Living with volcanic risk: vulnerability, knowledge and adaptation in the slopes of Tungurahua, Ecuador

Maria Teresa Armijos
Roger Few
DEV Reports and Policy Papers

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I. INTRODUCTION

This document reports on the outcomes of the field research conducted for Work Package 3 (Vulnerability) of the STREVA (Strengthening Resilience in Volcanic Areas) project in Volcán Tungurahua, Ecuador. WP3 focuses on understanding the long-term implications of volcanic activity on people’s life trajectories, wellbeing and livelihoods. It aims at investigating how social differentiation - underlined by socio-economic status, geographical location, (exposure to hazards) and access to entitlements and resources - influences the dynamics of vulnerability to volcanic hazards. In this light, this report presents the results of research that focuses on understanding people’s responses and ways of coping with long-term exposure to volcanic hazards.

Volcán Tungurahua reactivated in 1999 and has undergone various episodes of volcanic crisis involving a range of volcanic hazards such as: pyroclastic flows, lahars, tephra falls and gas emissions. By looking at the population numbers in all the counties affected by volcanic hazards, particularly ash, we have estimated that around 200,000 people live in the influence zone of this volcano, and approximately 30,000 live in the higher risk areas (INEC, 2010; Mothes et al., 2015).

This report constitutes a preliminary analysis of the information gathered during field research in the populated areas surrounding the Volcán Tungurahua between November 2013 and March 2014. It analyses data gathered at the household level in urban and rural areas located in the two provinces influenced by the volcano, Tungurahua and Chimborazo. It is based on qualitative research that included interviews to 67 local residents across 20 different locations and complemented by the data from a large-scale household survey (411 households) and observations during the 4-month period of field research spent in the area which included a reactivation of the volcanic system (Feb 2014).

To date, this research constitutes the only comprehensive study of the dynamic aspects of risk and long-term effects of volcanic activity across different locations with distinct exposure to hazards around Volcán Tungurahua. It offers an original perspective on research in Tungurahua, where studies of the social dimensions of risk have focused on the first evacuation of the area in 1999 and its aftermath effects among the residents of the largest town in the influence zone of the volcano, Baños de Agua Santa (Lane, Tobin, & Whiteford, 2003; Tobin & Whiteford, 2002a). By including the largely understudied rural areas exposed to volcanic activity in both Tungurahua and Chimborazo provinces this study provides a new and alternative
perspective into the understanding of vulnerability and resilience in volcanic areas. It is intended that this report will form the basis for co-authored papers in collaboration with those at the IGEPN who are interested on a range of topics including: (1) the impact of ash on agriculture; (2) policies and effectiveness surrounding resettlement sites and; (3) long lived exposure to volcanic hazards.

This report is divided into three sections. The first section provides an introduction to WP3 work, the conceptual background to the research, research themes, methodology and general information about the research site. The second section presents the analysis of the data collected in Tungurahua. It emphasises on understanding people’s experiences of volcanic activity over an extended period of time, approximately 15 years. In the last section, final remarks and conclusions in terms of vulnerability are presented.

**Conceptual background**

Vulnerability is commonly understood as a combination of exposure to hazard and susceptibility to its impacts. Social science research on disaster risk emphasizes that both exposure and susceptibility are to large extent socially-generated conditions, and that people have varying degrees of underlying vulnerability that tend to shape how severely they are affected when a hazard occurs.

In STREVA, the term ‘vulnerability’ is often defined as a condition of human subjects – of people, households, communities – as opposed to sectors, infrastructure and/or systems. This is because, ultimately, it is people who experience the consequences of hazards on their lives, wellbeing and livelihoods. Moreover, a people-centred approach to analysing vulnerability enables a focus on how different social groups experience and manage risk in different ways. Risk, in this sense, is defined as the interaction of hazard and vulnerability. We also use the term ‘adaptation’ to describe processes of response and learning that aim to reduce vulnerability; and we use the term building ‘resilience’ to denote a process through which people’s lives, wellbeing and livelihoods become less susceptible to the impacts of hazards (or multiple hazards/stresses).

Vulnerability can sometimes be analysed by looking at impacts – studying the effects of actual disaster events and how this varies for different social groups; but we can also analyse it as an inherent social condition in which we can assess the potential for exposure and susceptibility to harm.
Volcanic hazards may be brief and episodic in their violent phases, but the long duration of high-risk periods that characterize many eruptions (eg. Soufrière Hills, Merapi, etc...) have complex and chronic patterns of social, economic and political impact. Like many hazards they also have long-term implications for recovery – and the ability to recover (or not) is another key facet of people’s overall vulnerability to their impacts (and to the risks of their impacts – e.g. psychosocial effects, economic implications etc). This research aims at going beyond a focus purely on volcanic hazard events to seeing volcanic risk as an on-going risk process with on-going social impacts for the vulnerable (including implications for recovery), punctuated (and reproduced) by actual volcanic events. But as a process risk and its vulnerability component are therefore also inherently dynamic. People’s vulnerability can and does change through the course of an eruption.

Research Themes

Given that it has been in constant activity since 1999, Volcán Tungurahua provides an excellent case study to look at the dynamic aspects of risk and vulnerability in the long term. As noted above, vulnerability entails analysing a range of different factors, which are interconnected and linked to long-term changes to people’s livelihoods and well-being. In this light, the research conducted in Tungurahua followed various themes. Although they are used as guidance to assess vulnerability, they do not represent a comprehensive list of variables used to ‘measure’ or ‘map’ vulnerability, but rather an attempt to understand long-term implications of volcanic activity on people’s life trajectories, wellbeing and livelihoods from the perspective of those who experience these changes. These themes were used to frame the research process and are analysed and understood in relation to each other rather than as separate categories.

Long-term patterns of change, including both periods of exposure to volcanic hazards and periods of volcanic quiescence

Volcán Tungurahua’s prolonged eruption requires a long-term research approach to allow investigating how people cope with change and uncertainty in the long run. It requires exploring vulnerability during periods of volcanic crises as well as during the periods in between these crises (Dove, 2008). What happens during a volcanic crisis? How do people cope with the different types of hazards? What are the patterns of evacuation? But also, what happens in between? When are people more or less vulnerable? And how do they cope or do not cope with periodic exposure to hazards? What is recovery and how do people understand recovery in this context? What allows households to cope and recover? (Wisner, Blaikie,
Cannon, & Davies, 2004:357). In this light WP3’s research focuses on the themes listed below with an emphasis on both periods of crisis and periods of relative volcanic quiescence.

**Volcanic activity as a source of livelihood transformation**

WP3’s research in Tungurahua explores how patterns of vulnerability have shifted during the course of a prolonged volcanic crisis. In line with this aim, this report looks at how livelihoods in the area, mainly agriculture and tourism, have been impacted and changed in the past 15 years. In terms of agriculture, this includes for instance, changes in the types of crops harvested and the types and quantities of livestock herds kept by different households. How different hazards affect or benefit the crops (distinct ash types)? Are households adapting to minimize risk? What people do to protect their livelihoods during a crisis and during periods of relative volcanic calmness? How knowledge and livelihood patterns change with exposure to hazards? Questions around tourism in the area focused around impact and benefits brought about by volcanic activity. Can a volcanic crisis be beneficial for tourism? How do media reports about the volcano influence tourism? Vulnerability to volcanic hazards can only be understood in relation to other, severe changes, experienced by each household. In this light, WP3’ field research also collected data on significant political, economic and social changes that have affected local resident’s ability to cope with volcanic hazards. These include shocks at the national, local and household level such as: economic crisis of 1999, political transformations in Ecuador, market changes for agricultural products and inputs, rise in food prices, migration, drought and pests. In summary this theme within the report aims at understanding how livelihoods have changed and adapted to long-term exposure to volcanic hazards in the context of other important events experienced by local residents.

**Resident patterns**

Displacement, relocation and resettlement, is a recurrent impact of exposure to volcanic hazards. Tungurahua is not the exception in this respect, and in order to assess vulnerability this report also looks at resident patterns in the area. Where do people live and work? How have changes in residency transformed and affected livelihoods? How and why do people decide to resettle? Do people resettle permanently? Why are some reluctant to relocate? How do people use their homes in the resettlement sites provided by the State and other organizations? What are the effects of these patterns on community cohesion and cooperation in the long run?
Long-term impacts to people’s health, land and homes

In addition to direct impact of volcanic hazards to people’s health, such as respiratory illnesses, WP3’s research in Tungurahua also gathered data relating to stress as a result of evacuations and the exposure to hazards. The objective here is to understand how social and structural transformations in the communities, such as population movement, service withdrawal, lack of access to resources, land abandonment, change in the value of land has impacted people’s well-being in the long-term.

Coping with volcanic hazards over time. Access to resources, services, information and authorities are an important factor influencing peoples’ ability to cope with severe transformations in their livelihoods, such as those brought about by volcanic activity. In this light, WP3 data collection in Tungurahua also focused on understanding how citizenship rights are put into practice in the context of long-term volcanic activity. The topics analysed under this theme include access, improvement and withdrawal of services such as education, water, electricity, credit and road infrastructure. Additionally, the report looks into state assistance during emergencies and includes diverse topics such as access to emergency relief supplies and assistance to evacuate. Following these issues, various questions are posed: How living in a risk zone affects access to resources? What people can demand and who are they able to access? Is there a distinction between what people can demand during and after high volcanic activity? How are goods and help distributed to people during a crisis? Who is in the lists for emergency relief? Are people more prone to rely on the state for emergency assistance?

Knowledge transformation

Examining vulnerability in the long-term necessarily entails analysing knowledge about risk and understanding of volcanic hazards. More specifically, how knowledge about volcanic hazards and its effects on livelihoods changes over time and allows people to cope and perhaps adapt to these circumstances. WP3 is primarily concerned with the local residents, however, data gathered during fieldwork also included local residents’ interactions with and access to information and resources from vigías, scientists and local authorities which will also be included in this theme. Here, knowledge is defined in a wide context and includes amongst others, knowledge about volcanic hazards, evacuation drills, changes in the understanding of risk, perception of risk, access to scientific information and experiencing volcanic crises.
Background to the case study

Volcanic Hazards and on-going activity in Tungurahua:

Volcán Tungurahua is located on the border of Tungurahua and Chimborazo provinces in the Cordillera Central of the Andes Mountain Range of Ecuador. It lies 140 km south of the capital city Quito. Since colonial times it has had various periods of eruptive activity between: 1640–1641, 1773–1777, 1886–1888, 1916–1918 and from 1999 until the present (Biggs et al., 2010; Hall, Robin, Beate, Mothes, & Monzier, 1999; Ramón, 2009). During the current period of volcanic activity, on which this research focuses, there have been various eruptions ranging in magnitude of volcano explosivity index (VEI) levels of <1 to 3 and associated hazards including: ash fall, tephra falls, pyroclastic flows, gas emissions and lahars (Mothes et al., 2015). The most serious events with strong impact on the population, economic activities and local infrastructure have occurred in 1999, 2006, 2008, 2010, 2013, and 2014 (Biggs et al., 2010; Lane et al., 2003; Ramón, 2009) These crises tend to last from a few days to a few months at a time (Mothes et al., 2015).

When analysing the magnitude in volcanic activity in connection to the specific responses at local, regional and national levels that ensued these events, WP3’s analysis has recognised that the current period of activity of Volcán Tungurahua has been characterised by three distinct phases. The first one, from 1999 to 2005 includes the reactivation of the volcano in 1999, the subsequent decision to evacuate more than 25,000 people from the area, and their return to their homes between three months and more than a year later. The second period includes the most severe eruption of this current volcanic cycle, which took place in August 2006, and the aftermath emergency and recovery processes. The third period spans from 2007 until today. These periods are defined both by the activity of the volcano and the social and political consequences related to it.

1999-2006

After a period of extreme uncertainty following the reactivation of Volcán Tungurahua in September 1999, the local and national authorities, in consultation with scientists from the IGEPN, decided to order the evacuation of the residents of Baños de Agua Santa and the slopes of the volcano. The signs that a major eruption was going to take place pressed the authorities to take a decision that could potentially save the lives of more than 25,000 people (Tobin & Whiteford, 2002a). However, a few months into the evacuation order, the volcano had not produced the large eruption that was possible but instead there were several
explosions and sustained ash emissions. Many of the evacuees began to show signs of discontent. The forced manner in which the evacuation took place, added to the difficulties in finding shelter and the lack of assistance and the widespread loss of property, contributed to a general belief that it had been a wrong decision. By December 1999 strong voices of dissatisfaction became public, and organised in different groups, the residents of Baños de Agua Santa and the surrounding communities began to challenge the evacuation and to fight to return to their homes (Tobin & Whiteford, 2002b; Vieira, 2003). At the beginning of January 2000, following strong physical confrontations that lasted for many days in the vicinity of Baños between local residents and the police and military forces, national authorities decided to lift the restriction and allow residents to enter the area (Vieira, 2003). At the same time Ecuador was going through a deep economic crisis, which resulted in the dollarization of the economy. Various studies have concluded that the large-scale evacuation from the town of Baños de Agua Santa and many rural communities in the vicinity of the volcano, in addition to the economic crisis between 1999-2000, have had long lasting consequences and enormous social and economic impacts for the population (Lane et al., 2003; Tobin & Whiteford, 2002a).

