand / Contest			■		■			■												■	
	Plan in advance						■	■														
	Consult expert				■																	
	Take medication							■														
	Don't worry									■												
	Endure / Wait				■						■				■							

7.5 Identifying the future potential of the Galeras communities

The final stage of analysis sought to identify what the interviewees perceived to be the potential of their communities, and in addition what they thought was necessary to make that potential a reality. Of the 91 households interviewed 88 believed there to be future potential to the area in which they live. The remaining 12 all argued that with the relocation program in progress, that there was no future. Figure 7.8 shows the distribution of ideas for the future development of the communities.

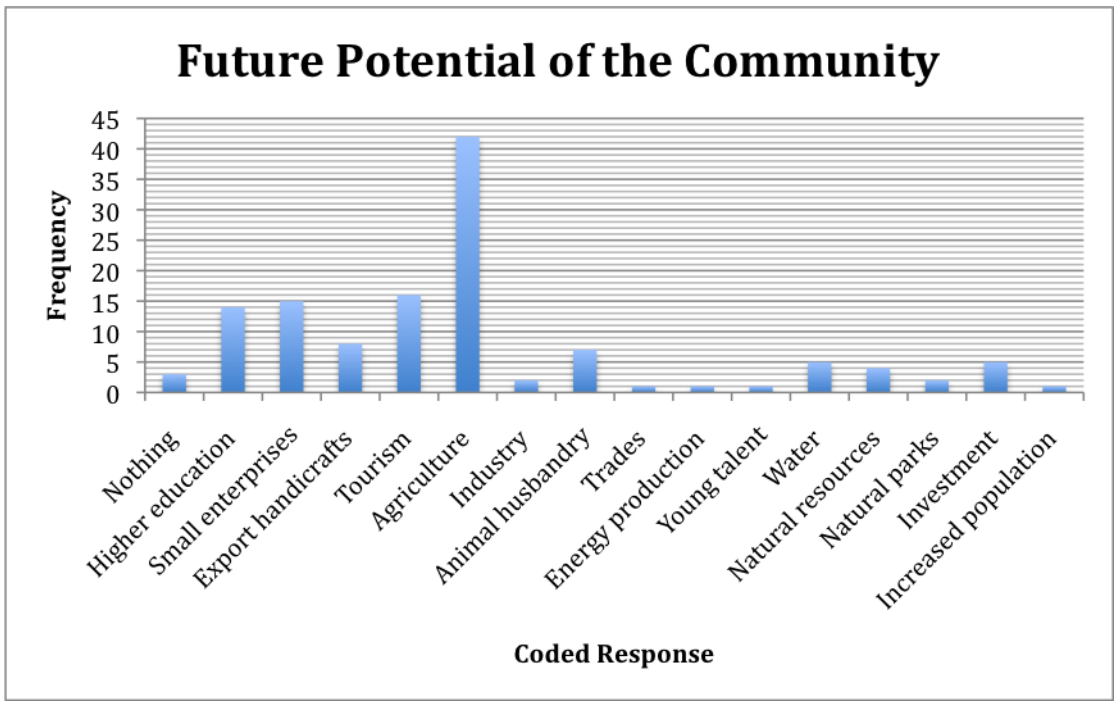


Figure 7.8. The perceived future potential of the communities of Galeras, as determined from the household interviews in the 6 communities studied (n=91 interviews).

The most popular option for future development was deemed to be agriculture (42/91). Opportunities identified included; further exploitation of the land, organic farming without the use of chemical, the cultivation of healthier crops, the cultivation of broccoli, coffee and panela for exportation and the growth of beans and tomatoes in greenhouses.

Tourism was the second most popular option (16/41), in particular ecotourism bringing visitors to the areas to see the natural highlights of the volcano such as the waterfalls and the wildlife.

The creation of small enterprises such as retail business and cafes ranked the third most popular choice (15/91). People hoped that the introduction of small companies would help to generate work across the volcano.

Higher education (14/91) ranked the fourth most popular choice with the emphasis being on not only the benefit to the individual engaged but also to the economy of the Galeras communities, which in turn it was hoped would attract external investment.

The production and export of handicrafts ranked as the fifth most popular option (8/91). In particular people were keen to revitalize the fique industry to produce fashion and household items for tourists.

Animal husbandry ranked sixth (7/91), with ideas focused on the exportation of cuy to China due to its ability to reproduce quickly and its high protein content.

The restoration of the cattle industry ranked seventh. Respondents argued that in recent years a successful and otherwise healthy dairy industry had collapsed due to the impact of the Declaration of Disaster frightening farmers and causing them to leave their land and move elsewhere.

The bottling of the spring water ranked eight due to its perceived high quality. In the last couple of years several drinks companies have discussed the prospects of a bottling plant being built on Galeras but to date nothing has happened.

Investment ranked ninth with respondents arguing the imperativeness of external investment both for the creation of jobs in the region but also for larger companies to buy the products being produced such as milk and dairy.

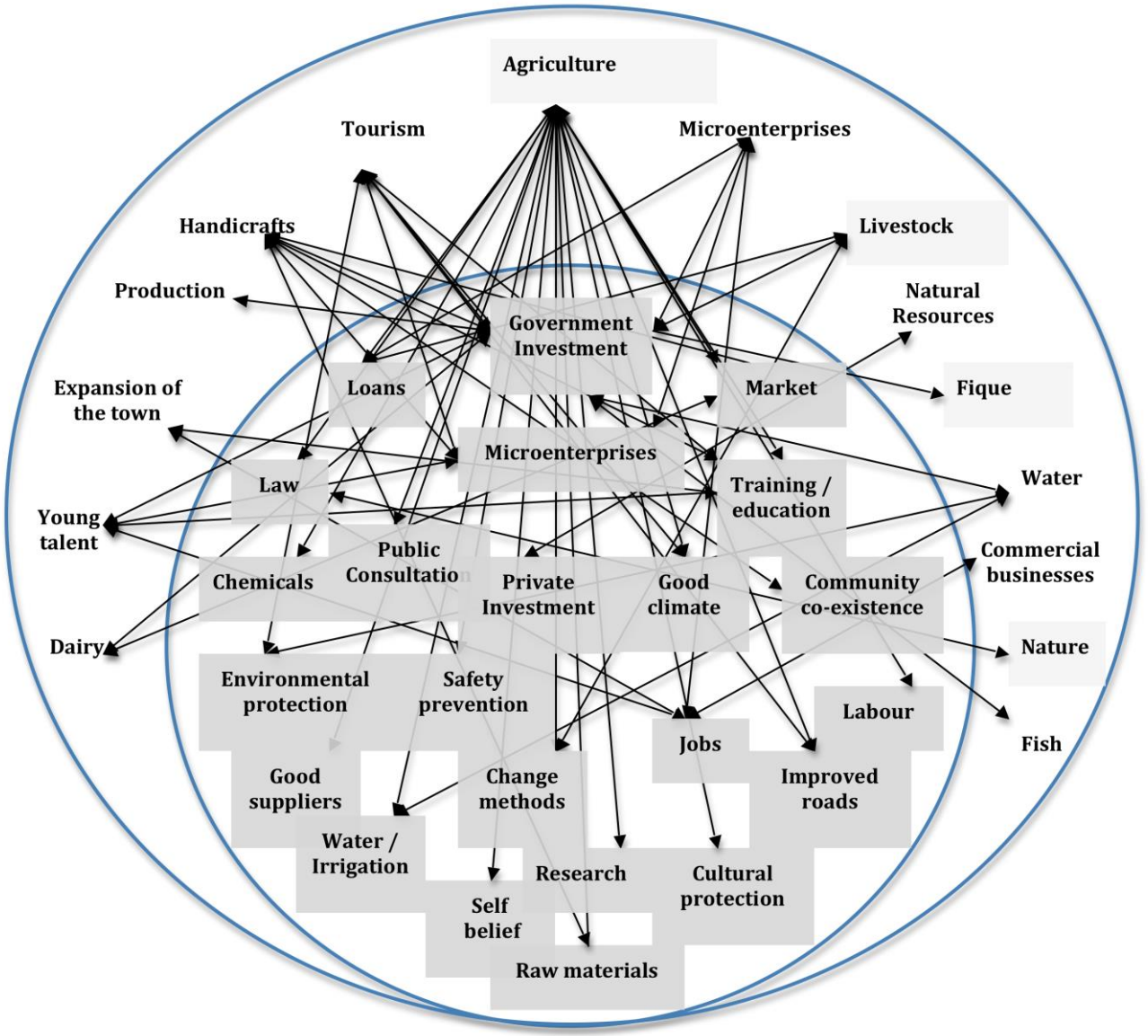
Building supermarkets, warehouses and factories was also seen as providing more opportunities to sell products produced in the region, such as yoghurt. Their establishment was also highly anticipated as being the means of producing new jobs, especially for the young and educated.

Exploiting geothermal energy from beneath the ground and opening more natural parks were also ways in which it was seen that people could exploit the natural resources available to them.

7.6 Realising the future potential of the Galeras communities

Having asked respondents what they thought the future potential of their communities were, the final question of the assessment asked respondents to identify what was necessary to realise that potential. Figure 6.9 Illustrates the system of inputs perceived to be necessary in order to achieve the potential of the area. The outer circle of the diagram identifies the opportunities identified and the inner circle identifies the elements needed to achieve them.

Figure 7.9. Conceptual model of the system of inputs perceived necessary for achieving the potential of communities on Galeras: Outer circle – opportunities, Inner circle – what is needed to achieve them.


Agriculture
Tourism
Microenterprises
Handicrafts
Livestock
Production
Natural Resources
Government Investment
Loans
Market
Fique
Expansion of the town
Microenterprises
Law
Training / education
Water
Young talent
Public Consultatio
Commercial businesses
Chemicals
Private Investment
Good climate
Community co-existence
Dairy
Nature
Environmental protection
Safety prevention
Labour
Jobs
Fish
Good suppliers
Change methods
Improved roads
Water / Irrigation
Research
Cultural protection
Self belief
Raw materials

The need underpinning almost every potential future initiative was thought to be good government investment. This could take a number of different forms; the main one being the provision of services, something that had for the previous ten years been severely lacking at Galeras due to the Declaration of Disaster, *"the policy has strongly affected the region and only certain people benefit", "there are places very close to the volcano that need water, first aid, light and drugs to help these distant populations', "we have land but we don't have help from the government".*

Provisioning projects to improve the road network and the quality of the road surfaces was of particular concern, to enable goods and people to be transported securely, "*good roads and transport for all is needed in case of emergency and to evacuate the city".*

The second investment required would be direct cash financing to be given to struggling households either as income subsidies, such as for agriculturalists to make up for low growth or sales, or as compensation for loss such as when harvests fail, "*we need government support because the chemicals for the farm are very expensive and the craftsmanship materials are very expensive".*

Finally non-monetary investment was also argued for in terms of guidance, encouragement and leadership for people wishing to start and build their own businesses, *"the government should help people to establish own business".*
Imperative to good government support was seen as a change in the Declaration of Disaster Law to permit new buildings to be built and to allow private investment in the areas. Both of which have been prohibited. This change would not only allow community members to build themselves new homes for their growing families but also allow companies to invest and build factories and business that in turn would lead to more jobs in the region, "we need help from businesses to provide work", "*the need to overthrow the law so that risk doesn't exist*",

An important issue raised was that the main problem is not with the national government but with the local Mayors, which governed the local communities being interviewed. Central government may build good policies but it is down to the Mayor to interpret them and put them into action and this is where problems have laid in the past, *"to have a good quality of life depends on the help of the Mayor, that the government through the Mayor does a good job".*

An additional reason for the previous failings of the government provision was the belief that the government members were disconnected from the communities of Galeras and therefore did not have a clear understanding of the life and needs of the people, *"politicians need to be aware of the common people, they need to understand what it means to live on a volcano".*

Some believed that due to the current poor governance that there was in fact no future potential of the region and that it would continue to decline, *"there is no potential because the government doesn't help us'.* As a result of the lack of government support in the past, the need for a voice was highlighted for the future, both to raise awareness of their challenges and to fight for their needs. *'we need a voice because the government left us, we need support'.* For those living in Genoy and Mapachico as part of the Cabildo (the indigenous council) they saw their leader Don Apparissio as being their voice, '*thanks to him, he helps the people'.* The need for more consultation between the government and the people was argued in order to give the communities a better platform to voice their views.

Education was also perceived as being essential to the future of the region, not just in terms of providing for young people with '*more schools, a college and a university',* but also in regard to providing training for the adult population to support them in the different industries that they might engage in. People believed education to be '*the fundamental basis for everything'*, that will give them a better future whatever it is that they do.

Education provision has for a time been considered to be failing in the region due to the government restrictions and little funding being made available for education. In addition, the cost to households of educating their children has often proved an obstacle. Whilst individuals believed in the importance of investing their own money into the education of their children so that they might have a better life, their resources are limited, "*our potential is in our young talent, and we need to train the young people ", 'we need opportunities to study for a low amount of money".* Although primary school education is free to all, there is a charge for secondary, college and university education as well as additional costs that are incurred such as uniforms, books and travel expenses.

Not only was it believed that higher levels of education would make it easier for people to get employed in higher level salaried work but it was also thought to be the case that a growing population of higher educated people in the region would encourage companies to invest in the area, building businesses and facilities that will require a higher skills set such as factories, "*education is appropriate to improve investment in town*". This growth in turn would provide much-needed job opportunities, '*we need opportunities for the young people to seek their future and can succeed', "without education there are no opportunities in this city", "education is the most important thing".* The ability to produce products in new factories and other facilities would not only mean that the community would have the things they need to buy, but it would also mean

that that money would go back into the community, '*We need Mapachico to be able to produce the products needed to help sustain the city'*.

Respondents also realised that movements into new enterprises would require the provision of more vocational training, both to learn new practical skills needed to carry out new crafts or trades and also to learn better business acumen to ensure the success and stability of their enterprises. People understand that education alone is not enough and that they still require additional support, "*We need orientation programs for agriculture',* "*we need training to deal with challenges and risk and to deal with life*', "*Education is the only way to turn the city into something better*", "*We need more s*kills'.

With many individuals wishing to build their own micro-enterprises, one of the greatest needs identified was finance to get them started. With the majority of the community members struggling with unemployment, irregular work and low salaries, they are unable to save the money needed to invest in their businesses themselves and require either public or private financial support. "*We need help with loans from the bank*", "*They need to make credit more accessible with low interest rates to help facilitate payments*". Unfortunately another key impact of the Declaration of Disaster was the fear it developed in the culture of banks and other financial institutions, leaving them too scared to lend money to people in case borrowers were killed in eruptions, leaving them with an unpaid debt. The communities have great entrepreneurial spirit but need support to realise these ideas, one example of which was a gentleman talking about his wife and cousin who together wished to open a small café. To do so they needed an investment of 2-3 million pesos, which they hadn't been able to secure. The respondent blamed the government arguing that, *'this is the sort of thing the government should invest in".*

The exploitation of the natural resources on Galeras was seen as a key opportunity on which to build a variety of businesses including agriculture, aquaculture, water and handicraft industries, *'We need to exploit and take advantage of the resources that are in Narino'.* Yet in contrast, for ecotourism the conservation of those resources was considered a priority so as to ensure *'product quality'. "We need to make sure we maintain the quality of our products', 'We need a healthy environment', 'We need to take care of the soils'.*

Needed for the development and success of any new businesses in the future is a stable market. In discussions of revitalising the dairy industry respondents were wary of there not being companies ready to buy the milk.

Finally, to strengthen and support all future development, the need for strong co-operation and co-existence between community members (both family and neighbours) was emphasised, *'We need a*

good union in the family', We need a community where everyone helps each other, lives honestly and doesn't make any problems for anyone', that there is no colour politics', 'that everyone is like family'. These needs of trust, support and neutrality were mirrored when discussing the building of new businesses.