Conflicting views about the state of the volcano following the 1999 reactivation and the evacuation resulted in the severe deterioration of the relationship between the local population, the authorities and scientists (Mothes et al., 2015; Vieira, 2003). It has taken many years and significant efforts from the authorities and scientists to re-establish it (Mothes et al., 2015; Stone et al., 2014). Additionally, as the findings in this report suggest, it is possible to say that the willingness to evacuate has been severely affected by the 1999 experience. As noted in the following pages, authorities, scientists and local residents have been challenged to develop new and innovative risk management systems, communication procedures and monitoring capacities. Most significant, has been the establishment of the Tungurahua Observatory run by the Instituto Geofísico of the Escuela Politécnica del Ecuador (IGEPN), the establishment of an Early Warning System and the formation of a group of community-based volunteers to monitor the volcano, known as vigías (Mothes et al., 2015; Ramón, 2009; Stone et al., 2014).

2006-2007

The second period, mainly 2006-2007 is underlined by the major eruptions of Volcán Tungurahua in July and August 2006 which produced, ash fall, tephra falls and large pyroclastic flows causing loss of life and significant infrastructure and economic losses across Tungurahua and Chimborazo provinces (Biggs et al., 2010; Mothes et al., 2015; Ramón, 2009; Sword-Daniels et al., 2011). In addition to the loss of 6 lives and 15
houses in the town of Palictahua in the Chimborazo Province, 40 families from Juive Grande lost their houses to a large pyroclastic flow that covered an entire section of the village (Cevallos, 2006; Mothes et al., 2015; Ramón, 2009). After these events the state and some non-profit organisations began a series of resettlement projects for families living in the slopes of the volcano. Today there are more than 750 resettlement homes built at Rio Blanco and La Paz in Tungurahua Province and Penipe, Pusuca and Guano in Chimborazo Province. The significant exposure to volcanic hazards, its direct effects on local population as well as the aftermath responses from scientists and decision-makers mark the 2006 events as a critical episode in the current period of volcanic unrest.

2007-Present

Finally, the third period spans from 2007 until present times. This period has been characterised by eruptions of variant magnitudes, the most significant during 2008, 2010, 2013 and 2014 with important hazards and effects on people’s livelihoods, particularly agricultural activities. Additionally, new governance structures for Disaster Risk Reduction at the national level, including the recently established Secretaria Nacional de Gestión de Riesgos (Risk Management National Secretariat), as well as strengthening of the local monitoring vigía system and the Observatory have played an important role in managing risk and uncertainty in the area during and after the events that took place 2006.

Research sites

Out of the approximately 200,000 people that live in areas potentially affected by Volcán Tungurahua, mostly by ash, it is estimated that more than 30,000 people live in the main influence zone of the volcano in both rural and urban centres (INEC, 2010; Mothes et al., 2015). This study focuses on the latter localities, where the volcano “dominates both the physical and cultural landscape of the area” and it’s the basis for the agricultural and tourism-based livelihood activities of most of its population (Tobin & Whiteford, 2002a:33).

Four main research areas across Tungurahua and Chimborazo provinces were identified and used to conduct WP3’s field research and analysis. These study areas were divided taking in to consideration

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1 Areas outside the main influence zone of the volcano that also experience sporadic ash fall are for example the city of Riobamba pop. 156.000, Quero Parish pop. 14.254 and the Cevallos Parish, pop. 8.163.
degree of exposure to volcanic hazards, resident patterns and previous research (See Figure 1). As a result, all locations in the proximity of the volcano were divided in to 4 different zones.

Interviews, surveys and participant observation took place in all four zones (See Figure 1). Although the following list includes all of the locations in each zone included the research, not all of the activities were conducted in all locations (see research methods section for more detail).

a. Zone 1: communities on the slopes of the volcano with high exposure to volcanic hazards: Chamana, Runtún, Pondoa, Juive Grande, Cusúa, Bilbao, Chacauco, Yuibug, Choglontús, El Manzano, Puela, Pungal de Puela, Anaba, Palictahua, Capil, Cahuaji Bajo and Palestina.


c. Zone 3: a sample of communities located in areas adjacent to the high risk zones with high exposure to ash and tephra falls: Cotaló, Pillate, San Juan, Pachanillay, Ghansi and Santa Fe de Galán.

d. Zone 4: largest urban centre closest to the volcano, Baños de Agua Santa located in Tungurahua Province, approximately 8km from the volcano.
While in the town of Baños de Agua Santa (zone 4), with a population of approximately 20,000 the main economic activities focus on tourism; the communities located on the fertile slopes of the volcano with an approximate population of 5,000 are mostly dedicated to agricultural production for the local markets (zone 1 and 3). People living in the resettlements (zone 2 not included in the map) conduct different activities that range from agriculture, mostly in their fields situated on the slopes of the volcano, to private and public sector jobs in towns and cities in the region. As the analysis presented in this report shows, the volcano has directly affected most people living in the area. The extent to which they have been affected
and the different ways in which they have coped with these experiences lies at the core of WP3’s research interest.

Although zones 1-4 have been included in the research, special attention has been given to communities on zones 1, 2 and 3 given that most research in connection to Volcán Tungurahua has been conducted in Baños de Agua Santa or zone 4 (Jones et al., 2013; Lane et al., 2003; Tobin & Whiteford, 2002a). In this light, most activities and effort during WP3’s field research were geared towards areas with higher exposure to volcanic hazards (zones 1 and 3) as well as the official resettlement sites (zone 2).

The choice of fieldwork locations - across provinces, different hazard exposure, rural-urban composition, and resident patterns – has been fundamental in developing a comprehensive perspective on the long-term effects and livelihoods changes experienced by residents in the influence area of Volcán Tungurahua. Residents in the four areas of interest have undergone diverse experiences - that although directly linked to their geographical location in relation to the volcano and their exposure to hazards – are, at the same time, defined by governance structures and citizenship action. Capturing the different factors that define these differences was central to WP3’s fieldwork activities.

**Research Methods**

Data collection for this report was conducted using a range of qualitative methods that included, semi-structured interviews, a questionnaire survey, conversations with local residents and participant observation.

**Interviews**

Semi-structured interviews with a total of 67 people from 20 different communities and resettlement sites were completed using a mix of snowball and purposive sampling methods. These interviews lasted in between 30 minutes and 2 hours each. The sites where the interviews were conducted were chosen based on the sampling zones established for the WP3 research (see Case Study section). It included urban and rural areas across the Tungurahua and Chimborazo provinces with different exposure to volcanic hazards. As part of the effort to emphasise this research on less studied communities, most of the interviews were carried out in rural communities on the slopes of the volcano. (See table 1 and 2).
Individual households were chosen randomly following purposive and snowball methods. Potential interviewees were contacted either through contacts provided by the IGEPN, mostly local *vigias* (men and women that live close to the volcano who are actively involved in helping scientist at the Scientific Observatory monitor the volcano), or people met randomly during the repeated visits to the area. Most of the interviews were conducted on the second or third visit to each particular household or individual. Although this method was time consuming it resulted in an enormous gain in terms of the quality and depth of the gathered information.

In order to establish an acceptable sampling size and prevent bias in the collected data, three or more people were interviewed in most communities. The intention was to gather various points of view, including those of the most vulnerable individuals rather than solely focusing on community gatekeepers. In this light, priority was given to interview women and men of different ages and social status from different geographical locations (exposure to hazards, and province) who have been impacted by different volcanic hazards (Tables 1 and 2).

Permission to do the interviews was sought from each respondent. This included a short summary of the STREVA project, an explanation of what the information would be used for, and request to tape the interview. All interviewees were given a leaflet with information about STREVA, contact information of the interviewer and explanation on the option to withdraw their responses within a month of the interview (See Appendix 3). Interviews were carried out in Spanish at people’s homes or fields. Unless otherwise noted, all of the interviewee’s names mentioned in this report have been anonymised.

The interviews were conducted in two phases. Phase one, which served as an exploratory phase lasted for a week during June 2013 (9 interviews, 17 persons in total). These interviews were conducted by Fernando Hernandez Espino and Dr. Roger Few. The second phase, during which the main field research for WP3 took place, included visiting households across 18 communities in the two provinces and was conducted over 4 months between November 2013 and March 2014 by Dr. Maria Teresa Armijos (36 interviews, 52 persons in total). The interview data was analysed using Nvivo, a qualitative data analysis computer software.
Table 1. Interviews per zone and gender (second phase)

<table>
<thead>
<tr>
<th>ZONE</th>
<th>GENDER</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Female</td>
<td>Male</td>
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<tr>
<td>Grand Total</td>
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Table 2. Interviews per zone and main occupation (second phase)

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<th>OCCUPATION</th>
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<td>0</td>
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<td>0</td>
</tr>
<tr>
<td>Students</td>
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<td>2</td>
</tr>
<tr>
<td>Total</td>
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Survey

A survey questionnaire was administered in 411 households across the two provinces affected by Volcán Tungurahua, Tungurahua and Chimborazo.

The sampling frame for the survey was designed according to the characteristics of every site, mainly exposure to hazards and previous research. Sampling involved 3 stages.

1) Visit to various areas of influence of Volcán Tungurahua and establishing the four different sampling groups:
   a. Zone 1: communities in the high-risk zones with high exposure to volcanic hazards.
   b. Zone 2: Resettlement sites in Tungurahua and Chimborazo provinces.
c. Zone 3: Communities located in an area adjacent to the high risk zones with exposure to ash and potentially other hazards.

d. Zone 4: Neighbourhoods with higher exposure to volcanic hazards (lahars and pyroclastic flows) in the largest urban centre in the area, Baños de Agua Santa located in Tungurahua Province. These neighbourhoods are adjacent to the Quebrada de Vazcún.

2) Mapping the communities.

Prolonged volcanic activity in Tungurahua has severely disrupted residence patterns in many of the localities close to the volcano resulting in the following types of residency:

a. Households based in communities in the high risk zone most of the time.

b. Households with some or all members traveling from their homes in the communities in the high risk zone to the resettlement sites or other locations on a regular basis (every day or every other day)

c. Households based at resettlement sites or outside high risk zones most of the time.

As a result of these diverse residence patterns, the only available statistical data, gathered for the 2010 national census is not entirely accurate and therefore difficult to use when designing a sampling frame focusing on household numbers. Thus to be able to establish the accurate number of households with members that reside on each zone on a regular basis (have a house where at least a household member spends some part of the week) it was necessary to conduct a mapping exercise for some of the areas included in the sample frame. This exercise was conducted by the team of researchers from IGEPN, Ing. Liliana Troncoso, Andres Ordoñez and a group of students.

3) Household allocation

Based on the results of the mapping exercise, a target number of households were allocated to each area in the sampling frame, proportionate to the estimated population in each. The target figures were 81 for zone 1, 144 for zone 2, 82 for zone 3 and 104 for zone 4 – making a total of 411 households in all. The total figure of 411 households is a statistically significant proportion of the total estimated population of these zones (=1558 households), at a confidence level of 95% and confidence interval of 5.

The survey questionnaire was designed by WP3 and WP4 with the assistance of local partners at the IGEPN, Ing. Liliana Troncoso, Andres Ordonez, Ing. Patricio Ramón and the 6 enumerators (students from IGEPN). It includes 21 questions that range from general information about households, employment,
residence patterns, impact of volcanic hazards, recovery and other shocks to state assistance and evacuation (See Appendix 1). The survey was applied using a random sample selection of households in each location. Prior to all the interviews, the team members explained the purpose of the survey, introduced the STREVA project and sought permission from each individual. A leaflet containing information was handed out to all of the respondents (See appendix 2).

The team of enumerators and supervisors who collected the data and assisted with the survey design was formed by: Ing. Liliana Troncoso and Andres Ordoñez from the IGEPN and a group of Ecuadorian geology students at the IGEPN, Wilmer Merino, Stefany Almeida, Marco Almeida, Yesenia Enriquez, Karla Morales and Andres Merino. The survey team received training by Dr. Ma. Teresa Armijos on research methods and ethics before they started their work in the field. The statistical analysis was conducted by a consultant hired by ODI, Nina Becker.

**Participant Observation**

During the 4-month fieldwork period, in addition to the semi-structured interviews, a considerable amount of time was spent with local residents while they conducted their daily routines and activities. This included long conversations with different people while they were working on their fields or simply talking to people encountered during the trips across the Tungurahua and Chimborazo provinces.

Coincidentally, during the periods spent doing fieldwork in Tungurahua, there was a strong volcanic eruption, which allowed experiencing first hand and analysing how different people, authorities, residents, scientist and the *vigias*, respond during such crisis. It became a unique opportunity to talk to people during a voluntary evacuation in the town of Baños and to observe what people do in the aftermath of an eruption.
II. LIVELIHOODS’ LONG-TERM TRANSFORMATIONS IN THE SLOPES OF VOLCÁN TUNGURAHUA

This section of the report presents the findings of WP3 research in Tungurahua. The aim is to understand vulnerability where there has been long-term exposure to volcanic hazards and their associated effects. In this light, the section is divided by topics. The first one presents a general introduction to changes in livelihoods since the reactivation of the volcano in 1999, with specific attention to agriculture and volcanic hazards. Here we will also look at coping mechanisms and recovery. The next section looks at changes in residence patterns, specifically how, as a result of continued volcanic risk, resident patterns have changed and transformed livelihoods. The third section looks at other impacts associated with long term exposure to volcanic hazards, for instance, changes in access to services, resources and entitlements, destruction of land and homes, changes in patterns of community cooperation and impact to health. By looking at emergency risk communication, knowledge exchange, the vigía network, amongst other topics, the last section explores how local residents and authorities are coping with long-term exposure to volcanic hazards.

Livelihoods and the Volcano (long-term effects)

This section will first present a discussion of the long-term effects that exposure to volcanic hazards has had on agriculture-based livelihoods. This discussion focuses on households located on zones 1, and 3 where agriculture constitutes their main activity. It also includes households in the resettlement areas (zone 2) who still depend on agricultural activities. The second part will explore other livelihoods that have been impacted by volcanic activity in the area, most importantly tourism and commercial services, shops and restaurants, with a stronger focus on zone 4 (Baños de Agua Santa).

Agriculture and volcanic hazards

The land on the slopes of Volcán Tungurahua used for agricultural activities is characterised by smallholding farms for crop cultivation and livestock production. Most of the farms are 1-10 hectares in size (Chiriboga, 2009; Sword-Daniels et al., 2011:38). Due to the different altitude zones used for agricultural production in the influence area of the volcano, ranging from 1500 to 4000 MASL, a large variety of crops are produced, including: maize, potatoes, beans, peas, onions, tomatoes, vegetables, citrus fruits, apples, plums, tamarillo and sugar cane. Livestock production in the area focuses on dairy and beef cattle and there is also intensive chicken farming. In addition, most households own chickens, guinea pigs and pigs for own consumption, which are occasionally sold in the market.
Data collected during the interviews and survey shows that since the reactivation of Volcán Tungurahua in 1999, households working in the agricultural sector are the most vulnerable to volcanic hazards. The single most disrupting hazard for these households has been ash. Almost a 100% of the survey respondents for zones 1-3, where many livelihoods are based on agriculture, noted that they had been affected by ash at some point since 1999. Although lower for zone 4, still 75% of the respondents noted they have been affected by ash at some point since 1999 (See Figure 3).
Lahars cutting off the main roads that connect communities in the slopes of the volcano with the closest towns, namely Baños de Agua Santa and Penipe have also caused difficulties in transporting produce and disrupting general communication. Vulnerability to volcanic hazards in the area has been exacerbated by the official responses to volcanic activity and the prevalent social and economic conditions of the country (Tobin & Whiteford, 2002a). As this report shows, enforced evacuation in 1999 and the eruption of 2006, which deprived many families from their activities, have been the most challenging events for people whose livelihoods depend on agriculture.

**Agriculture and Ash**

One of WP3’s research focus in Tungurahua was to understand how local farmers have been affected by ash over the years, and at the same time, how they have learned about and adapted their activities to this particular volcanic hazard. Farmers in the slopes of Tungurahua have had to endure persistent ash fall since 1999. Depending on the direction of the wind, ash tends to fall in areas closest to the volcano but has in more than one occasion travelled hundreds of kilometres and disrupted air travel in other parts of the country\(^2\). Areas located south of the volcano, such as the communities of Choglontus, Manzano, Puela, Anaba, Cahuaji Bajo, Palestina and Santa Fe de Galán; tend to be the most affected. This was reflected on

\(^2\) During the eruption of the 1\(^{st}\) of February 2014, ash from Tungurahua fell as far as the border with Peru in the south of the country, approximately 700 km away and disrupted air travel in the city of Cuenca, 320 km away (Universo, 2012). During the 2010 eruption, ash fall from Tungurahua disrupted air travel in Guayaquil (Sword-Daniels et al., 2011).
the data gathered for the survey where more than 60% of the households interviewed for the survey who are located in these areas (zones 1 and 3) noted that they are affected by ash *almost every time* there is an eruption (See Figure 4).

![Frequency of ash impact](image)

*Figure 4: Frequency of ash impact*

During each period of heightened activity, which can last from a few days to a few months, the volcano releases enormous amounts of ash. It has been estimated that during the 2006 eruptions more than 50 million cubic meters of ash were emitted from the volcano and approximately 19000 hectares of land were partially damaged by ash and tephra fall in the area (Guevara et al., 2009). Although considerably less hazardous than in 2006, other eruptions have also had a significant impact on agriculture. According to the Ministry of Agriculture, in 2010 and in 2014 volcanic ash partially damaged 4,329 and 6,402 hectares of agricultural land and affected 5,700 and 13,570 animals respectively (MAGAP, 2012, 2014).

As a result of the reactivation of Tungurahua in 1999, the agricultural landscape of the area has been severely transformed. Although, agriculture remains the main activity of most households, the amount and types of crops harvested as well as the animals kept have decreased. Before 1999, the slopes adjacent to the volcano were considered one of the main sources of produce for the markets in Ambato and Riobamba the capital cities of the Tungurahua and Chimborazo Provinces. Following the reactivation of the volcano, the mass evacuation of 1999 and constant ash fall and other hazards, the agricultural production diminished considerably as did the supply of produce to the nearby markets (Chiriboga, 2009; Lane et al., 2003). This was also reflected in the survey results, which show that almost 48% of the households interviewed in zone 1 and 82% of households interviewed in zone 3 who practice agriculture believe that their agricultural
production has diminished since 1999 (Figure 9). The most affected crops are roots, specifically potatoes, vegetables and fruit trees (Guevara et al., 2009).

Despite the severe effect of volcanic hazards on the land, agricultural production still constitutes the main income for most households who have decided to remain living in the area. While for zone one, 62% of the respondents’ main occupation is agriculture; the percentage is even higher for zone 3 with almost 70% working primarily in this sector. Even for zone 2 or the resettlements, agriculture continues to be a significant occupation with 30% of respondents.

The effect of ash fall on agriculture depends on the type of crop, its stage of maturity, the amount of ash fall and the type of ash (Ayris & Delmelle, 2012; Guevara et al., 2009:20). Since the reactivation of Volcán Tungurahua, local farmers who have lost crops and animals have gained significant knowledge about the different types of ash and their effects on different crops. Through experience and long-term exposure to volcanic ash, they have been able to experiment and identify the crops that are able to resist ash fall. According to some of the local farmers interviewed for this project, the most sensitive crops are those with large leaves that can collect ash and tend to hold it despite wind or rainfall. Crops like potatoes, some vegetables such as pumpkins and tomatoes and fruit trees are amongst the most sensitive. If after a few days of ash fall it does not rain and the sun is very strong, these crops’ leaves and/or fruit might ‘burn’ with the possibility of complete crop failure or a limited harvest. This coincided with scientific studies on the effects of tephra fall on vegetation, which suggest that while hairy leaves and fruits favour the retention of ash on the surfaces, waxy leaves retain less particles (Ayris & Delmelle, 2012:1913). The stage of maturity is
also important. For instance maize, which is generally thought to be more resistant to ash, can be severely affected if ash falls before flowering or when the maize kernel is on its early stages of development.

![Tomate de Árbol trees in Pondoa covered in grey and white ash (Maria Teresa Armijos, 2014)](image)

Different ash types are also important in terms of its effects on agriculture. Most farmers concur that there are four types of ash: red, black, grey and white, all with distinct impacts on their crops. Grey and white ash are the most damaging as they are a lot thinner and tend to glue on to the plants and grass and ‘burn it’. White ash is commonly compared to cement because when it rains after white ash has fallen it can become very hard and difficult to clean. This also coincides with scientific research conducted in Mount St. Helens where researchers observed that the “wetting of the surface during or after deposition may increase the residence time of tephra on vegetation by cementing the surface of the tephra deposit into a crust” (Ayris & Delmelle, 2012:1914). Black ash is considered the least damaging, as it tends to be larger in grain size, almost like sand (name commonly used to describe it) and drops off the plants more easily. Wind or rain after this type of ash has fallen is seen as favourable as it helps clearing it away. In moderate quantities, black ash is considered to be a good fertiliser.

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3 It is likely that ash colour is related to the average grain-size of the ash (colour will change according to how coarse it is, with white as the finest); red coloration may be an oxidation effect.
Black [ash] falls off with the wind or by shaking the plant a little... When black ash falls and it rains it is like fertilizer, the fields turn green. But when it falls and it becomes sunny, the plants do not develop properly.

Antonio from Pungal de Puela

Today, farmers in the slopes of Volcán Tungurahua chose their crops based on the crops’ resistance to ash and their exposure to this hazard. As a result, farmers have not necessarily changed the types of crops they cultivate, but focused on those which are more resistant to ash. This is the case of maize, which has remained the most important crop in zone 1. Overall, 68% of households interviewed for the survey in zone 1, which practice agriculture, said that before 1999 maize was their most important crop, while today 65% plant the same crop (Figure 7). There is a change as to how the crop is used. While today, farmers who have remained in the area focus on maize production and sell it when it is young or fresh for the local and national markets, in the past it was also used dried for seeds or food. Waiting until the maize is dry on the plant before harvesting is a risk that farmers prefer to minimize by selling it when it is young. This is often a problem for the household since they are forced to buy the dried maize for own consumption. Most damaging however is the fact that they have to buy the seed from somewhere else, risking not buying a good seed appropriate for their climate. It is therefore possible to say that although farmers minimize the risk of losing their crop by selling it earlier on, they become more vulnerable as they have to buy it for own consumption and for seed.

Another change identified in zone 1 has been a drop in the importance of fruit trees (plums, apples and peach) from being the most important for approximately 6% of households in 1999 down to being the most important for only 3% of households nowadays (Figure 7) Additionally, out of the interviewed households that conduct agricultural activities tomatode árbol (tamarillo) was identified as their most important crop by 5% before 1999 with an increase to 10% after 2006 and decrease again to 7% today (Figure 7) Similarly to maize potato production continues to be the most important crop for about 7% of the households interviewed in zone 1 with a slight change from 5% before 1999. Despite the difficulties identified by farmers to cultivate potato under constant ash fall, some of the interviewed farmers said that they take the chance or risk of planting potatoes given the high price of this crop at certain times of the year. Cultivating potatoes might therefore include having to clean/wash the leaves of the potatoes when there has been ash fall in the area, or losing part or the whole crop in some occasions.

4 Unless otherwise noted, all names on this report have been anonymized. This is part of the ethical guidelines followed by the project STREVA in all its research sites.
In contrast to zone 1, in zone 3 or in the southwest of the volcano, on the most regular path of ash emissions due to wind conditions around Tungurahua (Ramón, 2009), there have been severe changes in crop cultivation. For instance in places like Santa Fe de Galán, where potato production used to be the main income for most farmers before 1999, the most common crop nowadays is onion. The reason behind it is that ash is not easily retained on the pointy leaves of the onion. This is reflected in the numbers for zone 3 where while only 5% of households interviewed in this zone identified onion as the most important crop for them before 1999, approximately 27% of households acknowledged it as the most important for them today. Conversely, potatoes used to be the most important crop for 24% of households before 1999 while today approximately 10% identified it as the most important for them. This information was confirmed at an interview with a farmer in Santa Fe de Galán who noted that many in the area have made the change from potato to onion due to their high exposure to volcanic ash. However, it was also noted that although the change in crop has helped them sustain agricultural production, the price of the onion has decreased due to high supply. In the same zone maize has sustained relative significance from being the most important crop for 38% of the households before 1999 to being the most important for 34% of households today (Figure 8).
In other locations of zone 1 and 3 such as Pondoa, Runtún and Pillate many of the farmers have built or expanded their greenhouses to cover their tomato, *tomate de árbol* (tamarillo) and babaco (variety of highland papaya) plantations as a way of adapting to ash fall. In short, maize, fruits, roots, beans and vegetables are still planted, yet the quantities have changed in all zones.