7.7 Summary

This data identified within the communities of Galeras a specific profile of vulnerability consisting of assets that people needed to maintain access to, processes that people needed to keep functioning and things individuals needed to be able to do in order to deal with disruptive events to their livelihoods. This profile is identified in table 7.2.

Table 7.5 The Galeras vulnerability profile

Obtain access to		**Maintain ability to**
(Material Objects)	(Processes)	(Coping strategies)
Food	Availability of well paid employment	Change a standard of practice
Clean drinking water	Good governance decision making	Work in an alternative location
Agricultural inputs	Good government risk management strategies	Work more hours
A home	Good quality of health	Work more than one job
A good quality road network	Good quality healthcare	Travel to a different place
Land to cultivate crops	Good quality of education	Borrow money
	Knowledge to cultivate crops	Demand a 'right'
	Knowledge to run an efficient business	Contest a government decision
	Security from crime, terrorism and violence	
	Government welfare support system	

Chapter Eight: Discussion

Hand making melcocha in Sandona (Author, 2012)

8.0 Introduction

The introduction to this thesis identified both the need to manage risk and the challenges that decision makers face in doing so. It warned that with all risk management there is potential for failure, which can have negative long term consequences for the communities they are governing undermining their sustainability. One key reason for such failure was argued to be that risk management is largely influenced by data generated by risk assessments. It was therefore reasoned that if the initial assessment framework does not accurately capture the complexities of risk in an area then inaccurate or incomplete data might be generated. This in turn may be used as evidence by decision makers, the consequence of which could ultimately lead to risk managers and policy makers setting misguided and unsustainable objectives.

This thesis, heeding the above warning, questioned whether previous volcanic risk management that had led to a range of negative impacts at the community level, may have not been successful due to a tendency for top-down technical risk assessment frameworks being used in Volcanology and an absence of bottom- up participatory methods. Its aim therefore was to evaluate what insights a bottom–up, participatory assessment of risk faced by those living with volcanic risk can offer decision makers about the realities of the complex adaptive systems experienced by volcanic communities. Its results would enable the development of risk assessments that can guide Disaster Risk Reduction practices to achieve more sustainable community outcomes.

In order to meet the aim of this thesis, research was conducted in order to meet the following objectives:

1. To critically review past academic, mostly technological assessments of volcanic risk, including components, measures and methodologies.
2. To use identified components of volcanic risk to guide an analytical framework that can be operationalised during empirical research with communities living on an active volcano.
3. To explore the experiences and perspectives about risk of those living on an active volcano using an ethnographic approach.
4. To re-evaluate what components best comprise volcanic risk and should be included in future volcanic risk assessments.

The results of objective 1 led to a framework of interview questions to be used in the empirical study. Objective 2, which was discussed in the methodology chapter, led to the empirical research findings. This chapter presents a discussion of: Objective 3, '**To explore the experiences and perspectives about risk of those living on an active volcano using an ethnographic approach'**

and Objective 4, **'To re-evaluate what components best comprise volcanic risk and should be included in future volcanic risk assessments'.** The discussion begins by 'deconstructing volcanic risk', comparing the community experience of risk against the technical framework of risk summarised in chapter three. It ends with a discussion of how to 'reconstruct volcanic risk assessments' in the future.

8.1 Deconstructing risk at Galeras

In order to explore how comprehensive the volcanic risk assessments frameworks were of community life at the grassroots level the systematic review in chapter three examined how volcanic risk and its individual components were conceptualised and measured within risk assessments frameworks. The assessments reviewed showed that previous risk assessment frameworks had taken largely top-down technical approaches. When compared to the empirical data, the way in which the communities of Galeras had experienced risk proved to be very different. In reality people's direct experience of 'value', 'hazard' and 'vulnerability' were far broader and more complex. This was largely in part to the technical assessments being 'volcano centric', whilst the participatory approach asked participants to consider the 'riskscape' of Galeras as a 'place' (as described in chapter three), comprising all hazards, all values and all vulnerabilities in their responses.

To unpack the reasons for the myopic viewpoint of volcanic risk that was found within the literature it must be asked how Volcanology perceives the concept of volcanic risk. Although all volcanologists might be expected to have a similar interpretation of 'volcanic risk', data from the literature review suggested that such a clear vision might not actually be the case. In fact, a noticeable absence of a definition of volcanic risk was found in the majority of the papers reviewed even though their predominant focus was on volcanic risk. Although it could be contested that definitions are not necessary where all peers should have the same theoretical background, science communication theory argues that providing definitions in scientific reporting is an absolute necessity as assumptions of common beliefs can be consequential (Shipman, 2013). The purpose of a definition says Shipman (2013) is firstly to tell the reader the subject of the writing and secondly to avoid any misunderstanding. Many people, Shipman argues, use one word when they actually mean another, which in turn can weaken communication and lead the reader to make assumptions. The absence of a definition of volcanic risk within the literature, as well as a common absence of the other keys terms; value, hazard and vulnerability, raises a key concern, as not only does it leave little point of reference for other scientists contributing to the same debate, but it also leaves a lack of explanation for decision and policy makers to align themselves with.

The following three discussions will explore each of the component measures of value, hazard, vulnerability and resilience to highlight how they are experienced within the case study communities and how that experience differs from those assumptions in the technical assessments

8.2 Deconstructing value at Galeras

As already described in chapter two the literature review showed 'value' to be largely perceived by the volcanological community, as an estimation of what could be lost. This was most commonly measured by estimating population density, capital values of buildings and infrastructure, productive capacity or a combination of all three. The empirical data suggested however that value within the Galeras communities should not be expressed solely in this way, but that the level of importance that volcanic communities placed on different features of their landscape and society should also be represented along with how those values contribute to people's livelihoods and wellbeing. Themed discussions of quality of life, motivation to reside, income, land use, significant landscape features and future potential helped to paint a picture of what elements in particular the community placed a value of importance on as opposed to what economic value those features had.

Within the literature review only two authors seemed aligned with the view of value that emerged, of it representing things of 'importance' rather than just capital cost. Robertson (1995) argued that although value was commonly measured as an estimate of potential loss, that it should in fact be seen as a benefit and gain to the community for them to take advantage of. A separate argument made by Donovan (2012) described value to be relative specifically to the individual and dependent on '*cultural outlook and personal standards*". The analysis of these data showed that these two outlying perceptions were both mirrored in the variety of discussions had in the communities, as people were indeed 'benefitting' from living on Galeras but that specific benefits differed from individual to individual.

The following discussions present a series of insights into the way in which householders perceived the individual 'values' gained from living on Galeras.

8.2.1 The value of Galeras the 'livelihood system'

A common methodology seen within the technical assessments was to measure value by calculating population density (Alberico et al, 2008), which allowed an estimate of potential loss of life to be calculated in the event of a hazardous event. The main argument presented therefore was that a higher population would result in a higher level of vulnerability and therefore a higher level

of risk. Many of the worlds 'highest risk' volcanoes, designated as Decade volcanoes, and including Galeras, are designated as such not just because of their levels of activity but because of the high population densities that reside on them. This data suggested however that in order to be more representative of the reality of risk that volcanic communities face, that a measure of value was needed to represent the gains people take from the volcano and how volcanic livelihoods are a product of those multiplied gains.

As described in chapter five, when asked to describe the quality of life of people living on Galeras, a diversity of topics were raised in regard to what was good. 'Tranquility', 'community', 'safety', 'employment' and the 'volcanic activity' itself all ranked highly among the inventory of environmental, social and economic gains that were described. As well as praise for the benefits gained from the volcano, there was also a deep concern of the impact a loss of any of those benefits may have on people's welfare. When faced with the argument being made by the Colombian government that the volcano was a threat to life, the people argued that the reality was paradoxical, it was in fact the source of the majority of their livelihood activities. Some of those interviewed raised the argument that potential loss of life was not as important as their overall 'quality of their life' of which they saw as being severely threatened if they had to leave the volcano. This opinion was emphasised by one interviewee who stressed his anxiety not about the possibility of his death if he stayed on Galeras should it erupt, but about 'going hungry' if he could no longer access his farmland to grow food. Once dead he said, he would have "nothing to be worried about", yet in contrast, potential hunger presented him with a continuous daily challenge.

A scenario of gains being taken from active volcanoes is not completely exempt in the volcanic literature, even though it appeared absent from the risk assessments reviewed, however these gains are usually focused on the benefits to farmers of volcanic ash, argued to increase soil fertility and result in greater crop yields (Kelman and Mather, 2008, Dibben, 2008). Yet whilst ash may indeed lead to the improvement in the fertility of soils, an essential point to highlight is that not all people that live on volcanoes are farmers, as was the case at Galeras. As these data showed, these individuals engaged in a number of livelihood activities both on and off Galeras, and therefore in their narratives described a myriad of other gains that they benefitted from, both from the natural environment and the society that has developed upon it. However, despite the fact that volcanologists focus on fertile ash as the prime resource gain from volcanoes, the environment and all its component features (climate, flora, fauna, water) were in fact collectively mentioned less by those interviewed than the social and economic gains described. This suggests that such natural features were in fact the least importance in relation to the rest of the inventory. These results draw parallels with Kelman and Mather (2008) who in their paper 'Living with volcanoes: The sustainable livelihoods approach for volcano-related opportunities' argued that a gap exists

between the way in which benefits and losses are documented within studies of volcanoes, with many possible benefits from volcanoes not always being fully considered. Not only do these research findings support this argument but they go one step further to identify a wide range of benefits not discussed in such depth before in the study of volcanic risk management.

This case study showed that the value of the Galeras landscapes and the way in which it benefits the communities that live on it is far more diverse and complex than just the capital value of infrastructure alone that is measured in the volcanic risk assessments. One example, 'tranquility,' was ranked in the data as the greatest contributor to 'a good quality of life' on Galeras and was also identified as the greatest 'motivation to reside' on the volcano. It was also ranked sixth in the 'direct benefits gained' question. The gains people described from the tranquility of the region were not only a peace and calm from the surrounding natural environment, but that also there was peace and harmony amongst the people living in their community. The benefits of tranquility are identified within the external literature for its beneficial impact on wellbeing, (Smith 1994, Jones 2009). Efforts are also made in some placed to create tranquility where it not in order to provide that same benefit (Kavsh, 2002, Rogers, 2004).

'Community' was ranked in the data as the second most frequently mentioned contributor to quality of life, and was also ranked the fifth 'greatest motivator to reside'. The importance of the community, both as a whole and individuals provided a support network, an extension of family and characteristics and specific personality traits of which were deemed pleasant to live wit; happy, and honest and hardworking nature. The importance of community in the way it provides people with a support system is identified within the external literatures (Grinde, 2009) particularly to the way in which it supports specific demographic groups such as those affected by domestic violence (Hamby, 2000).

A final example 'safety' was ranked the third highest contributor to quality of life and the fourth highest motivator to reside. Within the volcanic literature discussions of risk perception suggested that volcanic communities don't move from active volcanoes because they believe the volcano to be safe (Bird et al, 2010). However, these data suggested that the people of Galeras were neither ignorant nor in denial of the dangers posed by the volcanic activity, but that when they referred to 'safety' they were in fact making reference to their overall safety in relation to all potential threats to their lives and livelihoods and not just volcanic activity. They did not argue their safety on the grounds that the volcano itself was 'safe' in terms of its activity, but that residing on the slopes of the volcano was by comparison 'safer' than any other places within Colombia. Colombia's insecurity is well documented (Deas, 2011, Cotte Poveda, 2014). Nariño, where Galeras is situated is within region of cocaine distribution and guerilla activity. Many interviewees described that up

until 5 years ago road blockades by guerilla were still common. Discussions also highlighted the fact that people in Colombia live with a selection of threats, and therefore that by living on Galeras, people 'only' had the volcanic activity to be concerned about, 'the only problem' or 'the only risk', which was by comparison perceived to be a far better option. These perceptions were supported within discussions of hazards and vulnerability, where livelihood disruptions were identified over a ten-year period. This showed that disruptions due to volcanic activity were only a small percentage of the overall events that took place.

In particular, those interviewed compared the security of their communities on Galeras to the dangers of the nearby city of Pasto where many of the community members work, particularly making reference to the believed high levels of violence and crime there. Many argued that they avoided the city as much as possible preferring to stay on the volcano where it was safer.

It may seem ironic to some, that a volcano labeled as one of the ten highest risk volcanoes in the world (Gilbert and Sparks, 1998) was actually deemed as a best option to many, but in light of the many other potential threats in places away from the volcano, the arguments appear validated. This highlights the fact that volcanoes and their communities are only one part of a much larger countrywide system that they are located within, and that what occurs in other areas of the country can also have an influence on the decision-making processes of those living on volcanoes.

Galeras as a place of safety and refuge was a perception not just to those born on Galeras, but was also said to be a draw for people displaced from other parts of Colombia due to the violence and crime associated with the cocaine conflict. Although immigration to the volcano, in particular to Sandona, was also raised as a problem by the interviewees, people in fact showed a pride of living in a place that others identified as preferential, particularly in light of the fact that many discussions of their communities focus on the danger of the volcano. The benefit of 'safety' and of 'feeling safe' is recognized in the external literature for its benefits to wellbeing (Gabriel and Bowling, 2004, Twemlow et al, 2002) and the way in which it can instill feelings of freedom within individuals (Adams, 1985, Kaminer, 1993).

8.2.2 The value of Galeras 'the mountain'

The acknowledgment of 'tranquility' and 'security' as two of the top three contributions to a good quality of life on Galeras presented a stark contrast to the images of destruction and chaos caused by volcanic eruptions commonly seen on the news and in film. Volcanoes as places of 'peace' and 'calm', where people can be 'safe', 'healthy' and 'free' may seem to some to again be somewhat surprising. However, this contradictory reality in contrast to the more stereotypical image of

volcanoes presented, reminds us once again that volcanoes are not in a permanent state of eruption and that when they are not, many are in fact mountain landscapes. This comparison however seems largely absent from the Volcanological literatures, perhaps because of the technical differences between the formation of volcanoes and mountains that distinguish them from one another, as was the suggestion of one volcanologist during this research. Yet within the mountain science debates this association appears more valid. Although there is a lack of a standard definition of a mountain, a series of descriptions present parallels with Galeras. Messerli and Ives, (1997) describe a ‘’steepness of slope’, whilst Funnel and Price (2003) present a more holistic view of a mountain being a mountain, not because of its geology, but because of its symbolism to the community that reside on it which is most certainly the case at Galeras where the communities identify Galeras as their mountain and themselves mountain people.

‘*A mountain is a mountain because of the part it plays in popular imagination. It may be hardly more than a hill but if it has distinct individuality, or it plays a more or less symbolic role to the people, it is likely to be rated a mountain by those that live at its base’ (Funel and Price, 2003)*

In the discussions of risk this observation leads us to question if there are also parallels within the community values of those living on Galeras with non-volcanic ‘mountain’ communities. On review, the top three most valued components of the volcanic landscape, tranquility, community and security as well as many of the other values identified by the case study, were also found reported within the mountain literature; Tranquility (Herzog et al, 1943 and parsons, 2007), Community (Evan et al, 2001, Rodriguez and Pascual, 2004) and Security (Gills, 2007)
In light of these parallels between the values of Galeras and other mountain communities, it is therefore reasoned that the importance of the volcano and all of its natural and socio-economic components to its communities are likely to be replicated at other strato and shield volcanoes. Therefore it is essential that ‘value’ is included in all volcanic risk assessments and that those values be represented in their entirety. However, despite this need, the analysis of previous risk assessments showed that not only was there a bias of how ‘value’ should be perceived and measured, but also perhaps equally as important was that significant amount of the number of papers reviewed did not include value as a component of risk at all.