Crops like broad beans, potatoes and beans are not that common any more, the production is not the same as before, they are easily damaged with the ash. The beans ‘burn’ very easily, the broad beans too. Maize though is still planted... It is easier to manage, you don’t need so many people to work; the land is prepared using the oxen, weeds are killed with chemicals, the earth is blanched and ready! Here people are also dedicated to farming inside green houses, crops like *babaco*, tomatoes and *tamarillo*. It is better because when ash falls you just need to clean the plastic covering the green house. We are looking for ways in which it is possible to work.

*Roberto from Pillate*

It is not that crops have changed since the reactivation, we just lose them when ash falls. Some crops are more delicate, for instance potatoes, peas and beans easily burn with the ash. During the first years after the 2006 eruption, maize would not grow properly either, it would not develop normally, and it would remain small. Once the soil mixed with the ash, maize started producing like before. It is only two years since it has been normal. You can see how ash is mixing with the soil and the production is going back to normal. Still it is a problem when ash falls, especially when the maize is small or the kernel is beginning to grow, it is as if it stops growing. Especially when white ash falls, which is the one that burns everything, the beans, even the maize, then we lose everything. Since the eruption began in 1999 we can’t plant potatoes, because if ash
falls on it when it is flowering or even later, we risk losing the entire crop. So we prefer not to plant that root until we know that the volcano is definitely going to stop.

Maria from Choglontus

As the quotes above show, although the local farmers are more acquainted and prepared to deal with ash fall—through the adoption of different crops or ways of cultivating and looking after their traditional crops such as maize or potatoes—agricultural activities in the area are not risk free. Ash, has in more than one occasion, partially or completely damaged crops. Additionally, market prices, opportunity and means also influence the choice made by farmers and the risk they are willing to take. This means that in some instances they might even plant ash-vulnerable crops like potatoes, given that if prices are high and ash does not fall, or falls in moderate quantities, they would be able to obtain a good yield. Sustained maize production in all areas around the volcano has also been influenced by a high demand of fresh maize in the market.

Overall, households interviewed in zones 1 to 3 consider they produce less than before 1999 (Figure 9). The most important change seems to have taken place in zone 3, which is where we have identified changes in the types of crops being cultivated as a result of exposure to volcanic ash. Here 82% of households that practice agriculture considered their agricultural output is less than before 1999. Similarly for zone 2, almost 60% of the interviewed households considered there had been a decrease in agricultural production since 1999. This change might be related to the move of most of these households to the resettlement sites, far from the slopes of the volcano where they have or used to have their land. The high percentage of households in zone 1 that practice agriculture and consider they have the same amount of production than before 1999 (43%) as well as those who consider that they produce more than before 1999 in zone 1 (9%), and zone 2 might be related to the following factors. First, there are many households who live in zone 1 or in the resettlement sites (zone 2) who are renting land from people who left the area to live in resettlement sites (zone 2) or elsewhere and conduct other activities. As a result, some households in zone 1 and 2 are cultivating more land than before 1999. Also, as noted earlier, there has been an increase in cultivation of fresh maize due to a high demand for this product in the markets, which has in turn made many households focus on this crop and increase their overall production.
Although, as the section above indicates, farmers have become more resilient to volcanic hazards - through knowledge about crops and cultivation acquired during the prolonged volcanic activity - their livelihoods are still vulnerable to volcanic ash. Uncertainty and risk are at the core of their livelihoods and define their everyday choices. Nonetheless, they argue that living in these areas, with great uncertainty over their livelihoods is better than moving elsewhere, places that are not their home, and where they are not able to do what they know, farming. Attachment to land and lack of opportunity will be further discussed later in the report.

Livestock and ash

Since the reactivation of the volcano in 1999, farmers in the slopes of Volcán Tungurahua have also had to deal with the effects of volcanic hazards on their livestock (Lane et al., 2003; Mothes et al., 2015; Sword-Daniels et al., 2011). Similarly to crops, the most damaging hazard to livestock has been ash. The main problem caused by ash is that the feed, mostly grass fields, is contaminated with ash. When the cows eat this grass, they are prone to getting ill, losing weight, producing less milk and even dying. The same applies to other animals such as sheep and guinea pigs that depend on grass as the main source of feed. During the strongest eruptions, for instance in 2006, animals have also died or have been severely injured after being caught in pyroclastic flows, surges and mudflows. These animals, mostly cattle, were feeding on the riverbeds on the course of the flows. The large chicken farms located in Cotaló, San Juan and Chacauco also experienced important losses during the eruption in August 2006 when pyroclastic flows covered one.
of the farms (50,000 chicken died) and the barn’s roofs of others collapsed due to the accumulation of heavy ash and tephra fall on top of them (Pinto, 2006; Sword-Daniels et al., 2011).

In a similar way to cultivated crops, as a result of their exposure to ash and other hazards over the years, farmers in the slopes of Tungurahua have acquired significant knowledge about the effects of ash on animals. The most common measure to stop animals from getting ill or even dying after an eruption is to prevent them from eating grass spoiled with ash. The main issue is that ash affects the animal’s teeth and intestines. As a result, and although time consuming, after moderate ash fall, most farmers would try to cut, clean and feed ash-free grass to their animals. Another common practice is to cut maize stalks, clean them and use these as feed. Additionally, immediately after there is an eruption, it is not uncommon for farmers to run to the fields and cut grass and store it indoors before the ash has fallen on the ground and contaminated the grass.

During emergency periods, when there is strong ash fall, the farmers also rely on animal feed obtained from the Ministry of Agriculture and the local government. The authorities have developed a system under which during and after a volcanic crisis all registered farmers receive animal feed such as green plantain and processed grains. This topic will be further discussed in the section on assistance of this report. However, despite the aid received, in many occasions when volcanic activity lasts for longer periods or is stronger, many of the local peasants have had to buy grass or feed to supplement their animals’ diet. Merchants in the closest towns and cities take advantage of this situation and charge very high prices for hay or grass bales. In the following passage, a family from Pondoa explains the difficulties of raising and keeping animals during periods of volcanic crises.

Juan
When ash falls, the work is to care for the animals by cleaning and sweeping the grass,

Monica
During those periods, we suffer a lot… sometimes we stop eating to be able to feed the animals.

Juan
Since they [animals] can’t eat much of the grass with ash, in some occasions we have to buy feed to supplement their diet

Monica
The cows are affected, the milk production is reduced, and they lose weight because they don’t have much to eat. We have to buy green plantain and feed.
Jorge
...So that the cows don’t stop eating, and they can somehow have a normal life

Juan
But they are anyway affected; I have even had to wash the grass for the cattle.

Monica
The work is constant, I spend most of my time with the animals, I don’t even have time for my own activities. In the morning I go look after the animals, go home to cook a small lunch and once again I have to clean and broom the grass to feed them. When we have other crops, such as grains, and roots we also give it to the cows.

In addition to the different measures taken by the farmers to care for their animals during periods of constant ash fall, when the eruptions have been stronger, animals have been evacuated to areas outside the high-risk zones. This was the case in 1999, 2006 and to a lesser extent in 2010 and 2014. Farmers take this as the last resort or measure, given than finding enough space and food for the animals is very difficult. In the following passage Carmen from Choglontus (zone 1) explains what happened to her animals when her family evacuated from their community to Penipe for more than a month after the 2006 eruption.

The cattle were mooing, the cows the calves all of them ‘screaming’...We could not feed them, or find a place for them. Here [in their fields] you just move them from one place to another, over there [Penipe] it was not possible. We used to give them very little food every day, some feed, and some plantain, but sometimes we did not get any. We had to go to the authorities every day, and ask if there was any feed for the animals, if not, we had to, little by little, go to the market and buy grass, but it was very expensive. With the ash it became scarce and it was expensive. How could we afford it? If we wanted to sell the animal, they would pay so little, like ‘dead chicken’. They would take advantage of us. The merchants would take advantage of the situation; they would look at the animal and say that it has already eaten ash and that it is worth less money. ‘If you like take it’... they would say.

Today, most farmers keep their cattle for shorter periods of time before they are sold. That means that even if they have already ingested ash, they would not lose weight or die from it before they are sold on. Additionally, as Carmen explains in the following quote, they try to have animals born and bred in the area, which are more resistant to ash.

The chicken born here from the hens that we have are able to stand the ash, but if you bring chickens from somewhere else, until they adapt, if they don’t die, they spend most of the time very ill. The guinea pigs, if they happen to eat a little ash they die. The cows resist a little better, but they lose a lot of weight. We have to constantly change the animals we have, because ash destroys their teeth, and after some time they are left with none. Ash is like sand paper and little by little it destroys the teeth. When they [animals] don’t have teeth, they lose weight and we need to sell the animal in the market.
The observations noted by the different farmers above were also reflected on the data gathered through the survey. For zones 1 and 2, it is possible to observe in the data a decrease in the importance of large animals such as cattle and horses between 1999 and today. Each household was asked to list the types of animals they had in order of importance to them. While in zone 1 (slopes of the volcano), respondents identifying large animals as their most important animal went from 41% in 1999 to 30% in 2014 (Figure 10), in zone 2 it went from 17% to 10% (Figure 11) It is also possible to see that between 1999 and 2014 there has been an increase in the importance of small animals for zone 1 (Figure 10). This coincides with the information gathered through the interviews where many local farmers mentioned that chicken are not only more resistant to ash than larger animals, but also cheaper, hence easier to recover, or buy them again.

![Most important type of livestock zone 1](image)

Looking closely at the data it is also possible to see that the most important change has taken place between 1999 and after the eruption of 2006. Just for zone 1, respondents identifying large animals as their most important animal went from 41% households before 1999 to 21% after 2006 (Figure 10). Although not as sharp as for zone 1, there was a similar change (decrease) between 1999 and 2006 for zone 2 from 17% to 10% (Figure 11). Moreover, despite the fact that farmers seem to have been able to recover in between after the eruption of 2006 and today, the importance of large animals has not reached pre-1999 levels for zones 1 or 2 (Figures 10 and 11).
Conversely, between 1999 and 2014 it is also possible to identify an increase of households without animals in zones 1, and 2. This trend is clearer for zone 2 where before 1999 only 2% of the households interviewed did not have animals to going up to 31% of households not having animals today. This coincides with the fact that many in zone 2 do not keep animals in their resettlement homes and have stopped farming or have sold their land in the slopes of the volcano (zone 1). Zone 3 seems to have been the least affected in the long run, where the importance of large animals has reached the pre-1999 level (Figure 12). Nonetheless it is possible to see that the eruption in 2006 affected farmers in zone 3 as well. Between 1999 and after 2006 there was a sharp decline in the importance of large animals; it went from 21% of households identifying large animals as their most important type of livestock before 1999 to 17% at the time when the survey was conducted in 2014. Similarly to zone 1, there has been a sharp increase of small animals in zone 3 (Figure 12).
Although it is possible to identify a series of measures that farmers have been taking during times of volcanic crisis to maintain their livestock, such as preventing them from eating grass with ash or selling them earlier than before, livestock is still vulnerable to ash and other volcanic hazards. Animals are not only more expensive than before 1999 but it takes a lot more effort and money to maintain them. This coincides with the survey, where 66%, 79% and 66% of households that own animals in zone 1, 2, and 3 respectively said that today they have fewer animals than in 1999.
Three factors were identified as being the most important reasons why farmers have less livestock than before 1999. All are related to the volcano. First, as mentioned in the next section of this report, during the evacuation in 1999 many farmers were forced to sell their animals, as they did not have a place to take them to. Outsiders and merchants took advantage of the situation and paid very low prices for them. In addition to that, and given the economic crisis that resulted in the dollarization of the economy of Ecuador, when people returned to their homes in the slopes of the volcano in early 2000 they were unable to buy animals again. They simply could not afford to get them and until today, many have not been able to replace the same number of animals as they had before 1999 or have not gotten any. The second factor mentioned by many farmers as the reason for having less animals today, is that in the context of constant ash fall, caring for the animals, especially for cows, sheep and guinea pigs is time consuming and expensive. Finally, the third factor mentioned by farmers is that land in the higher slopes of the volcano, in what is considered to be high risk zone (exposed to pyroclastic flows and ballistics), previously used to pasture cows and sheep. This has either been sold to the state (project to compensate and at the same time prevent local residents from entering high-risk zones) or simply not in use anymore. Having less animals means that today, local farmers, who have traditionally relied on selling livestock during times of need, have fewer assets to rely on in case of an emergency. Put in a different way, they are more vulnerable to shocks and abrupt changes to the household economy because they are not able to accumulate wealth, or animal assets as before 1999.

\[\text{Figure 13: Difference in amount of livestock 1999-2014}^5\]

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5 The percentage of households that answered “do not know” to the question: do you consider that you have less, more or equal amount of animals today than before 1999? Have not been included in this table. (1% of households in zone 1 and 3).
Evacuation and Agriculture

Farmers’ vulnerability to volcanic hazards has been exacerbated by the events and responses that ensue volcanic crisis. The clearest example in Tungurahua has been the mandatory evacuation in October 1999, which lasted three months for some, and up to a year or more, for others. Many of the farmers in Tungurahua and Chimborazo provinces experienced significant crop and livestock losses. Although some of the losses during that period could be directly linked to ash fall, most of it was lost in the period before and during the evacuation, when, in a state of panic, many of them sold their livestock at very low prices.

As the possibility of a major eruption grew and authorities began to consider mass evacuation from the area, merchants from different parts of the country, travelled to the slopes of Tungurahua during September and October 1999 to buy livestock and other property. Some farmers were able to secure places outside the declared risk zone for their animals, yet most had to sell or even give away their chickens, guinea pigs, cattle, sheep, pigs and horses. As mentioned earlier in the report, the already vulnerable situation of most people in the area was exacerbated by a severe political and economic crisis which ended with the ousting of the president Jamil Mahuad in January 2000 and the dollarization of the economy shortly after (Tobin & Whiteford, 2002a). Some of the farmers who had sold their animals before the evacuation in the former currency, sucres, were not able to afford a single cow when they returned as the livestock prices, now in dollars, had increased exponentially. This was also reflected in the survey where 76% of all households in zones 1 to 4 considered that the 1999 crisis had affected them.

They [livestock merchants] would come with megaphones in their trucks: ‘we buy cattle’ they would say, ‘we buy dogs, cats’… And our desperation, we did not know what do, they would come and come to buy. They would pay very little, and since we were in despair watching the cars coming, it was either selling or taking the animals elsewhere. We sold in sucres, and not long after, maybe a few months later, everything was in dollars. We could not afford anything

Maria from Choglontus

The merchants would take advantage of the situation, they would say that the animals were ill, that they had already eaten ash: ‘It already has ash, it is not worth the same price, it might die before slaughtering it’. And since the cows stopped eating the grass that had ash, there was not enough feed and they lost a lot of weight and so we were forced to sell…

Pedro from Puela
I left and sold my cows at 800, 600, 500 thousand sucres each. They were good cows with calves and producing milk. I used to live out of that before 1999. A few months later, when we started using dollars, the 10 million sucres that I went to exchange became 400 USD. With that money, I went to buy a cow but they would cost 800, 1000, 1200 USD each. That is when, how can I put it… I was left in the street. The volcano hit us on the one side and the dollarization on the other. I was left with nothing, we were left with nothing. We were finished…

Victor from Manzano

After the farmers returned to their properties at different points during the year 2000, some even later, they had to clean their land, and begin planting again. Some were able to return with a few animals while others had lost all. Still, many took the decision to return to their land. In the following passage Monica and Juan from Pondoa explain what happened to them during and after the 1999 evacuation.

Juan
We sold everything

Monica
And everything very cheap

Juan
That is when most of our lifetime work was finished, all of our sacrifices.

Monica
We were left with very little. Still we began again, we began to work. We are used to working, and since we have always had to start from having very little and we have managed, we began again…

It took many years before some of the farmers were able to recover; some have never done so. Local residents had to navigate the difficulties of living under constant threat, and learning how to endure volcanic hazards that threaten their life and livelihoods on a daily basis. After the return from the 1999 evacuation, the 2006 events proved to be very challenging for most residents in the area but despite the losses incurred during that eruption, many agree that there were fewer long-term effects than as a result of the 1999 eruption. Today, all of the experiences gained during the years give them a completely different perspective and stand vis à vis the uncertainty of volcanic hazards. Although they are aware of the danger they face by living near the volcano, most of the people interviewed for this research agreed that they are more prepared than in the past.

Conclusion

It is possible to say that so far, over the years, most farmers have learned to deal with volcanic hazards, particularly ash. Still, as argued in this report, it does not mean that households dependent on agriculture are not vulnerable to volcanic hazards or other shocks. What it means is that they are not as vulnerable as they were in 1999 when the volcano began its reactivation. As we will discuss later, less vulnerability or
more resilience to volcanic hazards in Tungurahua is linked to the farmers’ increased knowledge about ash and agriculture they have acquired over long-term exposure to hazards. In addition, monitoring capacities, communication and governance of volcanic risk, have improved dramatically since 1999 and are crucial to livelihoods based on agriculture in the slopes of Tungurahua. In the next section, we will discuss the changes to other livelihoods as a result of volcanic activity in the area. In addition to tourism, we will look at other commercial activities that have been severely affected by the volcano.

**Other livelihoods and volcanic activity**

While most of the livelihoods of people living on the slopes of Volcán Tungurahua are based on agricultural activities, many of the residents of the towns of Baños de Agua Santa and Penipe, of the resettlement sites (Rio Blanco, Penipe, Pusuca, Guano, La Paz) and other communities surrounding the volcano conduct a variety of activities that have also been affected by volcanic hazards since 1999. As a result of the reactivation of the volcano, many residents of the area have struggled to maintain their livelihoods, changed their activities or moved elsewhere to continue with them. This section will present an overview of two different groups of people who have been affected by Tungurahua: the residents of Baños de Agua Santa, where tourism is the main activity and, the residents of the communities surrounding the volcano who, as a result of volcanic activity, have had to adapt or change their livelihood activities. The last group includes people who have moved to the resettlement sites.

**Tourism**

In Baños, with a current urban population of approximately 20,000, many of the commercial activities and services are geared towards tourism (INEC, 2010). Foreign and national tourists visit Baños all year round where its natural surroundings and the hot springs located in town are the main attractions. In addition, thousands of Ecuadorian visitors arrive to this town every year to visit the image of the Virgin of Agua Santa. Hotels, restaurants, transport companies and tourism agencies, constitute the main economic activity in Baños. By 1999 Baños was already amongst the top 5 tourist destinations in Ecuador (Lane et al., 2003).

The reactivation of Volcán Tungurahua had a direct impact on the tourism industry in Baños (Lane et al., 2003). Although tourist began to visit the town after the evacuation and return of its residents in 2000, the number tourists did not reach the 1999 level resulting in a slow recovery for this sector. However as a restaurant owner in Baños explains below, after 2009, the volcano started becoming a tourist attraction.
Today Baños is once again one of the main destinations of foreign tourists visiting Ecuador. Although many visit Baños to see the volcano, most focus on adventure and outdoor sports such as kayaking, rafting, canyoning and hiking.

By the time of Carnival in 2000, we had a huge turnout of tourists. But since then each year the numbers have gone down and up, down and up, so it has been very unstable – primarily because of the volcano. This has not allowed people in the sector to accumulate wealth. But after 2009, the volcano became a tourist attraction in itself, which is helping the sector. In 2006 we had zero tourists here because of the eruptions and the effects of pyroclastic flows. This was magnified by the TV coverage and by weaknesses in the monitoring. Since 1999 many businesses have closed, but others have opened. The key issue is access to credit and terms of loans. Under President Correa, credit initiatives for the tourism sector – loans for long term with fixed rates - have improved.

According to a civil servant at the Baños Municipality, the fact that tourist have returned to visit their town is directly linked to more information about the volcano, improvements in risk management communication and target training to hotel and other tourism business’ owners on what to do to when there is an eruption. Similarly to the restaurant owner quoted above, she thinks that although tourism suffered after the 1999 evacuation of the area, the sector has recovered and today “the volcano has become a tourist attraction”.

Unlike Baños where tourism and other activities have been able to partially recover, residents of other areas surrounding the volcano who also depended on tourism have not been able to attract tourists as before 1999. For instance, before 1999, Pondoa, less than half an hour away from Baños, used to get many tourists every day. These people would use the village as a base for climbing to the summit of Volcán Tungurahua. After the reactivation of the volcano, climbing became illegal and this village lost the revenues they used to get from guiding tourists and selling products to them. Penipe Canton shares a similar experience. This includes the town of Penipe and the village of Puela and other areas where many weekend tourists mostly from Riobamba would visit. They used to take day trips to restaurants that served traditional Ecuadorian food such as guinea pig and roast chicken and had outdoor pools and football pitches. After the reactivation of the volcano, while all restaurants in Puela closed only a few remain in Penipe and the surrounding countryside. Although there are a few that have tried to reopen and cater for visitors from Riobamba, most of the restaurants that remain open, only cater for the local residents and the occasional outside visitor. In the following passage, Consuelo Bueno from Puela explains the type of business she had until 1999.
I used to work here [Puela]. I had my restaurant where many people used to come. Especially on Sundays, I used to prepare guinea pigs, hens, chickens. I used to sell between 80 and 100 guinea pigs, so much, so much... And that was just on Sundays, because on normal days I would get contracts from other places so I would prepare food for them. That was my livelihood, from that I educated my two daughters who are now professionals... This lasted until the volcano began, about 22 years I worked in the restaurant. It all finished when ash began to fall...

There are two main factors influencing the different effects in Baños and elsewhere. First, while in Baños, residents have been organising and fighting to maintain their daily activities in the town and the right to live there, people from other, smaller towns have not been able to successfully re-establish themselves in their communities. There are many reasons for this, but in general it is possible to say that organisations and citizen groups who were at the forefront of the ‘return’ to Baños have been very influential in negotiating with the authorities permits to conduct tourism activities in the area, and most of all, to be allowed to live in Baños (Tobin & Whiteford, 2002b). Despite its location on the medium risk or what is equivalent to the light pink zone on the hazard map developed by scientists and used by the authorities to authorise activities and infrastructure investments in the area, Baños’ residents were successful in negotiating their return to their homes and re-establish their activities after January 2000. Puela, which has the same hazard risk degree as Baños, did not experience the same. Although people are allowed to live in Puela, today there are only 7 permanent residents in the village. There are people who come on a daily basis to attend the school and to tend to their land but return to their homes in the resettlement sites in Penipe or elsewhere outside the risk zone areas. As a result of this situation, the provincial and the national governments have invested very little in the area. More on the topic of hazard maps and their effect on local communities’ livelihoods will be discussed later on the report.

Another important factor influencing the demise of tourism in the areas adjacent to the volcano in the Chimborazo Province is the role of the media in portraying the different areas and risks associated to the volcano. While residents in Baños, have fought against negative or what they call ‘damaging’ portrayals of Baños as dangerous, villages like Puela and Penipe, which are outside the high risk zones are continuously portrayed as ‘ghosts towns’ and unsafe places where their residents are defying danger (See: Jumbo, 2014; Pinto, 2006). This has had a direct effect on tourism and on the willingness to invest and visit these areas.
Other livelihoods

In addition to tourism, the volcano has also affected people who used to have small businesses and conduct commercial activities. For instance, many small shops and the transport cooperatives that operated in the area were directly affected by the evacuation in 1999 and took some time before they were re-established. Some of Baños’ residents have been able to go back to their activities, yet, similarly to tourism it has taken time and effort. In contrast to this, in the smaller communities many of the small services are gone. For example in Puela, which used to have many restaurants and shops, today there is only one small corner store where people can buy some provision (total village population 7, total parish population 662).

Mining is another interesting case in point. Small-scale mining companies that used to extract sand and stone close to Baños had to stop after the reactivation of the volcano. After a few months they were able to restart their activities, but were badly affected during the 2006 eruption when pyroclastic flows and lahars covered their installations and machinery in the Juive riverbank (Sword-Daniels et al., 2011). However, after some years and effort to purchase machinery, there are various legal mines operating in the area. It is possible to say that to a certain extent, some of them are benefiting from the volcanic hazards. Most of these mines are located in areas with material deposited by lahars and pyroclastic flows (Interview with local entrepreneur, Baños).

Conclusion

In a similar way to livelihoods based on agriculture, those based on tourism and other commercial activities have been severely affected by the reactivation of Volcán Tungurahua. Despite significant disruptions and losses incurred, many households who have remained in the area have been able to recover and continue with their activities. Some have changed activity others have adapted their crops or ways of working (tourism and mining) to the reality of living nearby a volcano. Still it is possible to say that although less vulnerable than immediately after the 1999 eruption and the subsequent evacuation out of the area, most households continue to be vulnerable to volcanic hazards and their effects on agriculture, tourism and other activities. This is clearly reflected when looking at the impacts of more recent eruptions, especially in 2006, when most households in the area have, in addition to being exposed to life-threatening hazards, also had to endure shocks to their livelihoods. Still, it is possible to argue that they were able to partially or fully recover and continue with their everyday activities faster than after the 1999 eruption. As argued later in this report, this might have to do with the difference between the time people spent outside
their homes in shelters and evacuation centres in 1999 and 2006. Also, by 2006 government assistance, communication and risk reduction mechanism had improved dramatically (Mothes et al., 2015; Ramón, 2009). In the following section of the report, we will look at how changes and disruption to resident patterns have had a direct effect on people’s livelihoods and ability to endure long-term exposure to volcanic hazards.