Adding to this debate of whether volcanoes are mountains was the data on what people perceived to be the direct benefits gained from the volcano. Approximately half of those asked argued that there were no direct benefits gained, despite the fact that there had been clear recognition of gains and benefits in previous discussions of quality of life, motivation to reside, income and land use. The explanation of this disparity was that when pushed, people described how ‘the volcano’ was to them just the crater at the centre of the summit of Galeras and not the whole of the Galeras

Mountain. Therefore when the question was asked specifically about ‘Galeras’ they were answering in respect to living on the ‘mountain’ but when we asked about the volcano they responded in relation to the crater. This is particularly poignant in discussions of value in volcanic risk assessment leading us perhaps to question where the volcano ends and the mountain begins.

8.2.3 Galeras the asset

In Volcanology it has also been argued that not only do people live on volcanoes due to poor risk perception, but also because they are too poor to be able to move away (Lavigne, 2008). The data from this case study contests that view on two accounts, the first is that as described people argued their motivations to stay rather than their inability to leave, and the second is that although they are not rich in wealth they appear able to meet many of their needs. There are those communities that are struggling to meet their needs, which will be described at length in the next two discussions; however these issues appear to have more to do with the lack of both public and private service provisions on Galeras than the lack of money people have to pay for them. One viewpoint from those interviewed was that the people on Galeras ‘have enough’ money for what they need. This in part appeared true; as many of the things community members praised about living on Galeras were the things they had access to of which did not necessarily come at a financial cost. These gains did not directly contribute to the income of the households but saved them from having to spend money in buying these products or services. Examples of these savings were; that the community provided labour and expertise in building homes and other smaller infrastructure, that neighbours provided childcare and that crops were traded or provided freely by neighbours in times of struggle. An analysis of household expenses was representative of these ‘savings’ exhibiting an absence of these factors from their monthly budget descriptions. It was also identified that a number of individuals seemed to also have disposable incomes evidenced by such examples as satellite dishes on houses and children with mobile phones.

There was at least one exception to this rule however, in that the greatest expense for many households was food, even though agriculture was one of the greatest land uses. Although the land provided a viable climate, topography, water and minerals to grow an exceptionally wide variety of crops, in truth people had to sell the majority of their crops to pay for their other expenses in light of unemployment and low salaries from other jobs.

The availability of natural and social resources on Galeras not only supplied individual households but also provided the foundations for a wide range of small and medium sized businesses and enterprises. The availability of such a collection of natural resources including fertile soils, minerals, aggregates, plants and animals resulted in 55% of income activities being based in

primary extraction; forestry, mining, agriculture and aquaculture. In addition these resources had a multiplier effect leading to the creation of production and service industries such as restaurants and handicrafts. As a collective of these businesses, Galeras can be said to have divided into a number of micro-economic zones, largely influenced by the changing landscape. The wide expanses of flat grasslands in La Florida have provided pasture for cattle both for meat and dairy, which subsequently support the small-scale production of cheese and other milk based products. In Genoy the grasslands have also provided pasture for the raising of guinea pigs, which have become a very popular local dish for tourists visiting the volcano at the weekend. The hotter climates of Sandona have provisioned the growth of coffee and sugar cane, both of which are high value products. In Sandona the growth of the fique palm has also supplied the local people with a material to make a variety of handcrafted products such as panama style hats. Many of the micro-economies at Galeras are unique to Galeras, not found elsewhere in Colombia. For example the microclimate conditions in Sandona are said to have attributed to the specific nutty flavour of the coffee beans grown in the region and the reason why some argue that the coffee has the reputation as being the best in the world. The spit roasting of cuys (guinea pigs) for eating is a delicacy found in Ecuador but not in other places in Colombia, only at Galeras.

From top left to bottom left: Hummocky ground in Mapachico, blackberries in Sandona, coffee beans in Sandona, Handicraft goods in Sandona, Cattle in Mapachico and flat pasture lands in Sandona. (Author, 2012)

The interaction of the communities of Galeras and their landscape have encouraged a number of tourism activities, where once just ordinary livelihood and recreational activities have now become viable economic options including; extreme sports such as paragliding from the steep slopes, spa bathing in the geothermically heated pools and celebrations based around the religious and harvest calendar. Yet it is important to stress that businesses have not developed around the provision of natural resources alone but the availability also of socio-economic draws such as a customer market, transport links and labour pools. In addition the rarity of some of these physical and social niches have also added value as people either cannot grow such products elsewhere (such as the coffee) or people can't participate in the same activities. The added value of 'niche markets' is explored within the economics and marketing literatures, in relation specifically to pricing and profit (Loureiro and Hine, 2002 and Laufenbert et al, 2003). In addition, the certification of niche products is identified as being one way of increasing income opportunities to mountain communities with little opportunity to diversity (Gonzalez Nigh, 2005; Shanley, 2008)

8.2.4 Informed and rational decision-making

Another common perception argued in Volcanology is that along with poverty, another reason people reside on active volcanoes is that they do not understand the dangers, referred to within the literature as having poor risk perception' (Paton et al, 2008 and Haynes et al, 2008). This estimation is largely determined by how 'correct' communities knowledge of volcanic hazards is in line with the scientific data and conclusions. Having discussed the gains of Galeras and how it has benefitted the communities in question, it is also important to highlight that many people interviewed fiercely contested the idea that the scientists and decision makers thought they did not understand the potential dangers of the volcano. They stressed that they had researched the volcano and that they understood the dangers but that they had accepted the activity of the volcano and the possibility of an eruption and they wanted to stay,

"We understand the danger, we have been on the Internet and we have attended the meetings, we understand but we have made our choice, we want to stay"

In contrast to the perception that they do not understand the risk, the data suggested that people were in fact actively evaluating potential costs against potential gains. They knew the volcano could be dangerous but were driven by the fact that on a day-to-day basis, when the volcano was not active, that there were opportunities to be had, and niches available on which to build their livelihood strategies.

Business and economics theory present a viewpoint of risk closer to data of Galeras than volcanic literature. Whilst the volcanic literature concentrates on value in risk assessment as potential loss, business and economic theory proposes that risk is resultant in gain (Knight, 2010) with some of the most profitable industries in the world also being some of the highest risk such as oil, nuclear and fracking. Fracking one of the most fiercely contested technological developments of the present time, is favoured by many government and economists because of the potential profits it could lead to (Cartwright, 2013 and Cusolito, 2010)

8.2.5 The value of Galeras for the future

The empirical data also showed that decisions were not only driven by the need to 'gain' for the wellbeing and prosperity of the current generations living on Galeras, but that individuals were factoring the needs of their future generations into their decision making. When asked what the future potential of the region could be, interviewees identified a number of possible opportunities both expanding on the resources they already utilise but also having identified new opportunities that were not already being carried out. The growth of new varieties of crops, the use of new technologies, the raising of different animals, specialization of ecotourism tours all expressed the potential for growth in the area. Peoples reasoning for future plans appeared both informed and rational, continuing to build on the resources available to them but with the knowledge that new niches and variations could provide them with higher profits.

Calculated decision making was also evident when asking people to reason why they used their land in specific ways, choosing to grow specific crops or keep specific animals. The level of detail from their description of their land used to support their decision-making was considerably high. Detailed descriptions were provided about variations of soils, climates, topographical features and winds along with which conditions were best suited to specific uses. Even those plots of land, which to the layperson may have appeared useless, were being utilised such as the heavily eroded field edges that fell into the valleys, which were in fact being used to grow specific crops. Maximum yield of the landscape always appeared to be the key objective of the majority of the landowners, finding ways to get the most from every inch of their land. In total 46 different land uses were recorded resulting in what can only be described as a mosaic landscape. In light of this local 'expert' knowledge, to suggest as in the volcanic literature, that these people do not know about their environment would really be a great misjudgment.

8.2.6 The value of Galeras the 'volcano ecosystem'

In describing this close relationship between the volcanic activity and livelihoods, one academic from the University of Nariño at described how the wide expanses of flat land found at La Florida were a result of a pyroclastic flow flowing down from the crater and obliterating anything in its way. This particular feature of the landscape now provides what the community perceives as being perfect conditions on which to graze cattle, preventing them from using up too much energy walking over difficult terrain, and keeping the animals relatively accessible for farmers needing to milk them. This niche landscape however, was different to the mostly rockier, more undulating topography found across the rest of Galeras and therefore presented La Florida with a unique opportunity not found elsewhere on the mountain. This exclusivity allowed a successful dairy farming economy to grow in Sandona unrivalled elsewhere on Galeras.

The interaction between the community and the mountain and the large number of dependencies that have developed exemplified the close relationship between the two. This strong relationship could suggest that the volcano and the communities should not be thought of as two separate systems, but part of the same one. Taking this perspective suggests that we might be able to draw from ecological theories to further the debate on value.

The theory of disturbance ecology suggests that natural phenomena such as fires, floods and earthquakes should not be seen as a threat to ecological communities as they ultimately end up creating new opportunities for plants and animals to colonise (Gurtz et al, 1988). Applying this theory directly to volcanic landscapes, Reice (2003) describes the eruption of Mt St.Helens in 1980. Having first witnessed complete devastation of flora and fauna across the volcanic landscape, within a matter of month's ecologists were reporting new species returning, taking advantage of the new ecological conditions. In addition, studies of wildfires, often a symptom of volcanic eruptions, showed that in their burning of the taller trees, light was released onto the forest floor where it had been largely absent before, which in turn encourages new growth. In considering the community of Galeras as part of the ecosystem we can draw clear parallels with this theory. The natural resources and landscape characteristics that have been utilised by the community in building their livelihoods have of course been created as a result of volcanic activity. In creating the 'mountain', volcanism has in fact led to a range in soils, climates, and topography as well as leading to the provision of water sources (Whiteman, 2000 and Beniston, 2002). In adapting their activities according to their landscape it could be said that people, like the other components of an ecosystem at Mount St. Helens have evolved to survive in line with the niche conditions that the environment presents; leaving the higher slopes for forests from which to take building materials, using the flat pasture lands for grazing cattle, using the hotter climates for growing fruits and the cooler climates for growing vegetables and using the acidic soils for growing coffee.

8.2.7 The value of Galeras 'the place'

Discussed already in this chapter has been the importance of many of the different components of the Galeras landscape to the communities residing on them. Not only has value been found in the natural resources of the mountain but in the way in which those gains can be multiplied to form livelihood activities, and grow mini economies. Examples of this association included; cattle rearing on the large, flat areas of grasslands, the growth of a diversity of crops, rain and river water being used for household activities and the transport of people and goods along the main road circumventing Galeras. However, in addition to their individual importance, the wider literature on 'sense of place' and 'place attachment' suggest that the sum of each of these components and the synergies between them may also have a significant value, giving communities an identity which in turn considerably aids their wellbeing (Assessment, 2005 and Lachman et al, 1998). This discussion shows that the value of Galeras is far more holistic than financial value alone, as suggested within the volcanic risk assessments.

According to the theory of 'sense of place' found in cultural geography, anthropology and sociology, 'the combination of natural locations and created features', such as those found at Galeras, can create a 'unique and identifiable place' (Stedman, 2003, Cross, 2001 and Hummon, 1992). This suggests therefore that the experiences that communities have had at Galeras may have led to a specific meaning of the 'place' developing, which may in turn have increased their perceptions of the importance and value they placed on Galeras. The data from this case study supports this theory, with people expressing feelings of 'provisioning' and 'security' in their descriptions of life on Galeras, evidenced by their praise of the mountain to provide them with a multitude of needs and the level of safety they feel living there. Data showed that members of the community thought of Galeras as an elder member of their family, referring to it as 'Tita', meaning both the 'mother' and the 'father'. 'Tita' they described protected the community and was the reason why only eight people had ever died on the volcano as these people had been outsiders who had not asked for protection.

The theory of sense of place is said to be built from a set of specific types of experiences (Jiven, 2003). At Galeras this appears to have taken place as a result of; experiencing the natural fluctuations of volcanic activity and other natural events, learning traditional knowledge from other community members and in particular the elders, dealing with the decisions of policy makers and living in the area and landscape in which they were born. Each one of these 'experiences' appears to have moulded individual's perception of the Galeras as a 'place to reside', and motivated the majority to stay.

People's experience of both the volcanic activity of Galeras as well as the other natural fluctuations of the mountain landscapes showed how continuous experience of the landscape had built through the generation. This had developed an ability of the community to adapt to the dynamism of the mountain and take advantage of its resources in order to meet their needs, which was particularly poignant in the data detailing the level of people's knowledge in how to farm the 'mosaic' of different geological and ecological conditions. Many livelihood strategies have been developed in line with the natural environment such as diet and water collection, building materials and housing design, saving the volcanic ash to spread on their field and clothing styles and materials, of which were all observed during the field study. A strategy of using natural plants as medicines was another popular activity, with people appearing highly knowledgeable of how to treat a variety of illnesses and ailments. One focus group discussion in Genoy exemplified the detail of local knowledge when individuals identified on the map given to them, the exact location where one specific type of snake could be located whose venom is used as an anesthetic. Observations showed that so much of what the community do is methodical, directly related to the dynamics of the Galeras landscape. These distinct activities appear to have developed into a culture different in so many ways from those that live off the slopes in Pasto and surrounding areas despite the fact that they are in fact considerably close.

Another contributor to the development of a distinct sense of place and cultural identity appears to have been the declaration of disaster and relocation program. Although people have lived on Galeras for hundreds of years the decision of the government in 2005 to declare the communities of Galeras too dangerous to live in, ignited the community to fiercely dispute the accusation that their 'Tita' would harm them. The subsequent decision by the government to move 3,000 inhabitants from Galeras encouraged the communities to fight for their indigenous rights based on their strong and historic relationship with their landscape. The communities' opposition to the judgment has been reasoned to be the cause of the community regrouping as an indigenous community and reforming their indigenous council, known as a The Cabildo, to represent their needs. This in turn had led the community to begin fighting for official recognition as an indigenous group of which in Colombia allows such groups a specific set of rights. One such cultural tradition presented as evidence in their application of their indigenous heritage was the traditional practice encouraged at the birth of new babies to bury the placenta in the ground to establish their relationship with the land.

The proposed relocation also appeared to have encouraged people to evaluate possible other locations to move to, however many argued that no other place would be able to provide for their needs in the same way as Galeras. A comparison of places appeared to have led to people questioning the importance and meaning of different places to themselves. Participants stressed that

they required things such as; land to grow their crops, land to divide to pass on to their children, an area large enough for the whole community to move to, tranquility, security, access to natural water sources, access to specific types of soils, volcanic ash, natively plants and animals and the Circumbalar road to transport themselves and their goods. Ultimately the prevailing argument the community gave in their fight against the relocation was that no other location would be able to provide all of these things. Although individually some of the features could be found elsewhere off the slopes Galeras, two particular features were exclusive to Galeras, the 'Tita' itself and the ancestors of who had been buried on the mountain. Therefore it seemed to many interviewed, an inconceivable idea to move elsewhere.

The fact that the majority of people interviewed had been born and raised on Galeras meant that it was what sense of place theory describes as their 'primal landscape' (Measham, 1988 and Trigger, 2008). The significance of this was that these individuals had spent their whole lives living in the one place and had developed a bond with their landscape and with each other. This historic timeline therefore meant that Galeras was for them a multitude of places including home, recreation, work and as already mentioned a place of ancestry, where previous generations are buried. This uninterrupted time on Galeras meant that for many, both their childhood and adulthood had resulted in a set of rituals and routines being developed to undertake everyday life a well as any specific challenges that may arise. A strong geographical identify may, according to sense of place theory, nurture a strong personal identity in community members and influence them in the way in which they do things (Hauge, 2008). This appears to have also been true within the communities of Galeras whose in describing one another; dependable, cohesive, hardworking with a fighting spirit, appeared to perceive each other in the same way in which they perceived Galeras, as 'provisioning' and 'protective'.

The empirical data showed that both a personal identity and a clear sense of belonging is clearly felt by the communities with people not only proud to be living on Galeras in their specific communities, but also that they are one generation of many who have lived in the same place. As a result, many of those interviewed identified themselves as 'indigenous' and have over recent years petitioned the government with their claims in order to get legal status as an indigenous group. This would in turn entitle them in theory to land rights and other provisions.

The importance of identity and sense of place appeared to have been highest during the period of the proposed relocation, when their access to Galeras and their communities had been under threat. Under the relocation proposals not only would people have been moved to the city but they would have been moved individually and not as a community. The community responded by re-grouping and re-establishing themselves as an indigenous group in order to give themselves a collective

voice. In times of discussion with the government this 'voice' has fought arguments put to them that they do not understand the risks of living on the volcano and need to be relocated to ensure their safety. However, discussions with government representatives suggested that the community 'voice' had been interpreted as trouble making and not as it was meant, of people raising their concerns over the potential loss of what they valued. In one conversation with an emergency planner the following descriptions of the community were noted; that they were not really indigenous people, that they had only argued themselves to be indigenous in order to not have to relocate, that they say they have an appreciation of the volcano yet they exploit its resources and that they have moved before and so are not even protecting their original land. They also complained that when the volcanologists and the emergency planners had invited the community to attend their meetings on the relocation they had not attended, instead holding their own meetings and in turn inviting the volcanologists and decision makers to attend those This emergency planner appeared to find it both humorous and frustrating that they had to make the journey to the communities and engage in their indigenous council protocols. Although representing only one persons perceptions, this person was in position of power within the decision making process and therefore had a considerable level of say in the futures of these communities.

The threat of being moved from Galeras as a result of the relocation has led to significant levels of conflict not just between the communities and the government but also on occasion between members of the same communities over their difference of opinion over whether to move or not. Some argued that the declaration of disaster was an attack on their culture and way of life, a result of a disregard for the impacts that loosing access to Galeras, their homes, their land and their community would have. One member of the indigenous community gave a sad warning of the impact that loosing the volcano would have on them, "Like trees without roots we will die".

8.2.8 Summary of value

This series of discussions on value saw Galeras presented as; a volcano, a mountain, a landscape, an environment, an ecosystem, an asset and a place. Each concept presented a different reality of the values of Galeras both to the communities of Galeras and to greater humanity, a reality far more complex than the population density and capital value of infrastructure depicted in the volcanic risk assessments. These discussions expressed the many reasons why people on Galeras had been motivated to stay residing there, identified as factors of importance to welfare. These reasons were different and at some times contradictory to reasons commonly given in the volcanic literature; fertile soil, lack of knowledge of volcanic activity and poverty. These discussions showed that contrary to the belief that people only stay living on volcanoes because they have no choice, the reality at Galeras appeared to be that people are actively deciding to stay, largely driven

by what they can gain and the fact that these gains are not replicated elsewhere. As a collection of values, data showed that a loss of Galeras to its communities as a result of risk management strategies could have a significant impact on wellbeing, the essence of which risk management is aimed at protecting.

In exploring 'value' at the community level, the activity of Galeras presents a paradox in that although the volcanic literature appears focused on loss as a result of volcanic activity, it is this same activity that has also shown itself in the empirical study to be a provisionary of gain and opportunity. Therefore it should be argued that there is a value not just of the individual elements of the Galeras landscape, both natural and man-made, but in the volcanic activity of Galeras itself. Therefore in direct contrast to the volcanic literature this data suggests that living with volcanic risk should not be perceived solely as a potential loss but also as potential for gain.

However, perhaps most interestingly of the literature review findings was the fact that a considerable amount of papers did not include value as a measure, suggesting that it was not perceived to be a component of risk. These empirical data directly contests this and argues that it is essential that 'value' be included in future risk assessments as it appears to be a representation of both individual needs and an indicator of what motivates people to stay.

In a stand alone paper within the review, Donovan (2012) described value to be 'relative specifically to the individual' and 'dependent on cultural outlook and personal standards". This perception appeared to be a good reflection of the scenario at Galeras where the community seems to have a specific perception of the value of Galeras.

8.3 Deconstructing Hazard at Galeras

The systematic review of volcanic risk assessments in Chapter two of this thesis suggested that the perception of 'hazard' within Volcanology tended to draw from two main paradigms of thought: that 'hazard' was used to describe the probability of a destructive event occurring; and that the cause of a destructive event on a volcano would be due to a process or product of volcanic origin such as a lahar or lava flow. Historical and regional analysis at the local scale revealed that, at the Galeras volcano, volcanic products and processes had only been held responsible for 7% of the total number of disturbances to people's quality of life between 2002 and 2012, a period of time that had included a significant amount of volcanic activity. This suggested that more understanding was needed of the full inventory of possible hazards that could affect communities living on active volcanoes and highlighted that assessment methodologies need to be able to capture this variety.

8.3.1 The Hazardscape of Galeras

To explore 'hazard' at Galeras a historical analysis of previous disruptions to the communities' quality of life was conducted using interview data. These data led to the identification of a 'hazardscape', defined by Cutter et al. (2000) as "a spatial distribution of hazards within a place". As described in Chapter three, such a methodology was designed due to the recognition that Galeras, like many other volcanoes, is a mountainous landform and that, like other mountains, according to studies of mountain geography, it is a location of multiple different types of hazards, not only those of volcanic origin (Ives and Messerli, 1981 and Zimmerman et al, 1986).

This conceptualisation of volcanoes as mountains and places suggests that Galeras was not only the site of 'volcanic hazards' like lahars and lavas but also of other natural and man made processes. To identify the full inventory of hazards present within the Galeras region a historical analysis was carried out to identify what the causes of disruptions had been over the recent ten-year period. Although some previous methodologies identified in the systematic review had showed that some studies had looked to past events as an indicator of what could occur again in the future, this had only been done to analyse geological processes that had taken place as the only hazards that had been measured were geological (Thierry et al, 2008).

Having identified what factors were deemed by the community as necessary for a good quality of life on Galeras, an inventory of 'disruptive events' that had affected the accessibility of those necessities was recorded to form the 'hazardscape'. The literature review highlighted that there was a common tendency within Volcanology to identify only volcanic processes and products as potential hazards, such as: pyroclastic density currents (Lirer and Vitelli, 1998, Marti et al, 2009, Cherry et al, 2012), lahars (Leung, 2003), tephra fall (Costa et al, 2000, Horwell, 2006, Keating, 2009), soil degassing (Ferreira et al, 2005), earthquakes (Marti et al, 2008) and lava flows (Kaye et al, 2009). However investigation of the Galeras hazardscape revealed that the community attributed only 7% of the disruptions recorded within the ten-year period to volcanic activity. Instead, the highest ranking hazards were social and economic in origin, with particular emphasis given to: 'poor or no government provision of public services and social security'; 'the declaration of disaster'; 'lack of financial resources'; 'lack of employment or low salary' and 'physical sickness'. Of those papers reviewed in Chapter two, only one, Gaillard (2008) identified volcanic hazards as being caused by anything other than processes and products of volcanic origin in his identification of 'every day hazards of poverty''.

The discussions of the Galeras' hazardscape also revealed that the volcanic risk assessments reviewed in Chapter 2 represented only in part the experiences of community life on the volcano.

For example, Arana and Ortiz (1996) defined volcanic hazards as a ”set of events taking place in a volcano that may cause damage to people and properties exposed to them”, when in comparison the data from Galeras suggested that potential hazards were not only events ‘in’ the volcano but also ‘on’ the volcano.

In contrast to this somewhat narrow view of hazard within Volcanology, generic definitions of hazard such as that used by the UNISDR (2009) appeared to be a better fit, more representative and inclusive of the complexity of the reality of hazard at Galeras.

”*A dangerous phenomenon, substance, human activity or condition that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage*.“ (UNISDR, 2009)

Whilst data collection for the Galeras hazardscape looked specifically at the causes of the disruptions, the scenario of each hazardous disruption also provided further insight into the dynamics of hazard on Galeras. Asking people to first identify what elements were needed for a good quality of life and then if they had had any problems in accessing those needs allowed a focus on the full impact of the hazardous event on the community. Although the literature reviewed in Chapter 2 suggested that Volcanology assumed the impact of volcanic hazards would be felt demographically and structurally by damage to infrastructure the Galeras data suggested that the greatest impacts of hazards at Galeras were in fact not on life and infrastructure but on employment, healthcare, physical health, education and tranquility.

Within the volcanic risk assessments reviewed there were a trend to classify volcanic hazards as ‘natural and more specifically ‘geohazards’. This mirrored the focus in the assessments on volcanic hazards being seen as processes or products of volcanic origin. However, the inventory of hazards recorded at Galeras suggested that a greater number of classifications were required in order to present a more inclusive representation of events at Galeras, these should include; biological events to represent crop failure and poor livestock health, and meteorological events to represent the poor climate. In addition, a significant number of social and economic hazardous events had been recorded which as a collective had resulted in a significantly greater number of disruptions than all the ‘natural’ events at Galeras. This therefore argued that in only perceiving to volcanic hazards as only natural or geo-hazard events that any risk assessment used would only present one part of the hazardscape to policy makers.

Some of the volcanic risk assessments reviewed also classified hazards on the type of impact they would have as well as their source (Wilson et al 2012, Horwell and Baxter, 2006) Although chapter four highlighted the many things that people gain free of charge from living on Galeras, this part of

the data set revealed that there are also many requirements that needed to be purchased. The highest ranking need 'employment' was reasoned to be the source of the majority of the household financing providing for such expenditures of which included; education, food and healthcare. Therefore in light of the trend to classify hazard by type of impact this data suggests that more representative risk assessments should focus on employment as a specific indicator of change.

8.3.2 The Heterogeneity of hazards

The Galeras hazardscape comprised a collective inventory of hazardous events that had occurred across the six communities of Galeras studied, yet local level analysis showed heterogeneity amongst the individual hazard inventories of each community. Whilst there were a number of extensive hazards experienced at the majority of the field sites, such as climate change, a number of other events identified such as immigration, crop failure and poor livestock health were localised to one or two specific communities. The notion that hazards could vary across the volcano was a phenomenon acknowledged within the volcanic hazard assessment literature although, once again, this tended to be in association only with volcanic processes and products.

As well as spatial variance, the Galeras hazardscape identified a temporal change of hazards throughout the decade of analysis. Not only did this show a change in singular events being prevalent at different times but also that simultaneous combinations of different events were possible. The majority of the volcanic risk assessments reviewed failed to capture this dynamic instead only concentrating on one specific volcanic product or process, which suggested that in the absence of that hazard there were no others of concern which of course was not the reality. Only one paper that was reviewed, Gaillard (2008), indicated that more than one hazard might occur at the same time.

In disaster and crisis management, consideration is given to the fact that hazards do not usually occur independently but that one initial event can cause or trigger a subsequent hazard, this phenomenon is known as a 'cascading hazard event' (Carpinano et al, 2009). Closer analysis of the disruptive events at Galeras over the ten-year period showed a multitude of linking events. Data suggested that the initial physical volcanic event of 2002 had triggered a cascade of other physical events, as well as social, economic and political hazard scenarios, of which all linked together. The greatest number of disruptions were attributed to employment, healthcare, physical health, education and water which the analysis showed the community to have attributed to the government's disaster management strategy put in place to mitigate the volcanic activity. These links not only identified a chain of causality but also exemplified how the hazardscape at Galeras was in fact systemic. Whilst the monodisciplinary approach within the volcanic hazard assessments

had meant that only a small number of physical hazards were identified, it also suggested why perhaps such linkages between events have also not been identified.

Many of the socio economic events identified as having occurred between 2002 and 2012 were still current at the time of the interviews. Whilst this could suggest that people were more focused on current issues of concern rather than on those, which had happened in the past, it might also suggest that the duration of impact of some the hazards were longer than others. Whilst some hazard events occur over a short period, their impacts may be longer lasting. For example, events that may affect people's employment may happen quickly, however the indirect impacts such as inability to purchase medication, education or public services may be longer lasting. Whilst impact was measured in the majority of volcanic risk assessments reviewed by the number of lives lost or costs to infrastructure this does not represent the ongoing impact that these events may have. The loss of a family member, for example, has far wider repercussions than solely the emotional loss of the individual such as the loss of the income that that individual usually contributed to the household. In addition, the loss of infrastructure does not only have financial repercussions but also social impacts if that infrastructure provided specific needs. These 'waves' of impact that had occurred at Galeras had had considerable consequences to the wellbeing of the community but would not have been captured by the volcanic risk assessments reviewed.

8.3.3 Differing community perceptions of risk

In natural hazards and disaster research, people's risk perception is often identified as an indicator of the level of adjustment an individual will make when faced with the threat of a natural hazard. This belief is driven by two key theories. The first is that those with low risk perceptions of extreme threats are less likely to adjust to the threat having determined that there is a low possibility that it will affect them (Paton et al, 2008 and Haynes et al, 2008). The second is that the perception of risk of one event is estimated in relation to other additional threats (Kates, 1971). Within the volcanological papers reviewed in Chapter three, only the first of these theories seemed to have been adopted, leading to the argument that one reason people choose to live with volcanic hazards is because they have low risk perceptions of them.

The Galeras case study data suggested that the second theory may have more significance in this particular case, that the Galeras communities' perception of risk to volcanic hazards may be being estimated by the community in relation to the many other additional threats they had identified. Of all the risk assessment papers reviewed only one discussed communities 'comparison' of different threats. In his study of the communities of Mt Pinatubo after the 1991 eruption, Gaillard (2008) concluded that people's perceptions of risk to 'everyday hazards of poverty' and 'cultural heritage'

were higher than to the risk perceived to volcanic hazards. In Galeras, a total of 24 different hazards were coded as were identified in Chapter Five, of which the volcanic eruption was only one of the lower-ranking events. This finding suggested that even though volcanic activity was very much a contemporary issue, the perception of its risk had become somewhat 'diluted' amongst the many other issues that the communities were faced with at the same time. This theory is supported in part by the discussions of security explored in the 'Value' analysis previously explored in chapter four. In particular, people had reasoned their motivation to reside on Galeras not because it was safe but that it was safer than other places and that it was positive to some that the volcanic activity was the 'only risk' that they perceived in their community in comparison to the many others found in different places. Perhaps therefore it is this 'dilution', that in part along with 'values' already discussed, the reason why so many people chose to stay living on Galeras despite the increased volcanic activity of 2002 and the subsequent declaration of disaster and relocation program that followed.

In addition to the two key theories of risk perception, the Galeras dataset suggested that there may be a third key factor to take into consideration, and which may be influencing interviewees ' choices to stay resided on Galeras. This factor was that although the Galeras hazardscape had been conceptualised from a historical analysis of previous events, what people perceived to be the cause of those hazardous scenarios was in fact subjective, therefore making the hazardscape subjective also. The inventory of disruptive events identified was dependent both upon what the interviewee identified as needed for a good quality of life, and what they attributed the root cause of any disturbances to be. The cause of many of the different events may be contested depending upon how other stakeholders understand events and what they attribute the source of the disruption to. However, despite this, the description of each disruptive event still provided a great deal of insight into the hazard dynamics at Galeras. One key area of possible debate may be the many disruptions that interviewees attributed to the governments risk manage approach to Galeras. Although the community placed blame on the government for factors such as stress or the lack of public or private investment in the region, it can of course be argued that without the initial volcanic eruption, the declaration of disaster would not have been put in place and therefore the relocation program would not have been conceived. If this was the case then it is also therefore arguable that many of the disruptions recorded would therefore not have occurred. Within modern paradigms of disasters studies, natural disasters are in fact widely contested as not being 'natural' events at all, and that a natural hazard only threatens the risk of disaster when measures to mitigate its impact fail (Blaikie etal, 2014). At Galeras, although the volcanic eruption that occurred was a natural event, the fact that so many people attribute the subsequence response of the government to have been the cause of so many disruptions adds to argument that living on Galeras should not only be classed as living with natural hazards.