**Residence patterns**

Since the reactivation of Tungurahua in 1999, residence patterns and population numbers have dramatically changed in the areas surrounding the volcano. While some residents who lived in the area before 1999 have stayed in their homes, many have permanently relocated to areas outside the risk zones of the volcano including resettlement sites. Many others have migrated to other provinces and even outside Ecuador. In addition, there is an important group of people who reside in both their homes located inside what is considered as the risk zone and in resettlements or other private homes outside this area (See Figure 15: Mapa de Peligros IGEPN).

It is possible to say that the events with the most lasting effect on resident patterns and population numbers have been the evacuation of more than 25,000 people from the area in 1999, and the 2006 eruption and the subsequent evacuation and relocation of thousands of local residents (Lane et al., 2003; Tobin & Whiteford, 2002b; Vieira, 2003). After these two events many of those who evacuated did not return to their homes and instead migrated to other provinces and even to other countries, particularly Spain. Survey data shows that at least one household member in 22% and 24% of the households interviewed in zones 1 and 3 respectively, has migrated out of their homes. Out of those who migrated, mostly between 1999 and 2006, 57% in zone 1 and almost 45% in zone 3 went to other provinces. A significant percentage of those who migrated went abroad with 32% and 21% for zone 1 and 3 respectively. We should be cautious in concluding that these people migrated abroad only due to the impact of the volcanic eruption and evacuation. Between 1999 and 2006, many other Ecuadorians from other provinces also migrated abroad due to the economic crisis in the country.

It is important to note that these numbers do not account for entire families that relocated elsewhere and that have not been represented in the survey. However, if we look at the population in the town of Baños, which is believed to be the most successful in the process of recovering its population after the evacuation of 1999, it is possible to get a general idea of the effects of volcanic activity in resident patterns over the
years. While in 1999 Baños had a population of approximately 16,000 by 2003 only 10,000 had returned (Lane et al., 2003:5). However, by the time of the last population census carried in 2010, the population in Baños accounted for approximately 20,000 and had been able to surpass pre-1999 levels (INEC, 2010). Although there has been a recovery in the population, for those that did return, re-establishing their livelihoods and normal activities has been quite challenging. The effect of population changes was especially visible at the beginning of 2000 when residents were allowed to return to the town of Baños de Agua Santa and only a few thousand did it immediately after (Tobin & Whiteford, 2002b). Many, had to wait a year or more until their children finished the school year they had started elsewhere, or themselves completed work responsibilities acquired during the evacuation period (Vieira, 2003). Additionally, following the return from the evacuation, banks, shops and other services remained close until the end of 2000. This had a direct impact on those who had chosen to return and who struggled to maintain their livelihoods afloat.

Depopulation is most severe in the slopes of the volcano, where some of the communities have been partially or completely abandoned. People still live in most places but the activity and number of residents has decreased significantly. As noted earlier currently the town of Puela, which is the head of the Parish, has only 7 permanent residents. Choglontus, in the same Parish used to have 48 residents, today there are only two families living there, with between 6-8 people in total. Pondoa, which is close to Baños, used to have 46 families, today only 20 live there permanently. Similar trends are possible to see across the communities, where most people who permanently reside in the area are the elder. Many of those who have relocated have moved either to resettlement sites or elsewhere outside what is considered the high-risk zone. Yet, as the next section explains, there is an important number of people that reside part time in their homes in the rural areas and part time in homes in the resettlement sites or other locations.

**Resettlement sites**

In addition to those who decided not to return to their homes and migrate to areas outside the risk zone, there are hundreds of families that used to live in the slopes of Volcán Tungurahua who have relocated to official resettlements sites. As a result of the devastating effects of the 2006 eruption, between 2007 and 2014 the Ecuadorian state and some non-profit organisations have built a number or resettlement in Tungurahua and Chimborazo Provinces. In total there are more than 750 homes located across the different relocation sites. The move to the resettlement sites has not been free or problems. Although there are many families
who have successfully permanently moved to their new homes, many of those who accepted houses in these locations have struggled to find jobs in the nearby towns or even in agriculture but outside the risk zone areas. After 1999, only 17% of all the household members’ occupations changed for those who were interviewed in zone 2. More than 30% of those that changed occupation did it between 2009 and 2013, the years following relocation to the resettlements. This shows that although there have been changes, not many have changed their occupation after they moved to the resettlement sites. In practice, this means that many households have not been able to maintain a livelihood that is not dependent on their land in the slopes of the volcano.

As a result of this situation, many households have resolved to live in both their homes in the resettlement sites and their land closer to the volcano. Different household members move from one place to another on a regular basis or live separately, some in the resettlements (and other areas outside the risk zones) and some in their rural homes. Data from the survey shows that this practice is not uncommon. For the households interviewed in zone 1, almost 25% of the combined households’ members only spend part of the week or never sleep in their homes close to the volcano. Out of those who spend part time in the communities, 18% stay in Penipe, 22% in La Paz and 23% in Baños the rest of the week. In other words, most of them are part-time residents of the resettlement sites or the town of Baños. These numbers only show who moves from one area to the other, they do not reflect the number of people who travel on a daily basis from the resettlements to the communities.

Both in the Tungurahua and Chimborazo provinces, in addition to dual residence, commuting on a daily basis is also part of the livelihoods strategies of many households. Every morning buses, private cars and motorcycles travel from Penipe and Pusuca to communities like Palictahua, Pungal, Puela, Anaba, Manzano, and Choglontus, taking local farmers from their homes in the resettlements to their agricultural land. Something similar happens to people living in La Paz and Rio Blanco resettlements in Tungurahua province. They travel to work in Juive, Cusúa, Bilbao, Chacauco, Pondoa, and Runtún. For some families this has even become a way of expanding and diversifying their investment in agriculture. Many, in addition to working the land they owned or worked before 1999, have rented land in areas where local farmers have moved out, and are planting more crops, generally maize, to sell in the markets. However, commuting is not cheap and therefore many stay in their rural homes as they lack the money to travel on a daily basis.
There are people in my community that don’t even have a dollar for the bus ticket to go from Nabuso [Pusuca Resettlement] to the communities. It is difficult, because only for the bus tickets we must have 5 dollars a week, so that we can manage from Monday to Friday. Some don't have that kind of money and therefore decide to stay in their homes in the communities most of the time. With that money they are able to at least buy a pound of rice or other things to eat.

Gustavo from Pungal de Puela

Residing in two homes or commuting on a daily basis from the resettlements to the rural areas is not only explained by the difficulties people have in finding jobs. Many of those interviewed argued that living in the resettlement sites was not only more expensive but also difficult to get acquainted to. They argue that living in an urban setting is difficult for them, as they are used to being with their animals and having more space. In general, it is possible to say that it has been difficult for many of those who accepted the resettlement home to sustain a livelihood not based on agriculture. Almost 80% of the households interviewed in zone 1 have resettlement homes. As argued in the passages below, living permanently outside their homes in the communities either in resettlements or private homes elsewhere is not easy for most.

Here [in the communities] we live from the land, over there [resettlement/town] there is nothing to do, and you can’t even have an animal. Here we have pigs, over there you have to buy everything.

Silvio from Cusúa

The problem in my case is that my age does not allow me to find a job in the city. First, the problem is education and then the age. They do not give jobs to us the old people. You can even have a master’s degree, but still there are no jobs for old people. In any case, what am I supposed to do in Riobamba, or in Quito where my daughter lives and wanted me to go to? Here is so beautiful, just now it is not so pretty because we have had a lot of ash fall, but I normally keep it very nice, clean and organised. Here I live a healthy life, because I eat healthy food. I have my chickens, eggs from my hens, I have guinea pigs... we eat healthy food here in Puela.

Consuelo from Puela

For us it is possible to find work here [communities], over there [resettlements] it is not possible to work. Here we have land and everything else, we just have to continue working, even if there is so much sand [ash] because there is nowhere else to go for work.

Ana from Manzano

Not living permanently in the resettlement homes is particularly challenging for those living in resettlements built by the Ministry of Housing in Penipe, Guano, La Paz and Rio Blanco. One of the

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6 The figure is not higher given that people who live in Pondoa, Runtún, Palestina and Cahuaji Bajo, all considered zone 1 in the data analysis for this report do not have resettlement homes.
conditions of acquiring a house in these locations is for their owners to permanently live in their new homes. The purpose of this rule is to make sure that people move out of the risk zone areas. However, as discussed above, many households have not managed to transform their livelihoods in a way that would allow them to live in the resettlement sites permanently. Mandatory use of these homes has therefore become a controversial aspect of living in some of the resettlements. Delegates from the Ministry of Housing make unannounced visits to make sure that people are using their homes. During these visits they check the water and electricity meters and the general state of the home. Those who are found not to be using the houses as stipulated by the Ministry of Housing, risk losing them. Thus many families have decided to split, with some living in the resettlement and some living in their homes close to their agricultural land. This has a direct effect on family relations and especially on children and young adults who are more often than not growing up by themselves in the resettlement sites where they go to school. This is the case of Josefina Andrade from Chacauco who resides at the community while her son and daughter, 22 and 16 respectively live in La Paz resettlement.

Even if the volcano gives us a lot of work, and affects us a lot, our source of pride is the work we put into our land. How are we going to abandon this land, if it is what maintains us? Even if they make us go to the resettlement in La Paz, they pressure us, but we do not have the necessary economic resources to live there. Over there, there is nothing for us to do, even less to be able to maintain our children and send them to school. At least here with the little we manage to sell from our produce, we can provide education to our children. When we go to La Paz we bring food from here, we bring things to eat from here, because over there you have to buy everything. With the money we have we might manage at the resettlement one, two days, but not more. There are people who have gotten used to living in the resettlement. Even if they only earn money on a daily basis, but they have secure jobs. They are ready and adapted to live there. Us though, we do not have secure jobs, that is why we are bound to be here in our land.

Josefina from Chacauco

Still, many of those who do not use their resettlement homes on a permanent basis, argue that having these places makes them less vulnerable to volcanic crisis, as they are able to use them as their primary destination during evacuation. In many occasions, even before the authorities have called for an evacuation, people voluntarily evacuate their homes in the risk zones and move to the resettlements. When the volcano is in moderate to high activity, many chose to stay in these homes for weeks and even months, depending on how long the process lasts. In the context of difficulties and losses experienced during early evacuations, particularly that of 1999, not having a safe place to go to during heightened volcanic activity became a major factor influencing people’s willingness to evacuate. It is therefore possible to say that
although today there is a small number of people who still chose not to evacuate, the fact that many have homes in the resettlement sites does increase the chances of evacuation.

**Community cooperation**

One of the direct effects of changes in population numbers and resident patterns in Tungurahua has been on community cooperation. Traditionally in the Andes, most peasant and indigenous communities have relied on periodic communal work to maintain services and infrastructure locally (Colloredo-Mansfield, 2009). Through the *minga* or communal work party, most communities have built roads, water systems and even schools. *Mingas* are called by the community council or water users association (elected every year or every two years) to clean roads, maintain or repair the water system, clear paths etc. As a result of the reactivation of the volcano in 1999 and the subsequent changes in population numbers, many communities in the area today are not able to secure labour force for communal activities. Although many of the communities still have a council and water users association, its members are scattered in many locations. In addition to having difficulties notifying community members before a *minga*, many live far away and are not able to attend on a regular basis. This has a direct effect on the services, such as water but also on the community cohesion, which is directly tied to communal activities and work parties. As Maria from Choglontus explains below, people do attend but not all the time.

> Before we all used to go to the *mingas*, to meetings to the *mingas*, even for a little bit. Now, since the evacuation took place and many did not return, people do come to the community but to work in their own fields. So when there are *mingas*, they sometimes they attend, other times they don’t.

Although *mingas* are still conducted across the different communities, the ability to secure attendance has drastically diminished in some of the locations. In addition to the effect of residence patterns on community cooperation, various interviewees noted that increase state and other agency assistance as a result of the volcanic activity has also had a direct impact on community cooperation. According to them, people expect to get more aid from the state, rather than providing their own labour as it has traditionally been done in the area. This topic will be further discussed on the section on assistance.
Conclusion

Residence patterns are an important aspect of the livelihood transformation experienced by those in Tungurahua. There are different ways on understanding this process in terms of long-term vulnerability. First, it is clear that changes in resident patterns are one important factor influencing people’s ability to conduct their economic activities, and maintain basic living standards both at the resettlement sites and the communities on the slopes of the volcano. For instance, it is clear that many don’t have enough funds and struggle to travel from their home in the resettlements to their land in the slopes of the volcano. Another important effect of changes in resident patterns in Tungurahua is the fact that children who live in the resettlements are more vulnerable as many tend to live alone. Additionally, it is possible to say that even if, those who have chosen to live in the communities are still vulnerable to physical exposure to volcanic hazards, having a resettlement home does increase the chances of evacuation. Finally, as noted in the last part of this section, changes in resident patterns have affected the ability of communities to cooperate and participate in community led projects which might make them more dependent on outside aid, particularly from the state. At the core of all these issues lies the fact that physical vulnerability to volcanic hazards (risk to lives) cannot be separated from economic and social vulnerability to long-term exposure to volcanic activity (risk to livelihoods). By looking at other effects of volcanic activity in Tungurahua this report will further build on this argument.

Other impacts: Long term transformations of land and homes

In addition to the severe impact on resident patterns and livelihood activities, the reactivation of Volcán Tungurahua has had other significant long-term impacts on people’s ability to sustain their livelihoods. This section would look at some of these impacts, specifically it will examine changes in services and infrastructure, the implications of the declaration of the high-risk zone on livelihoods in Tungurahua, and health issues associated to volcanic activity. This report examines the loss of services from the perspective of people’s livelihoods. For more analysis on service withdrawal and infrastructure see the research of Work Package 4, Governance, of the STREVA project.
Services and Infrastructure

Parallel to population loss in most of the rural communities on the slopes of Tungurahua, service provision and infrastructure has been severely affected by volcanic activity. The most affected services have been schools and rural health posts, some of which disappeared immediately after the 1999 reactivation of the volcano and the mass evacuation of the local population. Houses, roads, drinking water systems, irrigation channels, community centres and electricity infrastructure have also been affected (Sword-Daniels et al., 2011).

While some schools temporarily closed after the 1999 evacuation, others never reopened. This was the case of the schools in Pondoa, Juive and Cusúa, which closed at the beginning of the school year in 1999 and never reopened. Many of the children going to these schools had temporarily relocated to Ambato and Patate, and for those that returned, Baños was the only option. As a result, today many families with school children who are from these communities do not live in Pondoa, Juive and Cusúa permanently. Still, there are a number of students that travel every day from Cusúa and Juive to the different schools in Baños de Agua Santa. There is a special bus service in the morning which children are able to use. A local bus company covers the route on a daily basis.

Other schools, which have closed more recently, are those in Chacauco Pachanillay and Pillate. While the school in Chacauco closed after the 2006 eruption, the other two have closed due to a combination of fewer students attending and a restructuring process of the entire education system in Ecuador. As part of a larger project to improve education in the country, the Ministry of Education is building or expanding schools in centralised locations. The idea is to provide better facilities and services to more children by centralising schools. These schools are called ‘Millennium Schools’ and have been equipped with improved technological systems and more teachers. This is the case of the school in Penipe, which serves the town of Penipe and its surrounding communities. A similar school is being proposed at El Altar, where the students from Pachanillay are already attending after their school closed last year and where students from the school in Puela would be potentially attending in the near future. Similarly children from Pillate are going to the school in Cotaló.

There are three key effects of school closure in the area. First, children that still live in the communities have to travel longer distances on a daily basis to attend school. This is the case of children living in Cusúa,
who have to travel for at least 30-45 minutes on a bus to get to school in Baños. Another important effect of school closure is the decrease in young population in the slopes of the volcano. Although it is possible to say that schools have closed due to lack of students, students have also left due to lack of schools. Pondoa is one interesting case, where in 2014 a baby was born in the community after almost 10 years. The final, and for many local residents, most important effect of school closure, is that when communities lose their schools they lose one of the main centres of activity and cohesion. Puela is an example of this. While there are only 7 permanent residents in this town and approximately 600 in the Parish, the school has 97 students who attend the local school and come from the surrounding areas (Choglontus, Manzano, Pungal, Anaba, Chontilla) and even from Penipe. However, due to the recent changes in the structure of the school system in Ecuador, the school in Puela might close and merge with a planned bigger one in El Altar, which would serve more communities. Residents and parents of children who go to the school in Puela are determined to fight this decision. For them, closure of the school in Puela would be the last blow to their ‘dying’ community, which has already suffered greatly from the volcanic reactivation.

The last thing is that they want to take the school to El Altar. We don’t want that, we are fighting, and hopefully my children are able to finish here. The school makes the village, it improves the village, but if it is gone, everything is finished, Puela will be buried. At least the school makes the Parish feel alive, but once it is finished, the entire Parish will be finished.

Irene from Anaba

Overall it is possible to say that schools have closed in many of the communities in Tungurahua as a result of the volcanic eruption in 1999, the mass evacuation and the long-term depopulation of the area. Additionally, the general re-structuring of the schooling system in Ecuador is influencing changes in the education establishments across the area. Withdrawal of schools is also linked to the declaration of risk zones adjacent to the volcano, where the state is not allowed to invest in infrastructure. This topic will be further discussed in the next section.

Health centres have also closed across the communities, for instance in Juive Grande, Pondoa and Cusúa the small health posts that existed before 1999 have all closed. Yet, a new hospital is being built in Baños, which would be able to serve all these communities. Although the health centre in Puela closed, they still have access to the Peasant Social Security Health Post in Manzano, where more than 1000 people from the area are registered. Here they are able to get general medical attention and dental care. In case of an emergency or more serious cases patients are transferred to the hospital in Riobamba. Various people who
were interviewed and use this service expressed satisfaction with it and hoped it will remain in their community as it is one of the few services that has not been withdrawn.

In terms of infrastructure, roads, water systems and electricity have all been affected by volcanic hazards in various degrees. Perhaps the most damage has been done to roads, particularly the road connecting Baños to Penipe, which has been impacted by lahars and pyroclastic flows on numerous occasions. This road passes by many of the rural communities on the slopes of the volcano and is vital for their communication and access to markets and other services (Juive Grande, Cusúa, Bilbao, Chacauco, Yuibug, Puela, Pungal, Anaba, Pachanillay). Although the local municipalities (Baños and Penipe) have made an effort to maintain the road open most of the time, the state has not invested in improving the road in many years. Instead a new road on the other side of the river Chambo, which is thought to be less exposed to volcanic hazards, is being built and will soon be finished. This road takes off from the main highway connecting Baños to Ambato, and passes by Cotaló, San Juan, Cahuaji Bajo and only crosses the river Chambo upstream from the Puela River, where the risk to volcanic hazards is thought to be significantly less. This road, which has a cost of more than 35 million dollars, is envisioned as a safer alternative to communicate Penipe and Baños. However, many of those who live between Juive and Cahuaji on the slopes of the volcano feel that the new road would not serve them and worsen their already precarious situation. Again, similarly to the schools, by law the state is not able to invest in areas considered of high risk, in this case high volcanic risk. The main road from Baños to Ambato has also been damaged by lahars and pyroclastic flows, mostly in the Pájaros area close to Baños at the Juive River. For more detail on infrastructure damage as a result of volcanic activity in Tungurahua see Sword- Daniels, Wardman et al. (2011).
Other infrastructure affected by the volcano includes drinking water systems, irrigation systems and houses. Most of these have been affected by ash and tephra fall, particularly during the 2006 eruptions. The most serious infrastructure damage to homes took place in 2006 when 46 families’ homes in Juive Grande were covered by pyroclastic flows. However, since the first eruptions in 1999 houses that have not been maintained after the stronger eruptions, or had weak roofs have collapsed as a result of the weight of accumulated ash and water on the structures. Today, people who live in the most affected areas, zones 1 and 3 prefer to build houses with cement roofs, which are more resistant to ash. Drinking water systems have also been affected by ash, lahars and pyroclastic flows. Although most systems depend on ground water, it is sourced from water springs and conducted in tubes to collecting tanks from where it is distributed to the different households. This prevents most of the contamination from ash. However, given that some of the water springs are located high up on the slopes of the volcano, in various occasions the pipes have been damaged by pyroclastic flows and lahars. The water systems of Pondoa and Runtún are particularly vulnerable.

Electricity has been the least affected, and today most people living in the slopes of the volcano and the towns around it have access to electricity. As a prevention measure, electricity has been suspended when the volcano has been in high activity. The service has been reconnected shortly after. Since the reactivation
of the volcano in 1999, and after people returned to their homes in the rural communities on the slopes of the volcano, electricity has been provided for free to all households given that the area is currently under emergency status.

Not all investment in infrastructure has been halted, in some cases, there has been significant improvements. For instance, the road from Baños to Puyo, which is an important communication route for people and markets in the area, has been repaved. This is one of the main roads from the Highlands to the Amazon basin in the country. The road to Pondoaa, has also been improved and now it does not pass by the Juive River which is one of the high risk zone areas as it is prone to pyroclastic flows and lahars. Similarly the road to Runtún has been repaved and its residents are benefitting from it as their tomato crops don’t get damaged during transport any more. As mentioned earlier, the school in Penipe and a larger hospital in Baños are also important improvements to the local infrastructure. Yet, it is important to note that all these improvements have been outside what is considered the high-risk zone or the red zones in the hazard map for Tungurahua. The next section looks at the implications of the declaration of a high-risk zone, on access to services, infrastructure and general livelihood activities in Tungurahua.

**Zona de Alto Riesgo**

One of the most important aspects of risk management in Tungurahua has been the delineation of the high-risk zone area. The national and local authorities in charge of managing risk to volcanic hazards in Tungurahua base their understanding of the high-risk zone (zona de alto riesgo) on the Volcanic Hazards Map for Tungurahua. These maps, produced by scientists at the Instituto Geofísico de la Escuela Politécnica Nacional are aimed as a tool for the local authorities and residents to reduce risk. Grounded on extensive field research and based on historical data of previous eruptions of different magnitude, these maps indicate the areas exposed to diverse volcanic hazards. Considering the magnitude of the eruption, the map divides the influence areas of the volcano into different zones, each with a specific colour depicting the potential risk. There are three volcanic hazards maps for Tungurahua, the first was published in 1988, the next in 2002 and the latest version in 2008. This section, will refer to the latest map in circulation, published in 2008 which includes the volcanic eruptions of 2006, the largest in magnitude of the current eruptive cycle and on which political decisions on the area are based on. This map was elaborated by the IGEPN (Samaniego et al., 2008).
The declaration of the high-risk zone has different implication for the various actors involved in the risk management in Tungurahua. For the authorities the high-risk zone is the area that needs more attention during the emergencies, and where people’s lives are more at risk. The areas included in the high-risk zone area have changed since 1999, when people from most communities in the influence zone of the volcano were forced to evacuate. Since then, and as a result of research conducted by scientists monitoring the volcano, a map published in 2008 is the main determinant for the different activities involving risk.
management in Tungurahua. For instance, evacuation orders, which nowadays are not mandatory orders but publicised as a prevention measure to be followed on a voluntary basis, are based on the hazard map. In recent years evacuation of the red zone areas has been suggested during most eruptions while the evacuation of areas in the pink zone of the map, such as Baños and Cotaló has only been suggested during stronger eruptions, particularly that of 2006.

Perhaps the most important effect of the establishment of the high risk zone has been a general effort towards trying to relocate the residents living in this area (zone 1 for this research) to other areas considered to be less dangerous (zone 2 or to the resettlements). The main steps taken towards this aim have been the projects to build resettlement sites and state led initiatives to buy land in the high-risk zones. Both initiatives are aimed at decreasing exposure to volcanic hazards by decreasing the population in the area. Another, equally important policy has been to decrease and possibly stop investment on infrastructure in such areas. The new road across River Chambo outside the high risk zone is a case in point. The closure of all the schools in zone 1 and of some of the health centres is also relevant in this respect.

For the local residents the declaration of the high-risk zone has important effects on their everyday lives and livelihoods, both positive and negative. One of the most influential aspects of the declaration of the high-risk zone has been the construction of resettlement sites where most local residents from zone 1, particularly the most economically disadvantaged, have been given homes. Through national policies geared towards disaster risk management, the Ministry of Housing and the Secretariat for Risk Management have intervened in Tungurahua and encouraged people to move to the resettlement homes.

As noted earlier, having a house outside the high risk zone area has in some respects been an important gain for most of these families, as they have been able to secure a safe place to live or, when required, a place to stay when they evacuate their homes in the communities closer to the volcano. Although most people interviewed for this research who got a resettlement home were satisfied with this measure, they agreed that having a house in the resettlements has not necessarily solved the problems of the local population. Securing livelihoods based on activities other than agriculture in these new locations has been particularly difficult and has forced many people to maintain their activities on the slopes of the volcano. It would be a mistake to say that people only stay close the volcano because they don’t have alternative opportunities elsewhere. There is also a significant element influencing people’s decisions regarding their
location of residence which is the difficulties involved in abandoning the land and homes or what could be described as attachment to land and to their ways of living.