One possible re-classification of the hazards recorded at Galeras may be found in the emergency planning rhetoric, where the term 'political hazard' is often used to describe episodes of civil unrest, which occur as a result of a population feeling that their needs or rights are not being met by the governing system (Delios et al, 2003). It is argued that this scenario can lead to 'community disruption' or 'civil disturbances' such as 'labor unrest', 'strikes' and 'civil disobedience' (Henisz, 2004). This theory therefore perhaps suggests that the tensions both between the communities and the government and between the community members themselves identified at Galeras between 2002 and 2012, may have been because of the blame people placed on the government for many of their needs not being met. In addition, this suggests that non-natural hazards at Galeras should not only be classified as 'social' and 'economic' but also 'political' and that as a result of the dominance of 'political hazards' on the Galeras hazardscape, such events and their impacts require significant attention within future risk assessment frameworks.

As already identified, the conceptual Galeras Hazardscape was formed not on objective scientific data but on the subjective interpretation of events of those interviewed when accounting for disruptions caused to their key needs between 2002 and 2012. Once again this highlights both the influence of peoples values and the fact that those values of the communities of Galeras differ to those identified in the volcanic risk assessments as was previously discussed this chapter. This difference in values, may account for many of the failures of government risk management strategies at Galeras, as although the declaration of disaster and relocation program in theory aimed for the protection of lives this was ultimately not the priority needs of the communities themselves, who in contrast identified employment and tranquility amongst their greatest priorities. The fact that lives and infrastructure were identified as common measures of value within the volcanic risk assessments reviewed, suggest that the values identified in Volcanology may have been of influence. At Galeras, a great deal of power was given to the volcanologists involved in the overall risk management as described in chapter one, therefore suggesting that those biases seen within Volcanology may have trickled down from the been adopted and applied by the decision makers at Galeras.

Despite whether or not it was the governments decisions or other events that occurred between 2002 and 2012 that were blamed for the disruptions to; people's livelihood activities, health, homes, and surrounding infrastructure, the governments role was to 'govern' and ensure the needs of their population were met of which as shown did not always occur. Therefore in returning to the UNISDR (2009) definition of hazard, '*loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage'* were all caused, therefore supporting the theory that, whether directly or indirectly, 'political hazards'

are present within the Galeras hazardscape and need to be accounted for in the management of risk of the community in order to protect lives and welfare.

One other hazard classification that also appears prevalent within the Galeras hazardscape but of which is also absent from the volcanic risk assessments reviewed, are 'psychological hazards'. Although traditionally 'psychological hazards' is a term applied in psychological work environment research and occupational psychology (Johnson and Hall, 1996), the theory also appears to fit the Galeras situation and therefore it would be appropriate to apply it in order to further understand. As already described in chapter three, businesses and livelihoods, such as those at Galeras, share a lot of similarities, as they are both systems of flows and processes. In addition, data showing that Galeras is the predominant location for a large majority of its communities' income activities, as well as many other livelihood functions, suggests we can identify it as a 'work place'. 'Psychological hazard' is a term used in reference to the negative impacts that interactions between job content, work organisation, management, other environmental and organizational conditions, and employee competencies and needs have on health' (Cox, Griffiths and Rial-González, 2000, ILO, 1986). If we make direct comparisons between traditional concepts of workplace and Galeras we can make the case for direct links between the elements including; job content and livelihood activities, work organisation and social organisation, management, environmental and organisations conditions and local formal and informal governance, and employee's needs and community member needs.

Psychological hazards are said to have a 'hazardous influence on employee health both mental through stress and physical through related heart disease, depression and musculoskeletal disorders' (WHO, 2015), which as reported in chapters five and six, are both prevalent at the communities of Galeras. Community members attributed much of the stress and related physical health problems to the impacts of the declaration of disaster and relocation program, in the same way that workers may place blame on 'management and other environmental and organizational conditions'. In addition, as seen in chapter six, both members of the communities and many of the experts interviewed blamed levels of stress and depression for the Galeras region having one of the highest levels of suicide in Colombia. Quotes such as '*this is psychological terrorism*', expressed the strength of objection and discomfort within the communities.

Psychological hazards in the work place are said to be attributed to individuals perceptions and experiences (Cox and Griffith, 2005), in the same way in which we have explained that it is the subjectivity of peoples interpretations of events and the needs they have, that have driven the hazardscape identified at Galeras. Whilst decision makers may question the significance of such 'perceptions', the data showed that at Galeras a significant number of those interviewed prioritised

their need for good health and a significant amount felt that those needs were not being met. Therefore it seems essential that these 'perceptions' be factored in to future decision making.

Although the impacts and causes of psychological stress has been explored within the study of natural hazards and disaster management, this has largely concentrated on peoples mental wellbeing as a result of disaster frequency, severity and subsequent loss (WHO, 1992) and the loss and uncertainty caused by relocation (Goto et al, 2006). These results show, however, that there is a need to identify and explore further the psychological stresses caused by risk management to volcanic communities. In these situations, where likelihood of loss may be perceived by governments but where prediction may remain uncertain, governments may retract financial support and service provision in the interim period between policies being announced and enacted. This scenario exists at Galeras, where ten years after the initial eruption that prompted the declaration of disaster, decision making over the future location of the communities remains largely unresolved and where as a result communities still feel high levels of insecurity.

8.3.4 Summary of hazard

This discussion of hazard has shown that the causes of disruptions to quality of life on Galeras between 2002 and 2012 were only in small part perceived to be due directly to the volcanic activity of Galeras. Therefore, volcanic risk assessments that concentrate solely on hazards of volcanic processes and products only present a small section of the community experiences of hazard at Galeras. In looking at volcanic risk we also need to account for the risks of the management decisions put in place and account for the negative impacts that these may have as well as the positives. The risk management of Galeras was blamed for loss of life, health, livelihoods, infrastructure, and services, which arguably as a collective appeared far more detrimental than the volcanic activity it was put in place to manage during the period of time under scrutiny. Regardless of whether the government and its risk management strategies were the proverbial 'chicken or egg' cause of many of the social and economics problems in this time, much information was still deduced in regard to the complexities and interconnectivity between different key hazard events. Whilst we may not necessarily be able to agree on the 'whys' of these events, this dataset has uncovered more detail on the 'whats', 'wheres', 'whens' and 'hows' of the past and present 'hazards' at Galeras. This complexity highlights the considerable narrow focus of the way in which hazard appears to have been perceived within previous volcanic risk assessments and highlights specifically that for future practice it should be understood that volcanic activity does not occur to the expense of all other hazards but in addition to and that volcanic hazards and hazards within volcanic areas are in fact two different things.

8.4 Deconstructing Vulnerability at Galeras

The systematic review showed that vulnerability within Volcanology was perceived predominantly as both the potential for loss and susceptibility. Whilst 'loss' concentrated on elements that could be lost or damaged as a result of an event, susceptibility described the way in which certain characteristics of an element made that loss more likely to happen. Once again, as in the discussion on the analysis within the literature of hazard, there was a predominant focus on volcanic products and processes. Whilst field data showed some similarities to the reviewed literature, considerable differences and sometimes opposing views were apparent.

8.4.1 The Galeras vulnerability profile

Empirical data exploring historical events that had occurred on Galeras; their impacts on the community and the actions that the community had to engage in to deal with those impacts, highlighted a profile of vulnerability, as seen in Table 7.1 that was specific to the communities of Galeras. The profile suggested that in order to secure a good quality of life on Galeras and to cope with any of the disturbances experienced, an individual needed to be able to meet the following inventory of criteria.

Table 8.1 Profile of necessities for a good quality of life on Galeras

Obtain access to		**Maintain ability to**
(Material Objects)	**(Processes)**	**(Coping strategies)**
Food	Availability of well paid employment	Change a standard of practice
Clean drinking water	Good governance decision making	Work in an alternative location
Agricultural inputs	Good government risk management strategies	Work more hours
A home	Good quality of health	Work more than one job
A good quality road network	Good quality healthcare	Travel to a different place
Land to cultivate crops	Good quality of education	Borrow money
	Knowledge to cultivate crops	Demand a 'right'
	Knowledge to run an efficient business	Contest a government decision
	Security from crime, terrorism and violence	
	Government welfare support system	

The association of vulnerability as a measure of 'strength' had emerged in a number of the papers reviewed, describing vulnerability as a matter of 'susceptibility' (Mauriello, 1999). These discussions had described strengths or weaknesses that would influence the level of impact an event might have on a person or a material element. A couple of papers looked specifically at the susceptibility of people, calculating it as a function of proximity to the 'volcanic' hazard, with the people closest being those of highest vulnerability. This empirical data presented here in the profile of vulnerability shows that proximity should not to be seen as the only factor but that the needs of an individual within an area are also of great influence.

Within the volcanic risk literature only Leone, (2009) drew on Cutters theory of 'Social Vulnerability to Environmental Hazards' which suggested that an individuals vulnerability was, in addition to proximity, determined by a set of specific attributes of the individual within that given

place such as those identified in the 'Galeras vulnerability profile'. Where the vulnerability profile also contributed to the understanding of vulnerability was that vulnerability at Galeras was a function of exposure to 'all hazards' and not just volcanic processes and products that the papers reviewed had assumed it to be.

The vulnerability profile presents a description of what people needed to have and be able to do if they are to live a good quality of life and cope with disruptions that may occur. What this data suggests therefore is that unless an individual is able to access these materials or able to enact in such ways, a quality of life on Galeras, deemed to be acceptable to the community will not be possible. It also suggests that these are the fundamental functions of the community that need to be protected and where necessary provided for in order to maintain a sufficient level of wellbeing and security within the communities of Galeras. It should be stressed, as described in chapter three, that not all of the individual characteristics listed in the profile were identified by all of those interviewed, an individuals vulnerability profile was directly influenced by what needs they perceived themselves as having to meet for a good quality of life, which in turn influenced what disruptions they experienced, which in turn influenced what coping strategies they enacted.

As was discussed in chapter three, a livelihood can be defined as '*adequate stocks and flows of food and cash to meet basic needs'*, (Chambers and Conway, 1991). The vulnerability profile highlighted the 'stocks and flows' of the Galeras livelihood system that were necessary to be maintained. Therefore to understand variation in vulnerability we need to identify which strategies each individual engages in and where their dependencies lie. Strategies that were dependent on land, agricultural inputs, the road and water could be classed as of higher vulnerability. 'Well paid employment' as a need, highlighted that although communities gain many things for free from Galeras, people have certain aspirations for things, which need to be purchased elsewhere. Good government decision-making and risk management, good health and associated good healthcare and security were all also deemed to underpin many of the livelihood activities.

Whilst some of the literature had discussed social and economic vulnerability (Alcorn et al. 2013), there was a focus on the capital value of infrastructure that could be lost. This data showed that it was not necessarily the things of highest value that are the most vulnerable as many of the factors identified could be described as multipliers of social and economic value due to their function, such as the land which had a capital value but of which allowed for a great number of activities all of which generated additional value.

Dependency was also a factor discussed in terms of future opportunities for the communities. As discussed in Chapter 4 individuals had been asked to identify "the future potential" of their

community and in addition what that future was dependent upon. Opportunities including agriculture and tourism as well as other economic strategies that were argued to be dependent on a mix of different materials and processes, including; public and private investment, improved education for all, professional training, improved infrastructure, improved environmental quality, greater access to markets, higher levels of safety, good governance, better regulation and a more reliable climate. As was also discussed, each of these individual factors were all interlinking aspects of a much larger complex system where access to one was very much dependent on access to others.

8.4.2 The coping capacity of the Galeras communities

The empirical dataset also highlighted a number of coping strategies that people had previously exhibited in an effort deal with the impact of the many different disturbances they have suffered. These strategies enabled them to both maintain access to the resources and social functions that peoples livelihoods were dependent upon. Chambers and Conway, (1991) identified coping capacity as a requirement for a livelihood to sustain itself. The data showed that in order to sustain their livelihood, people needed to have both the opportunity and ability to change or adapt. As the vulnerability profile showed, this was primarily in relation to work where individual strategies involved a change of location, an increase of hours, a diversification of work and acquiring additional employment. This large focus on employment could again be related back to the fact that many of the needs of the community were not available for free and therefore had to be purchased. These strategies also suggested an impetus to act and adapt as new challenges arose even if those challenges had not been experienced before. The ability to "demand a right" and "contest a government decision" were also presented as coping strategies that had emerged to deal with the large number of disruptions that the community had attributed directly to the government.

Both the individual livelihood systems that people had adopted as well as the coping strategies that they carried out, demonstrated traits of flexibility, creativity, organization, resourcefulness and strategicness within the community that appeared to have helped individuals deal with change. What appeared, however, to be placing this capacity under threat in some areas was the dependency that the community had on the government and the blame they placed on the government when they were not able to access certain needs. Whilst the community appeared to have both the knowledge and capacity to deal with a wide range of what were identified as social and economic hazards, they seemed less able to deal with the impacts of the government declaration of disaster and subsequent relocation program. Perhaps this was because as indigenous community generations had experienced many of these same natural disruptions before and therefore developed strategies to deal with them, however, in contrast they did not have any

previous points of reference to draw from in regards to the declaration of disaster. The inability to cope with this "political hazard" had therefore led to high levels of social and economic impacts that had been experienced. A notion supported by previous discussions within this chapter on psychosocial stress, and the high levels of mental health issues. Therefore it can be said that the government's perception of the community as being vulnerable to volcanic activity had systematically increased levels of vulnerability where policies were implemented to decrease them.

8.4.3 The influence of volcanic activity on social vulnerability

The overriding perception of vulnerability within the literature reviewed was as a potential for impact specifically to volcanic products and processes. Whilst damage to crops, death of aquaculture and livestock were all attributed by the community as being as a result of volcanic ash, such impacts only accounted for a relatively small amount of the overall disruptions experienced between 2002 and 2012 as was discussed in the previous review of hazard.

Despite this relatively small level of impact attributed directly to the volcano, it can of course be argued that without the initial volcanic activity the government would not have passed the declaration of disaster. Therefore it may be argued that those impacts attributed to the government risk management such as prevention of new build, prevention of public investment and a process of relocation were an indirect result of volcanic activity.

Although as a whole the profile of vulnerability at Galeras can be said to be specific, many of the individual characteristics of it have also been reported in other locations, many of which are not volcanic, supporting the argument that vulnerability should not be attributed solely to volcanic activity. One example of this is the relocation programme, a strategy applied in many other countries as well as Colombia to communities, but to communities facing a range of other issues food insecurity, poor drinking water, social insecurity, poor transport networks, lack of land rights, poor healthcare, low levels of education and an absence of government welfare all of which were identified in the profile and all in fact global issues of prominence.

In using an 'all hazards' approach, a history of events were recorded which had occurred over the last ten years. In discussions of cause and effect these events were shown to be complex and interlinked with many singular events cascading from others. Although individuals showed coping capacity, levels of impact were largely dependent upon how many of the overall events they were exposed to. Rautelas (2006) theory of disaster, vulnerability and poverty cycles focuses on the idea that a singular hazardous event can remove the resources an individual requires for a secure livelihood, in turn exposing their vulnerabilities during their period of recovery. However, this

period makes them more susceptible to other hazardous events therefore perpetuating vulnerability. What the Galeras hazardscape suggested might have occurred at Galeras was that although volcanic activity was sporadic other events continued to occur in the interim periods leaving people exposed to other hazardous events. One such example was seen by those affected by the pyramid selling scheme, which saw many invest their savings and borrow money. When the pyramid scheme collapsed they did not recover their money and were left with debt leaving them unable to pay for necessities. The declaration of disaster was attributed as causing disruption to the accessibility of many of the community's needs including; education, healthcare, jobs, land and housing requiring large numbers of people to, recover. Whilst other events were of relatively short duration, the declaration of disaster has caused continuous disruption for ten years. Disasters are said to occur when vulnerability becomes so high that communities cannot function sufficiently enough by themselves. It could therefore be argued that this has been the case at Galeras; however it has not been triggered by the volcanic activity but by the policies implemented to prevent a "volcanic disaster".

8.4.4 Risk perception as an influence of vulnerability

Within the literature it is suggested that those with poor risk perception were of increased vulnerability because their lack of understanding of the risk meant that they failed to adjust (Haynes et al, 2008, Paton et al, 2008). These studies focused their methods on testing people's knowledge of the volcanic products and processes likely to impact them. However to claim that the people of Galeras were residing there because of poor hazard perception is in light of the data already discussed highly contentious. As discussed in this chapter previously communities appeared to have a great knowledge of the cause and effect of hazards. However the difference lies in the fact that this methodology took a multiple hazard approach and was not looking to evaluate only people's knowledge of volcanic hazards. Again as discussed previously people's perception of risk specifically to volcanic hazards may have been somewhat diluted when compared to the multitude of other disruptions that they had experienced. Therefore this data shows that people were not living on Galeras due to poor risk perceptions but that their estimation of risk had been based on a different conceptual framework to that of the volcanologists. To support this argument we can also refer back to discussions on value and the multitude of opportunities that the volcano appears to present people with and the way in which people have diversified their livelihoods to take advantage of. Whilst the volcanic risk literature largely appeared to perceive risk as a function of loss, in business and economics risk is a product of gain (Knight, 2012). Therefore this may suggest that due to the amount of value people placed on the volcano that this may be driving their risk management decisions.

8.4.5 Summary of vulnerability

This discussion of vulnerability highlighted that the communities of Galeras had a distinct profile of vulnerability, which related directly to their dependencies' on materials and processes to meet their needs and sustain their livelihoods. This dynamic had not been acknowledged within the volcanic risk literature reviewed, which itself had focused largely on people's exposure and susceptibility solely to volcanic processes and products. Whilst the volcano was not the direct cause of vulnerability on Galeras, it had influenced the way in which its activity had driven a risk management strategy, which had significantly restricted people's ability to access their needs. In addition, the volcano itself had also provided many of the communities needs, therefore collectively being 'depended' on.

Although risk perception was referred to in the volcanic risk literature as being one function of vulnerability, this interpretation and discussion suggested that communities do not understand risk as they have a lack of understanding about volcanic hazards. This empirical data argued in contrast however that people did have a good conceptual understanding of hazards to their livelihoods but that this understanding was based in a 'multiple hazards' scenario and included a multitude of disturbances that they had experienced over time. Therefore it could in fact be argued that where communities were said to have poor risk perception due to their lack of understanding of volcanic hazard, it could also be said that volcanologists do not have a full understanding of volcanic risk either because of their lack of understanding of 'value'. Perhaps therefore it is the volcanologist's lack of risk perception that is reflected in the risk management decisions, which in turn have increased vulnerability. Therefore in conclusion to this discussion vulnerability at Galeras could be described therefore not as a function of volcanic activity but to a complexity of interactions between people's needs, space, perceptions and government power.

8.5 Reconstructing volcanic risk assessments

Having deconstructed what comprises the risks facing the communities of Galeras this final discussion seeks to meet objective number four of this study and '**re-evaluate what components best comprise volcanic risk and should be included in future volcanic risk assessments'.**

The analysis of each of the data sets of value, hazard, vulnerability and resilience have all drawn the same broad conclusions, that the way in which the volcanic risk assessments have traditionally been carried out within Volcanology have been narrow in their focus and unable to capture the complexity of issues influencing communities to reside on active volcanoes. Whilst the technical

assessments cast light on only a partial view of day to day life on a volcano, the participatory method used in this study gave a greater level of insight not only of the hazards people face but also how their livelihoods and wellbeing are anchored in the volcanic ecosystem and within the volcanic society itself. Whilst the technical assessments reviewed provide invaluable data on the processes and behaviour of volcanic hazards that people living on volcanoes might be exposed to, they do not present a complete image of the risks that people face, as they are inevitably 'volcano-centric'. However as chapter three argued and the empirical evidence from this study has mirrored, Galeras like many other volcanoes is a mountain and therefore volcanic hazards are not the only process that poses a threat to those living them. In addition, in being a mountain there are many context specific social, economic and political drivers of social vulnerability of which have not been acknowledged in the volcanic studies but that provide explanation as to some of the root causes of volcanic risk and potential volcanic disasters. Mountains including Galeras present people with a wide range of natural resources on which to build their livelihood strategies and indeed develop regional economies on. These in turn help to stabilise people's access to those things they need for a good quality of life but are again not acknowledged in the volcanic literature of which only appears to conceptualise volcanoes as threats to livelihoods and not a potential source of them. Reference to levels of resilience within volcanic communities and how that in turn helps to minimise levels of risk has remained largely absent from the technical approaches to risk assessment, only referring in part to levels of risk perception as an indicator. However as the mountain literature reviewed in chapter three suggests and as was found within the empirical data, volcanic communities do appear to have an inherent level of resilience within them enabling them to cope with the many challenges that they face living in such regions.

Therefore in identifying which components best comprise volcanic risk and should be included in future risk assessments this thesis argues that although the same components of hazard, value and vulnerability that have been traditionally used should remain, in addition the resilience and coping capacity of the community should also be evaluated. However whilst the components used should stay the same the wider conceptual framework and the subsequent design of the risk assessment methods need to change in order to capture the full complexity of parts of the enviro-social system. To do so this thesis argues that the risk assessment of volcanoes should approach volcanoes as 'mountains with mountain riskscapes'. The focus of the risk assessment should not be volcano-centric as has been in the case with previous top down methods but that they should be 'mountain-centric', seeking to assess all hazards, all vulnerabilities and all values within the regional boundaries.

In order to ensure as much complexity as possible is captured participatory approaches such as the one used in this study should be encouraged in order to address which hazards, values and

vulnerabilities are in fact underpinning the decision making of communities risk management decisions can be made in line with sustainable development to protect peoples livelihoods and to alleviate levels poverty.

8.5.1 A need for further development of value and vulnerability assessment tools

Whilst methods to assess hazard have been well developed within the volcanological literature, the measure of value and vulnerability have been far less well understood. Whilst the tools to assess vulnerability are more readily available, those to address the 'value' of the volcano will require further development. Whilst the volcanologists technical approaches appear to focus on losses of assets and belongings, the communities of Galeras, and other volcanoes reviewed in chapter two, seem to appear in contrast to perceive gain and opportunity being provided by their volcanoes and their activity. The development of valuation techniques therefore needed not only to be able to identify what 'values' will be lost in the case of an eruption or other hazardous event, but also in the event of the relocation of communities off of the volcano. This data highlighted that not only that there is a considerable value of Galeras to the communities but that those values are great and diverse. However at the time of this study very little appears to be being done by the risk managers to protect these values for the people dependent on them. Either an eruption or relocation could potentially permanently separate the community from the assets that the volcano provides

Either a large-scale eruption or relocation program will place a burden on the communities of Galeras just because they live within the boundaries of the volcano.
The theory of environmental justice argues for the fair distribution of environmental benefits and burdens rather than exposing specific sectors of the community unfairly to crime, pollution and other 'bads' (Harvey, 1996, Schlosberg, 2007). In both perceiving the volcano as a threat, when the community sees it as a benefit and in identifying the city as a good location to relocate people when the community see it as unresourceful and threatening, suggests that both the volcanologists and the community have a different perspectives on what is a' good' and what is a 'bad'. Therefore in 'distributing what the decision makers think are 'goods' in fact only leads to the community being exposed to 'bads'.

In regard to 'vulnerability' there appears to be an assumption developed within the volcanological literature that volcanic communities are vulnerable because they live on a volcano or because they are lacking the knowledge to understand the level of risk they face. Whilst the focus of vulnerability assessment remains on only measuring peoples proximity to volcanic hazards or their accuracy of scientific knowledge about hazard processes, the true causes of their vulnerability as outlined in chapter seven will not be acknowledged and measures to counteract those

vulnerabilities will not be put in place, meaning people's needs could go unmet. This appears to have been the case at Galeras where in trying to 'save lives', access to so many of things that the community need has been removed through the Declaration of Disaster Policy Framework. These needs including; education, poverty alleviation and healthcare, are all things that remain global targets for development (United Nations, 2015), yet for those living on Galeras they do not appear to have been prioritised by the government. Whilst the Declaration of Disaster is seen as a tool to save lives, it appears in fact on analysis of this data, to have resulted in a glass ceiling to development, preventing people from accessing their needs and preventing them from prospering and meeting their potential. In targeting vulnerability, the government's management plan has arguably increased levels of vulnerability.

8.5.2 The need to protect volcanic cultures

Another consideration in both the future assessment of value and vulnerability is the culture of volcanic communities such as of those at Galeras of which underpins the way in which they utlise the volcano and in addition the way in which they are able to deal with the challenges they face in doing so. Without access to the volcano the communities of Galeras will loose access to many of the assets and resources that form the foundations of that culture. If volcanic communities have to move away from their volcanoes either due to an eruption or relocation program then not only is their knowledge of how to live and survive in harmony with nature lost, such as farming techniques and natural medicines, but also their unique culture. Such a prospect not only presents a significant loss to volcanic commutes themselves, but in addition, to the non-volcanic people also. On an international policy scale cultural diversity is described as 'analogous to biodiversity', argued as equally as vital to the long term survival of humanity and life on earth (UNESCO, 2011). Therefore in only making short term decisions and not long term sustainable strategies, the impacts of risk management decision making at Galeras and other volcanoes could have wider implications for everyone.

This participatory research has provided a human face to volcanic risk not evident in the volcanic risk assessments reviewed in chapter three. It has shown that contrary to the stereotypes and assumptions of volcanic communities that have recurred within the literature, the community members of Galeras were knowledgeable, informed, rational, motivated and resourceful. The information that they provided in their discussions of value, hazard and vulnerability presented a level of detail not seen previous in volcanic studies as to the benefits to be had from living on volcanoes and the challenges faced in doing so. Such information holds great value to future volcanic risk assessments and management. However, as was described in chapter three of this study, these 91 individuals and their views do not represent the lives of all volcanic community

members across the world. Whilst this data set provides a richness of information, it is essential that more research is continued with volcanic communities worldwide as what this research has also highlighted is that whilst the literature can suggest we know so much, in fact we often know very little.

8.5.3 The need for a cultural shift within Volcanology

In the development of future volcanic risk assessment there is first required an attitudinal shift in the way in which Volcanology perceives those that live with volcanic risk and the level of importance that is placed on their perceptions and needs. In the same way in which we do not suggest that those 91 community members represent all volcanic community members, this study also does not suggest that all volcanologists follow the profile identified in this research. Whilst there were definite biases within the different studies reviewed there were also 'lone ranging' individuals moving closer towards the participatory approach used in this study to collate this empirical data set. However, despite these few it was still evident that the greatest gap between the top down technical approach and this participatory approach was in the way that the volcanologists appeared not to see value in the volcano or understand how those values motivated people to live with volcanic risk. Whilst this is the case there remains the likelihood of a continued absence of community engagement in the risk assessment process such of which has been carried out in this study, as levels of conflict between communities and risk managers are likely to develop in the same way they have done at Galeras.

Without the presence of community voices the volcanic risk assessment process will remain largely driven by the volcanologists and the way in which they conceptualise volcanic risk. If the concept remains of volcanic risk only being a product of people living in close proximity to volcanic hazards and not of all the other dynamics considered in this study then risk assessment data provided to decision makers will be incomplete and inconclusive. This data has proven the value of community engagement within volcanic risk assessments and advocates its continuation in future research. However, this engagement should also always place the community in a position of equal power to the volcanologists, with an appreciation on both sides that neither is the expert. It is this division of power of which can be seen to have caused so many problems at Galeras.

Combining the 'traditional', 'top down', 'analytical', 'technical' framework to volcanic risk assessment with the 'bottom up', 'experiential',' participatory' approach will undoubtedly raise considerable challenges. Due to the diversity of interpretations of: volcano, risk, hazard, value, vulnerability and resilience shown in this thesis it is argued that essential from the start of any discussion between scientists, risk managers however, is the identification of key terms and what

they each mean to all groups. Without clear definitions and descriptions no common point of reference will be likely for either group. Most importantly, as identified in this chapter there is a need to define what data an assessment of 'volcanic risk' is in fact presenting. If it is only an estimation of volcanic risk based on the interactions of volcanic products and processes then it must be identified as such and the limitation of its ability to explain all 'the risks of living on an active volcano' highlighted. Likewise, where communities may seek to describe the motivations and challenges associated with 'living on an active volcano' it must be highlighted that this information is in regard to all:

All values x all hazards x all vulnerabilities within the geographical boundaries of an active volcano.

In designing the assessment framework and in collating and analyzing the data this study has also highlighted the need for interdisciplinary research to assess volcanic risk in order to be able to capture and consider the complexities that community life on an active volcano involves. Perhaps the focus on relocation stems from Volcanology being anchored in the traditional physical sciences where quantification is the main tool. Where in order to decrease risk an emphasis has been placed on decreasing proximity to the hazard. Therefore in order to reduce vulnerability and risk in other ways a range of disciplines should be encouraged to participate in discussions and studies. It should also be ensured that with the potential of such a complex and dynamic set of different data, as a result of such interdisciplinary research, that there are methods capable of producing 'the bigger picture' with their data analysis techniques and not just thin sections of it.

8.6 Summary

This chapter has summarised the analysis of the empirical data. The following chapter will summarise the main conclusions of the study to show how the aims and objectives of the study have been met.

Chapter Nine:

Conclusion

9.0 Conclusions

In order to meet the aims and objectives of this study a gap in knowledge was identified in chapter one, identifying the need to improve risk assessment frameworks for the purpose of managing risk in volcanic regions in a more sustainable way. An evaluation of both traditional top down approaches and participatory bottom up approaches was made, concluding that participatory approaches, not widely used before in the assessment of volcanic risk, would be beneficial in capturing the complexities of community decision making that lead people to live alongside volcanic hazards.

An assessment of the literature was carried out in order to review the way in which volcanic risk has previously been assessed and to identify components to explore at the community level in an empirical study. These four components; hazard, value, vulnerability and resilience were used to formulate an interview transcript to be used in a series of participatory approach across six communities living on the Galeras volcano in Colombia.

A summary of the literature review provided a technical framework of volcanic risk with which to compare the findings of the empirical data set. In dong so a number of key conclusions were drawn in order to answer the main aim of the research: **To evaluate what insights a bottom–up, participatory assessment of risk faced by those living with volcanic risk can offer decision makers about the realities of the complex adaptive systems experienced by volcanic communities.** These conclusions are as follows:

That there were significant gaps between the way in which volcanic risk has been conceptualized by volcanologists in the past and the way in which the communities of Galeras have experienced it over the last ten years.

That whilst traditional technical approaches have assessed volcanic risk from a volcano-centric perspective focusing only on people's exposure to volcanic hazards, the communities of Galeras have experienced it as a product of multiple hazards, multiples vulnerabilities and multiple values.

Whilst the technical framework of volcanic risk has measured value by the capital cost of infrastructure that might be destroyed or damaged, the community place value on a multitude of assets and resources that the environ-socio system provide, that present people with a wide range of opportunities on which to build livelihood strategies and wellbeing.

Whilst the technical framework of volcanic risk has measured hazard by the magnitude and frequency of volcanic products and processes, the community has blamed the disturbances to their livelihood strategies on a far wider range of natural, social, economic and political causes. Most important to not was that the volcanic activity was blamed for very little of the disturbances and the government policies for a great many.

Whilst the technical framework of volcanic risk has measured vulnerability by people's proximity to volcanic hazards, the community's experience of impact has been largely dependent upon what assets they are dependent upon for livelihood security.

Whilst resilience was not measured within any of the technical frameworks of volcanic risk reviewed it is considered a key component of risk in many external disciplinary and risk management approaches. These results showed that the communities of Galeras have experienced a long history of different disturbances to their livelihood strategies and have in response reacted with many different coping strategies. However whilst they have coped well with the impact of natural hazard events they have struggled to cope with the impact of the governments relocation policy of which they have no experience or knowledge of.

This research has shown that volcanic risk and its many components are both complex and dynamic. It is generated from a paradoxical scenario where the same natural processes that provide opportunities and motivation for people to build livelihoods, security and wellbeing, are also those same ones that threaten to destroy them. Traditional technical methods of risk assessment have to date not seemed capable of capturing this level of complexity which may have led in part to the failures of previous risk management responses to secure both the safety and long term sustainability of volcanic communities around the world. At Galeras this also appears to have been the case, where a strategy to relocate those at high risk was met with conflict and disdain from the communities in contest of the loss of their homes, livelihoods and communities that they would have to entail in moving. This study, had it been carried out prior to the relocation plan being put in place, could have helped prevent the many social, economic, environmental and political problems that the communities of Galeras are currently facing of which they themselves attribute directly to their governments risk management strategy. However whilst much of the data from this study remains unique to these individual communities, it is hoped that the conclusions drawn can be applied to other volcanic communities around the world, helping to prevent future negative impacts from occurring.

In summary this research concludes that those volcanic communities who risk management strategies are put in place to protect, will ultimately shoulder the burden of any failures of risk

assessment strategies. It is therefore the moral and ethical responsibility of 'volcanic risk assessors' to ensure that they represent the 'realities' of those communities as comprehensively as possible in the risk assessment process. They also need to ensure that they communicate their knowledge as accurately as possible to the decision makers. The future of volcanic communities globally is not only threatened by the hazards that they live alongside but also by the lack of understanding of their culture and their decision-making. To manage this particular risk this thesis concludes with the following recommendations. Where gaps in knowledge remain, methods and skills sets should be developed to fill them. Where assumptions are too easily accepted without empirical evidence they should be questioned and requestioned. Where no community voices are heard they should be sought after and amplified.

9.1 Recommendations for future volcanic risk assessments (VRA)

For future volcanic risk assessments it is recommended that the following guiding principles and risk assessment process be applied.

In making recommendations for future volcanic risk assessments, the following terms should be used to signify the following principles.

Table 9.1 Guiding principles for future volcanic risk assessments

Term	Significance	Should not assumed to mean
Volcano	Within the geographical area boundaries of a mountain or hill feature that has a crater or vent through which lava, rock and gas are released.	Only the crater or vent of the volcano.
Volcanic community	All communities living within the geographical area boundaries of the volcano.	Only communities that identify as indigenous.
At risk	All risks, volcanic and non volcanic in source that volcanic communities are exposed to. Communities living on volcanoes in periods of quiescence can be as at risk as those living on volcanoes during periods of activity.	Only due to exposure to volcanic hazards.
Volcanic risk	Risk specifically to volcanic hazards and in generic relation to volcanic activity.	Not the overall risk to the community.
Hazard	Any phenomenon or activity that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods, social and economic disruption, or environmental damage.	Not only phenomenon that are volcanic in origin.
Volcanic hazard	Any phenomenon that is volcanic in origin that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods, social and economic disruption, or environmental damage.	Volcanic hazards are not the only phenomenon or activity that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods, social and economic disruption, or environmental damage.
Vulnerability	The characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of all hazards.	That a community, system or asset is only vulnerable to hazards of volcanic origin or when volcano is active.
Value	The element or elements (assets) at risk. Assets are identified as anything that the community in question identifies as necessary for a good quality of life or good quality of livelihood. Where assets identified are intangible (lacking in physical substance) and difficult to price, such as those that are aesthetic or cultural, new methods of quantification will need to be sought.	Value should not only refer to assets of which have monetary values such as infrastructure and personal belongings.

Resilience	The ability of the volcanic community exposed to all hazards on the volcano (volcanic and non volcanic in origin) to resist, absorb, accommodate to and recover from the effects of hazard in a timely and efficient manner	The ability to resist, absorb, accommodate and recover from the effects of hazards only of volcanic origin but of every origin.
Coping capacity	The ability of volcanic communities to use available skills and resources, to face and manage all adverse conditions.	The ability of volcanic communities to use available skills and resources, to face and manage adverse conditions caused only by volcanic hazards but hazards of all origin.

Figure 9.1 below presents the recommended risk assessment process.

Stage 1: Community selection for risk assessment

All government and non-government agencies should assume that all **volcanic communities are** potentially **at risk** to loss of life and belongings due to their:

a) Exposure to all **hazards**
b) **Vulnerability** levels
c) **Coping capacity**

Risk is not solely determined by volcanic activity.

Justification:

As this thesis has discussed, volcanic communities can be exposed to many different hazards, not only those volcanic in origin.

In addition this thesis has also identified that there are many root causes of vulnerability within volcanic communities, and that it is not only a product of proximity to volcanic hazards. These root causes include: poor quality infrastructure, a lack of options for job diversification, a lack of skills training and fluctuating global market prices. These 'vulnerabilities' as well as many others are mirrored in the mountain geography and mountain development literatures when describing mountain communities.

Due to these two observations it is argued that volcanic communities should be deemed as possibly at risk and in need of risk assessment even when the volcano that they live in is in a period of quiescence. If risk assessment is only carried out due to increasing levels of volcanic activity then the underlying causes of vulnerability and therefore potential ways of treating some of those vulnerabilities may be missed and the needs of those communities potentially not fully provided for.

Stage 2. Baseline studies

A baseline study should be carried out within each **volcanic community** using participatory methods to identify local riskscapes and coping capacities.

The baseline study should assess:

a) **Value**: Assets (natural and unnatural) on the volcano, which are valued by the community for their lives and livelihoods
b) **Hazard**: Threats that exist to each of those assets
   i) Causes of historical disruptions to access to each asset
   ii) Perceived potential future disruptions to access to each asset
c) **Vulnerabilities**:
   i) Impacts caused by disruption to access to each asset
   ii) Root causes of impact
d) **Resilience**:
   i) Community capacity to cope with past historic disruptions
   ii) Community capacity to cope with potential future disruptions

Baseline survey to be repeated on a regular basis to reassess which assets are being prioritised by the community.

Justification:

Baseline riskscapes should be identified as levels of risk and its drivers will not be homogenous throughout every community on the volcano. If homogeneity is assumed to be the case by decision makers and empirical evidence not gathered, then there is the potential for community needs not to be identified or provided for in turn increasing levels of vulnerability. Riskscapes will change over time as community's prioritization of assets changes. If these changes are not recognised then again community needs may not be identified or provided for and levels of vulnerability increased. Therefore a need for regular reassessment is required.

Participatory methods such as interviews, community focus groups and public participatory geographical information systems (PPGIS), should be used in order to establish knowledge of community priorities, experiences and coping strategies.

Stage 3: Hazard Assessment

A technical multi-**hazard** assessment to be carried out of all **hazards** of which have either caused disturbance to peoples access to assets in the past or are perceived as likely to cause disturbance to them in the future.

The multi **hazard** assessment should include:

a) All geological, hydrological, meteorlogical, biological and technical **hazards** identified by local authorities, agencies and scientific bodies.

b) All additional **hazards** identified in stage 2b by the public through participatory methods.

Justification:

The risk to the lives of volcanic communities and their belongings is generated in part by all of the many different hazards that the communities are faced with, not only those that are volcanic in origin. Whilst local authorities, agencies and scientific bodies may focus on specific hazards, assessing the causes of disruptions to livelihood assets as identified by the community themselves will ensure a more comprehensive view of the riskscape of the region. This method ensures that no hazards are missed or assumed unimportant.

Stage 4: Volcanological specific risk assessments

For volcanologists using traditional technical risk assessment frameworks to identify the behavior and location specifically of volcanic hazards, their assessments should be informed by the baseline surveys in stage 2. This will allow the volcanologists to identify what assets the communities are dependent upon in order to provide '**value**' data. Once this has been established it can be identified which assets are exposed to which volcanic **hazards**. Where possible mitigation strategies can then be established and put in place.

With each repeat of the baseline study, the volcanic risk assessment should also be repeated to ensure the true extent of risk is understood.

Justification:

Although this research argues that risk assessments of volcanic communities should focus on an all-hazards approach and not solely on the risks only from volcanic hazards, it is appreciated that volcanological specific assessments have considerable value and should therefore continue to be conducted. When this is the case and the traditional approach of 'risk = hazard x value x vulnerability' is applied, it is advised that value should represent the assets to peoples lives and livelihoods that are located on the volcano, and that vulnerability should represent not just proximity of people and assets to volcanic hazards but also their sensitivity to them. Incorporating the baseline line data also captures the impact of other non-volcanic hazard events on levels of social vulnerability.

Volcanologists incorporating local context / local needs into traditional risk assessments

Fig. 9.1 The Risk assessment process:

9.1.1 Summary

Where volcanic communities choose to remain living in at risk areas the focus should be placed on increasing their coping capacity to deal with the challenges of that environment. Not everybody's level of risk that chooses to live in a particular place on the volcano will be the same even if they are all exposed to the same volcanic hazard. That is because each individual's set of values is vulnerable to a different set of hazards. Due to this level of complex diversity within communities, different individuals will require different skills and resources to help them cope with the challenges of their ever changing society and environment. In allowing people to remain living on volcanoes it should not be assumed that everyone faces, or will face the same challenges or that they will cope with those challenges in the same way. Individual needs and abilities therefore need to be identified through baseline studies. Making assumptions of behavior and coping capacity

without baseline studies could lead to an increase in risk if communities are left to reside unsupported.

For the future assessments of risk to volcanic communities there is a need to revisit the fundamental geographical principals of ‘people’ and ‘place’ and how the two interact. The question that should be asked about volcanic communities is what people are doing within the place of the volcano and how that is influenced by their beliefs and values. Once their values are understood then the individual hazards to those values that make them vulnerable and therefore subsequently ‘at risk’ can also be identified. The studies of ‘Mountain Geography’ could provide much insight on which to the build baseline assessments of volcanic communities as suggested. However an application of much of this knowledge has to date been largely absent from previous studies of volcanic risk exhibiting arguably a lost opportunity to increase understanding. For future risk assessments, mountain geography theories and empirical knowledge should be applied to volcanic communities to help fill knowledge gaps. This in turn will help to build levels of understanding of how some volcanic communities already live with volcanic risk and how they might be supported to do so in the future. Using participatory methods to gather further empirical data will ensure that knowledge is not only increased of what people are doing on the volcanoes that they live on but why they are doing it and what needs these actions fulfill. This knowledge will allow us to ensure the needs of those choosing to live with volcanic risk are maintained throughout all stages of the disaster management cycle.

This thesis argues that ‘Value’ within the risk equation should in future studies be assessed as the value of all assets to lives and livelihoods and not only the economic value of replacing and repairing buildings and infrastructure in the region of hazard. This description however raises the question of how to value the more intangible assets such as those mentioned by participants interviewed in the Galeras case study, including ‘community’ and ‘tranquility’. If risk assessments frameworks remain quantitative then new valuation techniques will need to be developed to provide data to input into the risk equation as it stands. Methods of valuation such as those used in the assessment of ecosystem services should be applied. As geo-system services are already a subset of ecosystem services that are already valued, perhaps a sub-analysis of ‘volcano-system services’ could be established using the data from this study as a base as well as other empirical studies.

Appendices

APPENDICES 1: HOUSEHOLD INTERVIEW TRANSCRIPT (EXAMPLE)

A. Basic Information

Name of Municipality	Consaca
Surname	XXXXXXX
Address (Marque en el mapa – codigo CASA)	
Household code	
Date of interview	24.08.12
Time of interview	3.00 pm
Interviewers	Patrick and Jessica

B. The life at Galeras

Q1. How would you describe the life of people living here in Sandona?		
<u>Positive</u>	<u>Neutral</u>	<u>Negative</u>
In the countryside the quality of life is better because there is always work , we are dependent on ourselves	Most people work in agriculture	Lots of people without jobs
	Works predominantly in sugar cane and coffee	People who are educated dont find work here
	Starts work at 5pm depending on here the location of the field is	
	Regular, average	

C. Household description

P2. Were you born here? (If yes go to Q6., if no continue to Q3.)	Si
P.3 Where were you born?	
P.4 For how long have you lived here	
P.5 What were your main reasons for moving here?	1.
	2.
	3.
	4.
	5.

Q.6 What are your main reasons for living here?	1. Used to life here
	2. Know lots of people here
	3. Have farm – rooted here
	4. Son studies in Bogota but she's lived here forever
	5.

D. Household Composition

Q7. How many people live in your home? 4		
Person	Q.8 Age	Q.9 Gender (M/F)
Person. 1	43 …… years	M
Person. 2	……39…….. years	F
Person. 3	……21…….. years	M

Person. 4	……70…….. years	M
Person. 5	……. years	
Person. 6	…….. years	
Person. 7	…….. years	
Person. 8	…….. years	
Person. 9	…….. years	
Person. 10	…….. years	

E. Income

Q.10 What are your main sources of income?	Q. 11 Who is resposinble for this source?	Q.12 Where does this activitiy take place? (Name of town)	Q.13 When does this activity take place?	Q. 14 What are the three main sources of income in order of importance
1. Coffee	1 43 / M	1. Consaca	1. Not Everyday	1. Coffee – most sustainable
2. Sugar cane	2. 43 / M	1. Consaca	2. Not everyday	2. Sugar cane
3. Beans	3. 43 / M	1. Consaca	3. Not everyday	3. Beans
4.	4.	4.	4.	
5.	5.	5.	5.	

F. Expenses

Q.15 What are your main monthly expenses? (Items not figure)	Q. 16 Three main expenses in order of importance
1. Workers	1. Food
2. Fertilisers	2. Workers
3. Food	3. Fertilisers
4. Light	
5. Water	
6.	

Q.17 Do these three principal expenses ever change? Yes / **No** (circle) If yes, go to Q.18, if no, go to Q.20	
Q.18 When do they change?	Q.19 Why do they change?
1. Same thing	1.Everything has increased in price
2.	2.
3.	3.

G. Land

Q.20 How many different parcels of land do you use? …7			
	Q.21 Where is the parcel? Marque en el mapa – codigo P1, P2, P3 etc	Q.22 What do you use the parcel for?	Q.23 Why do you use the parcel for this activity?
Parcel 1	1. P1	1. Coffee / beans	1. Acid in the soil
Parcel 2	2. P2	2. Coffee / beans	2. Acid in the soil
Parcel 3	3. P3	3. Coffee / beans	3. Acid in the soil
Parcel 4	4. P4	4. Coffee / beans	4. Acid in the soil
Parcel 5	5. P5	5. Coffee	5. Acid in the soil

Parcel 6	P6	Sugar cane	When coffee harvests are small it is good to grow beans around. Cane isn't profitable. Sugar depends more on fertilizers.
Parcel 7	P7	Sugar cane	When coffee harvests are small it is good to grow beans around. Cane isn't profitable. Sugar depends more on fertilizers. More sugar cane with more fertilizer.

H. Agriculture

Q.24 Do you grow fruit and vegetables? **Yes** / No (circle) (If yes, go to Q. 25 , if no, go to Q.28)		
Q.25 What do you grow?	Q. 26 What is the main purpose of this crop? Personal consumption (PC), or selling (s)	Q.27 What are the three most important crops to you in order of importance?
1. Coffee	1. S	1. Coffee
2. Sugar cane	2. S	2. Sugar cane
3. Beans	3. S – assuming there's enough	3. Beans
4. Corn	4. CP	
5.	5.	
6.	6.	
7.	7.	
8.	8.	

9.	9.	

I. Animals

Q.28 Do you raise animals **Yes** / No (Circle) (If yes, go to Q. 29, if no, go to Q. 33)			
Q. 29 What animals do you raise?	Q.30 Why do you keep these animals? (What product?)	Q.31 What is the main purpose of this crop? Personal consumption (PC), or selling (s)	Q.32 What are the most important three animals to you in order of importance?
1. Horses	1. To transport the coffee	PC (Working)	1. Horses
2. Pigs	2. Meat	PC and S 2.	2. Pigs
3.	3.	3.	3.
4.	4.	4.	
5.	5.	5.	
6.	6.	6.	
7.	7.	7.	
8.	8.	8.	

I. Water

Q.34 From where do you obtain water? Mark on the map the location using a code A1,A2,A3 etc		Q.35 Code on map	Q.36 How do you store your water?
1. Drinking	1. Aquaduct	1. A1	1.
2. Bathing	2.Aquaduct	2.A1	2.
3. Agriculture	3. Private source	3.A2	3.
4. Washing food	4.Aquaduct	4.A1	4.
5. Cooking	5.Aquaduct	5.A1	5.
6. Toilet	6.Aquaduct	6.A1	6.
7. Washing clothes	7.Aquaduct	7.A1	7.
8. Animals	8. Private source close to finca	8. A1	8. Don't store but higher up dig holes, fill with plastic and collect rainwater – many people collect like this
9. Other ……	9.	9.	9.
10. Other …….	10.	10.	10.

J. The value of Galeras

Q.37 What things do you recieve from Galeras?	Q.38 What do you use these things for?	P.39 How frequently do you use these things? Daily (D), Weekly (W), Monthly (M), Annually (A), specific time (ST)
1. Water	1. Agriculture	1. D
2.	2.	2
3.	3.	3.
4.	4.	4.

5.	5.	5.
6.	6.	6.
7.	7.	7.
8.	8.	8.
9.	9.	9.
10.	10.	10.

K. Livelihood

Q. 40 What things are necessary for a good quality of life for you and your family here in _____ __?	Q. 41 For how long can you survive without access to these things? (Indicate the answer using the options provided)					Q. 42 What are the consequences if you don't have these things?
	Hours	Days	Weeks	Months	Years	1. Financial loss because it takes three years before you can sell – 3 years of expenses
1. Good coffee price to balance out with profits – costs						
2. Need businesses that employ skilled labour – people that are educated can't get a job						2. Some people stay, but other people don't want to stay here if no jobs – as there is a rise in crime.
3.						3.
4.						4.

5.						5.
6.						6.
7.						7.

L. Challenges

In reference to the things you identified in Q. 40, that you and your family need for a good quality of life in _____.			
Q.43 Necessities (Write all the things listed in Q.40)	Q. 44 In the last 10 years have you had any problems accessing these things ? Yes (Y) or No (N)	Q. 45 What was the cause of the problem?	Q. 46 How did you cope with this problem?
1. Coffee price	1. Y – Two years ago it was fine, this year bad.	1. Harsh winter – not enough volume produced	1. Can't do anything Coffee has to be sold straight away, can't hold onto it
2. Not enough businesses - people that are educated can't get a job	2. Y – especially for people in town who don't want to work in the fields	2. Not enough for her family	2. One son studying and one son working
3.	3.	3.	3.
4.	4.	4.	4.
5.	5.	5.	5.
6.	6.	6.	6.

7.	7.	7.	7.

Q. 47 In the last 10 years have you experienced any other problem in maintaining a good quality of life? **Yes** / No (Circle)			
Q.48 What was the problem?	Q. 49 Qhat was the cause of the problem?	Q. 50 What was the consequence?	P. 51 How did you cope with the problem?
1. Prices of production of coffee harvest and low selling price	1. Increasing production costs, decreasing selling price.	1. Live off the crops. If prices low, short of money, if too low, won't be able to sustain themselves.	1. Keep varied crops. If one is low hopefully the others will be ok.
2.	2.	2.	2.
3.	3.	3.	3.
4.	4.	4.	4.
5.	5.	5.	5.

M. The Future

Q. 52 In your opinion, what could be the potential for future generations living here in …….?	Q. 53 What is necessary to reach this potential?
1. Cultivation and agriculture	1. Need materials and workforce, because busy farm
2. Thought about having a greenhouse to cultivate tomatoes but depends on the price	2. -
3. Business to employ young educated people e.g. textiles or shoes	3. Needs someone to coordinate the project
4. Would expand to pigs	4. If oldest son stayed on the farm and couldn't find work
5.	5.

N. Thank you

Q. 54 This is the end of the questionnaire. Are there any other comments you would like to make regarding life on Galeras?

- A good life, people are hardworking and enjoy working
- They have legal crops which they can sell, so people with work are fine
- It's been a hot Summer, not normally this hot which means that crops have been drying out. Hopefully the weather will change otherwise there is a risk of losing crops.

Additional Notes

(My observations)

Difficult to get a good price for corn

Not much benefits after an eruption
At the moment eruptions affect crops and animals which eat the ash and die.

APPENDICES 2: Research Ethics Form – 2011

Environment Department
Application Form for Ethics Committee Approval

10.1 1. DETAILS OF APPLICANT(S)

Name:	Jessica Roberts
Department:	Environment
Email:	
In case of undergraduate/postgraduate students	
Name/level of course/degree:	PhD
Name of Supervisor(s):	Carolyn Snell and Jayne Glass

10.2 2. DETAILS OF THE PROJECT

Please provide a brief outline of the research project.

Title: The sustainability of volcanic livelihoods: Case Study, Galeras, Colombia

Research summary:

My research looks at the relationship between the livelihood systems of volcanic societies and the landscape in which they live.

In order to assess the sustainability of those livelihood system and to enable policy recommendations to be made, the following three research objectives have been set:

1. To evaluate the indicators and measures of risk used in the assessment of volcanic risk?
2. To assess variation of risk, spatially and temporally across the geography of volcanoes
3. To evaluate policy provision for the management of volcanic risk

The study will comprise both a secondary literature review and an empirical field study in order to collate evidence for the culminating policy review.

Funding source of project:

Primary: ESRC studentship quota award Secondary: Private funding

Provide a brief summary of the study design and the method(s) involved in the research.

Stage 1. Secondary literature review Stage 2. Explorative scoping study (April 2011) Stage 3. Primary field work period (April 2012 – September 2012) Stage 3. a) Secondary data review b) Field site visits (rapid rural appraisal tools of observation) c) Key stakeholder interviews (semi structured / theoretical sampling) d) 12 x Focus groups within community groups (to set indicators to test at household level) e) Approximately 200x Household semi structured interviews (with translator) to record indicators set in focus groups f) Feed back activities to report key findings

3. ETHICAL IMPLICATIONS

Ethics Checklist	YES	NO
1a. Does the study involve human subjects?	/	
1b. If you answered 'yes' to 1a, does the study involve participants who are particularly vulnerable or unable to give informed consent (e.g. children, people with learning difficulties, people particularly vulnerable to official surveillance)?		/
2a. Does the study involve animal subjects?		/
2b. If you answered 'yes' to 2a, what species are involved?		
2c. If you answered 'yes' to 2a, please describe briefly any legislation or licensing systems in place to regulate work on these species, and confirm that your work is being done according to any best practice or legislative guidelines for the species concerned.		

3. Will the study require the co-operation of a gatekeeper for initial access to the groups or individuals to be recruited (e.g. members of support group, residents of a home or closed community)?	/	
4. Will the study involve the use of private archives/collections for which permission needs to be sought?		/
5. Will any covert methods be necessary (e.g. observing/interacting with people without their knowledge that they are subjects of research or without their knowledge of the nature of the research?		/
6. Will the study involve discussion of sensitive issues?	/	
7. Will financial inducements (other than reasonable expenses and compensation for time) be offered to participants?		/
8. Does the study entail meeting unknown respondents off university premises?	/	
9. Is the study likely to require copyright clearance for the use of images, text or tables?		/
10. Does your study involve the use of a questionnaire, workshops or focus groups? If 'yes' you must append a copy of the draft questionnaire or relevant topic guide.	/	

If you have answered **'yes'** to any of the above questions, please describe what steps you will take to address them

3. A formal collaboration has been made with the University of Narino, Pasto Colombia. Key gate keepers will comprise: The Dean of Agricultural Studies and lecturers in Engineering, Geography and Psychology – all of which have previously conducted empirical research within the communities of the volcano.

These three people will make the initial links with key representatives of the community on my behalf, who in turn will provide direction on how to access individual community members.

6. The communities of whom the study will be engaging with are currently involved in a resettlement program. This is a highly sensitive subject of which has resulted in a high level of stress and anxiety amongst the people. Although the topic under review in this research is not the resettlement program, the direction of discussion (land use and livelihood security) will undoubtedly mean that people will want to discuss it.

If the discussion arises it will be made clear that the line of enquiry is not in association with or in any way associated with the current government management plan and that all responses will remain anonymous. Neutrality will be maintained at all times by the key researcher as well as research assistants engaged in the project.

8. The study entails meeting a large number of unknown respondents off of University premises. The following actions shall be ensured:
- Initial telephone contact to establish contact and agree a meeting place and time
- A secondary person will be enrolled to accompany the researcher (research assistant Kari Williams where the meeting will be conducted in English and a translator from the University of Narino when the interview is to be conducted in Spanish
- The outline and purpose of the interview will be explained at the on set and anonymity will be assured. Permission will then be gained via a signature on a records sheet.
- Participants will be informed of how to access a summary of results at the culmination of the study.
- Contact details will be left with the participant along with an invitation to contact the researcher for further information.

For Safety purposes all visits will be logged and a system of 'checking in and out' maintained with the research assistant and key representative at the University of Narino.

10. This study entails the use of semi structured interviews, focus groups and household surveys. An initial skeleton outline will be reviewed with the following representatives of both partner universities:
- Dr Carolyn Snell – University of York
- Dr Jayne Glass – Center for Mountain Studies, Perth
- Dr Tulio Cesar Lagos – University of Narino
- Dr Elizabeth Odeja – University of Narino

A final drafted interview script will then be used with key stakeholders.
A reviewed version of the same script will be used to drive the focus groups.

The key aim of the focus group is to create the assessment criteria for the household surveys. Therefore the household survey transcript will not be available up until this point.

In order to ensure that this assessment meets the criteria of this ethics review, a secondary ethics committee approval will be sought after the focus groups but prior to the household surveys.

A record of all discussions, drafts and edits will be kept for review at all times.

Are there any other ethical issues you consider important?

Please explain how research participants will be a) identified and b) for human subjects, how they will be informed about your research

The impact of the researcher on the community participants.

The nature of this research, within the indigenous farming populations of a Latin American country raises the issue of the impact of the researcher (a white, female, non-Spanish speaker) engaging with the local population.

The impact of the presence of the researcher on participants has been reviewed and the possibility of participant bias and likelihood to answer questions to 'please' the researcher is acknowledged. This again is a key reason for using 'gatekeepers' from the University to provide 'intermediary' support. Although the researcher will be present at all times at all interviews, focus groups and household interviews, the focus groups and household interviews will not involve continuous translation - the organisation of the activities will ensure that the script is well rehearsed and the aim clearly understood by the Colombian translator. Clarification will be sought after the process on the 'interview' – therefore creating the feeling of 'conversation' between translator and participant.

To ensure clarity, a summary review will be made between the researcher and translator at the end of every interview in order to clarify any misunderstanding or ambiguity of the researcher.

- Initial telephone contact with all participants to be interviewed will be made to establish contact, explain the purpose of the research and interview, seek initial agreement to participate and agree a meeting place and time
- A secondary person will be enrolled to accompany the researcher (research assistant Kari Williams where the meeting will be conducted in English and a translator from the University of Narino when the interview is to be conducted in Spanish
- The outline and purpose of the interview will be explained at the on set and anonymity will be assured. Permission will then be gained via a signature on a records sheet.
- A summary sheet of the research will be provided to the participant along with the contact details of the researcher.
- Any photographs taken, videos taken or recordings made will seek an additional signature of permission.
- Participants will be informed of how to access a summary of results at the culmination of the study.

Please describe what steps you will take to keep your data secure? (You need to consider both security for confidentiality reasons on a day-to-day basis as well as long-term security, e.g. back-up procedures)

- All observation data will be recorded in a fieldwork record book, on associated maps and on a Dictaphone recorder. At the end of each study day all data will be reviewed and a formal document produced. This document will be dated and stored on the researchers computer and on 2 separate memory sticks.
- A second copy will be made on memory stick.
- All data recorded on the researchers laptop will be password protected, with access only to the researcher.
- All 'paper' based data records such as interview notes; focus group observations and household questionnaires will be stored in a locked room at the accommodation of the researcher.
- On departure from Colombia the majority of 'paper' based data will be transported back to the UK with the researcher. Any surplus documentation will be disposed of in accordance with the rules and regulations of the University of Narino.

What do you anticipate will be the output from the study? *Tick those that apply:*

Peer-reviewed publications	\
Non-peer-reviewed publications	\
Presentations at Conferences/Meetings	\
Press releases	
Other publications	\
Student project or coursework	\

4. SIGNATURES

The information in this form is accurate to best of my knowledge and belief and I take full responsibility for it.

I agree to report of any adverse or unexpected events that may occur during this project, to seek approval for any significant protocol amendments and to provide interim and final reports. I also agree to advise the Ethics Committee if the study is withdrawn or not completed.

I confirm that I have considered the following:	**YES**	**N/A**
1. Responsibilities to participants	\	
2. Responsibilities to gatekeepers	\	
3. Responsibilities to the academic community	\	
4. Ethical issues arising from funding source or the nature of the research	\	
5. Intellectual property rights	\	
6. Consent and understanding of participants	\	
7. Protection of data	\	
8. My personal safety	\	

Signature of Applicant (s): J.Roberts …

Date:…(01/05/ 2012) ……

The completed application form should be emailed to the Chair Research Committee, Environment Department abab500@york.ac.uk

Enquiry framework for key stakeholder interviews, focus groups and house hold surveys

The interviews will comprise of four main lines of enquiry:

1. The Ecosystem services of the volcano
2. The livelihood activities of the people living on Galeras and their land use of the volcano
3. The hazards that pose a potential threat to their livelihood activities
4. The resilience strategies of households to deal with hazards

The following lines of questioning will be followed in each of the data gathering methods:

The final version of interview scripts for each methodology will be discussed and agreed with Dr Elizabeth Odeja, a community psychologist at the University of Nariño.

1. What are the ecosystem services of the Galeras volcano

- How does the volcano divide naturally into different regions:

Altitude, climate, geology, soil, ecology and natural features (e.g. rivers and valleys)

2. What are the land use activities of the volcano by the Galeras communities for their livelihood security

- What are the key livelihood activities of the Galeras communities?
- What is the location of those livelihood activities?
- What ecosystem services do those activities depend on?
- What and where are the niche areas of the volcano, and how are they used for livelihood activities?
- What do you need to sustain your livelihood?

3. What are the hazards that pose a potential threat to their livelihood activities?

- What hazards have impacted different livelihood strategies in the past 20 years?
- What hazards pose a potential impact to different livelihood strategies in the next 20 years?
- How do the hazards rank in order of impact?
- What is the geographical distribution of different hazards

4. The resilience strategies of households to deal with hazards
*Resilience is used in this research as a measure of vulnerability within the communities. The lower the resilience the higher the vulnerability inferred.

- What were the impacts on livelihood strategies of different hazardous events?
- What is the impact on each livelihood of not being able to access the volcano for:
    - One day
    - Two days
    - Three days
    - One week
    - One month
    - Three months
    - Six months
    - One year
- What essential activities does your livelihood depend on to survive?
- Who does your livelihood depend on to survive?
- Who depends on your livelihood?
- What are the different parts of your livelihoods supply chain and where are they located?
- What strategies do you engage to deal with each of the potential impacts listed?
- What makes one person's livelihood more resilient than another?

Household surveys:

For the household surveys the following description information will also be sought from the household head:

- Age
- Gender
- Ethnicity
- Profession
- Size of household
- Ages of household
- Size of land
- Land tenure
- Number of years lived in area?
- Why moved to area?
- Why stayed in area?

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*References marked with an * at the end were analysed in the literature review (Chapter 2).*

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