A negative effect directly linked to the declaration of a high-risk zone has been the sharp decrease in services in the area, particularly access to education, health services and road infrastructure. Ecuadorian law does not permit the state to invest in areas of high risk to natural hazards. The construction of the resettlement sites is another factor influencing service withdrawal and a sharp decrease in investment in the slopes of the volcano. By providing secure housing in locations with access to most services, the state is in a way exonerated from continuing investment in the high-risk zone areas.

The authorities are telling us that this is a high risk zone area and that is why the government gave us the houses in Pelileo [La Paz Resettlement], and that they are not able to invest on anything here because we are in danger…

Esperanza from Cusúa

They say that they don’t have money and that the other parishes have a priority, because they do not fall under that law. They [other parishes] get the money because the state can invest there and here they can’t because it is a high risk zone.

Irene from Anaba

Yet, as argued before, securing livelihoods outside these areas has proven a difficult task for many households. As a result, people who chose to stay in the rural communities adjacent to the volcano, are in a disadvantaged position in respect to other citizens living in non-risk zone areas not far from these communities. Service withdrawal is also related to falling population numbers, which is directly linked, to prolonged hazard exposure and again to the declaration of a high-risk zone area. Several of the interviewees living in the high-risk zone argue that the government is not investing in the area aiming at forcing people to leave. In the following passage Silvio from Cusúa explains this point:

“Look, the government wants this area to be clear of people, they want everyone to leave and make this into a national park. But this area is very expensive, the land here is valuable. The houses in the resettlements are not very expensive, maybe 11,000 dollars each. They say they don’t have money to invest here, they are tricking us, and they are forcing us to leave.”

This statement, which needs to be read carefully, is not only showing that people are affected and frustrated by the situation, but also that there is confusion and misinformation relating to state programs to relocate residents and other plans such the creation a national park. In other words, there is little
information dissemination in relation to the legal aspects and impacts behind the declaration of high risk zones, land exchange programmes and the establishment of a natural park in the area.

In addition to withdrawal of services, the declaration of the high-risk zone has had a negative impact on land value. A decrease in land value means that if someone with land in the area is willing to sell their land, and are able to find someone to buy it, they would only get very little money in return. This in turn affects people’s ability to secure loans and credit from private and public sources of finance.

[The high risk zone declaration] affects us because our land has lost value, we are not eligible for loans, or to get a mortgage and buy a car or a house elsewhere. They [banks] know that the volcano has affected this land so they do not have faith on it, and say that it can be covered and they would lose the money of the loans... If I sell some 30 hectares that I have, I would get something like 40.000 dollars but with that I can only get two ‘cuadras’ (less than a hectare). That is the problem, and everyone here is aware of that, they don’t want to sell.

Antonio from Pungal de Puela

Despite the fact that state has put into place a series of programmes to buy land or exchange land in the slopes of the volcano with land in areas considered of low risk, local residents feel the declaration of the high-risk zone is affecting their ability to trade their land or secure credit. Moreover, those who own land in the high risk zone are saying that the programmes are valuing their land too low, land which before the 1999 eruption was worth a lot more as it is considered to be very productive. In practice, it means that in order to buy land elsewhere, in addition to the money they would potentially get from the state, residents would have to get a loan. A number of those interviewed also reported that buying land elsewhere is very difficult given a sharp increase in land prices in recent years, particularly in areas not far from their homes but not considered of high risk.

Despite the negative implication of the high-risk zone, it is important to note that the state still invests a lot of money on assistance to those who live in the high-risk zone area, particularly during emergencies. More on this topic will be further discussed on the section on assistance. For now, it is important to note that for the state, the fact that people still conduct a range of activities in what they consider to be the high risk zone, translates into regular large investments, nowadays, every two or three months when the volcano is active. Continuous emergency assistance might be difficult to sustain in the long term. In this light, the relocation of most people out of the high-risk zone takes on a higher priority for the state.
Given all the implications related to the high risk zone areas and the hazard map of Tungurahua, it is important to highlight the politics involved in the negotiations and applications of the hazard map. Credit, land value and access to services in the area are all tied to where people live in relation to the volcano. It seems that rather than lines on a map it is political decisions that determine these issues.

The application of rules and directives about the high-risk zone is not the same across the entire area. If we look at the case of Baños and Puela, both lie on the same colour or degree of risk according to the hazard map, pink. For instance while residents of Baños are getting all the services, including a new hospital, various schools etc., Puela is struggling to maintain their school and their rural heath post. It is true that there are very few residents living in the area, 600 approximate, yet the fact that they don’t receive state investment, also affects population numbers. Land in Baños canton is still quite valuable, while land in Manzano and Puela in the Penipe canton and in the same colour area on the hazard map is not. There are many factors influencing this difference, apart from the higher demand for land in Baños, the most important one is the degree of citizen organisation and political influence that has taken place in Baños. Local residents and authorities have been heavily involved in the recovery of their community and have struggled to get access to resources from the government. Puela, which unlike Baños that is the head of the canton, is only a parish and their political weight in the larger Chimborazo province is not as significant as that of Baños in Tungurahua. It is possible to say that residents and authorities of Baños have managed to attract investment and maintain their livelihoods in their town while those in Puela are struggling to maintain the school and the few residents that permanently remain there. Historical and current political decisions, rural and urban differences and the different decisions taken by local politicians, the Ministry of Housing and the Secretariat of Risk Management also influence this distinction.

By highlighting the politics and negotiations involved in the use of the hazard map in Tungurahua, this report is not trying to diminish or discredit the value and significance of the map, but rather, to bring into the discussion the different uses and socio-political implications that underline using a map as a tool for disaster risk reduction. It is true that the map has an important value and that currently it is the best tool authorities and local residents alike can consult and use when trying to manage risk. Yet it is necessary to highlight on the one hand, the political negotiations implicit in the use of such a tool, and at the same time the direct effect, both positive and negative, that a hazard map can have on the local population, their assets and livelihoods.
**Health impacts**

Health problems are one of the effects of long-term exposure to ash and other volcanic hazards in Tungurahua. Although health specialists have not conducted any specific long-term research on this topic, WP3 data collected at the household level indicates that residents in the influence zone of the volcano (zones 1-4) believe their health has been affected by volcanic hazards, particularly by ash. 40% of the households interviewed for the survey, stated that their health has been severely affected by ash, 20% that it has been moderately affected and 30% affected at some point by ash (See Figure 16). This supports the information gathered through the semi-structured interviews where various respondents noted that the most common effect of ash on their health has been on an increase in respiratory illnesses.

![Ash impact on health](image)

*Figure 16: Ash impact on health*

Additionally several interviewees noted that stress levels during emergencies and evacuation have also been very high which also coincides with previous studies conducted in the area by other researches (Tobin & Whiteford, 2002a). Three of those interviewed reported that stress during the 1999 evacuation has caused them hearing problems. According to them, their doctors have confirmed this. The next section will look at other impacts that people in Tungurahua have had to cope with on a regular basis.
Other impacts

In addition to the challenges posed by the volcanic activity, residents of the slopes of the volcano have had to cope with impacts generated by variations in climate patterns, economic and political changes in the country. Data gathered for the survey shows that the most frequent events affecting households in the area have been an increase in food and product prices, an increase in the prices for agricultural input products, the decrease in market crop prices, and the 1999 economic crisis that hit Ecuador the same year the volcano reactivated. Almost 76% of all the households interviewed in zones 1-4 were affected by the 1999 crisis, and the majority or more than 88% have been affected by an increase in food and basic product prices (Figure 17). An increase in agricultural input prices as well as a decrease in crop prices has also been felt by most households particularly those in zones 1, and 3 which depend on agriculture for their livelihoods. More than 63% of households reported having been negatively impacted by an increase in agricultural input products. A similar number of interviewed households reported having been affected by a decrease in crop prices. A high percentage of households also reported having been impacted by severe weather, such as drought, excessive rain or pests.

Figure 17: Other shocks zones 1-4

These numbers are significant because they show that in addition to the impact of volcanic activity, most households in the area are also economically vulnerable. As noted earlier the majority of respondents across all zones, noted that they have been impacted by an increase in food prices. Another significant find is that most households, but specially those located on zones 1 and 3, the area most affected by volcanic
hazards, seem to be vulnerable to changes to prices in agricultural produce and inputs, on which they
depend as a main source of income, but also to extreme weather conditions affecting their farming and
cultivation activities. When asked about how they cope with these shocks, most households responded that
they continue working and try to save money and spend less. The next section discusses some of the ways
in which residents of the influence zone of Volcán Tungurahua are coping with long-term volcanic activity.

**Coping with Volcanic Hazards over time**

The previous sections have looked at the impacts of volcanic hazards on people’s livelihoods, services and
infrastructure, this section will explore some of the ways in which local residents are coping with long-term
exposure to volcanic hazards and other impacts associated with it. It will explore how, given the permanent
exposure to volcanic hazards and the political, social and economic transformations associated with them,
people living close to Volcán Tungurahua are able to maintain their livelihoods strategies in the long term.
In this light, this section will look at assistance and the role it plays in relation to the coping mechanism
developed by local residents. Additionally, it will look at experience and knowledge as a critical factor in
understanding vulnerability and resilience in Tungurahua. This includes the development of emergency
risk communication strategies, preparedness and training, evacuation patterns and the *vigía* system.

**Assistance**

State and non-state assistance has been available to the local residents since the reactivation of the volcano
in 1999, particularly during the volcanic crises. The type, quality and quantity of this assistance have been
changing over the years and play an important role in the everyday lives of people in the slopes of the
volcano. Most of the assistance, state and non-state, has often been focused to emergency periods, or when
the volcano is in high activity. This type of assistance can be divided into assistance during emergencies
that have required evacuation and those when people have been able to a large extent continue with their
normal activities in their homes close to the volcano.

**Assistance during 1999 and 2006**

The largest emergency situations, which required aid and assistance at a large scale, were the 1999 and 2006
eruptions. During both this events, shelters, food and all types of emergency relief services were put into
place. Although there were shelters and food distributed, most of the people interviewed agreed that
during the 1999 evacuation, organisation and access to resources was not very well planned. The effects of the 1999 evacuation have been discussed in detail by Tobin and Whiteford (2002a) and Lane, Tobin et al. (2003). For the purposes of this report, it is important to mention that while many people did receive assistance and access to shelters, many others who had to evacuate did not even have access to shelters and some were left in the streets of Patate, Ambato and Riobamba to see for themselves. This was reflected on the data gather for the survey, where approximately half or 54% and 53% of all respondents reported having received aid during or after the 1999 and 2006 eruptions respectively while the other half did not.

![Figure 18: Aid received during and after eruptions in 1999 and 2006](image)

In addition to state aid in the form of food and shelter during the 1999 and 2006 events, many people have received help from private institutions and citizens of Ecuador and other countries that sent aid to Tungurahua. The distribution of all aid, state, non-state, national and international has not always been the same across the different locations and has been subject to criticism and accusations of corruption and mismanagement. Nonetheless, many agree that even if not always sufficient, the emergency food and basic provisions has been helpful. Data from the survey shows that out of those that reported having received aid 68% for 1999 and 65% for 2006 considered that the support was adequate. This coincides with the testimony given by Victoria from Manzano below.

Yes we have received aid from the beginning; we have gotten little here, little there, from private people, from the government or the municipality. We have received from everywhere. We have been benefited. Although some [authorities] have mismanaged the aid, we have not starved. We have received help.

7 The remaining percentage of households interviewed answered ‘did not know’.
Additional emergency aid

Although emergency aid and provision for shelter has been particularly important during the evacuations of 1999 and 2006, the state has also provided assistance to the local residents during other emergency situations. Most significantly, by providing food supplies, animal food and assistance to evacuate. This section will present a general description of the role of state assistance in helping local residents cope and recover from long-term exposure to volcanic hazards. Although housing in the resettlements is a key element in this respect, this section will focus on emergency assistance, given that resettlement has already been discussed in detail in an earlier section. In short, this section aims at exploring the role of aid in sustaining livelihoods in the slopes of the volcano.

Depending on the alert level the state provides different types of support to the residents of the area (See WP4 for detail). Most of the assistance is provided when the alert levels are orange and red. When the orange alert is on, which can last for several months at a time, military personnel stationed in different military bases in Tungurahua and Chimborazo provinces mobilize to the communities on the high risk zone to provide transport and general support for evacuation.

Figure 19: Military vehicles stationed in Penipe, during orange alert in March 2014 (Maria Teresa Armijos, 2014).
During the day, military vehicles are on permanent watch at key locations in the different communities. The idea is that if there is a strong eruption, they would be able to evacuate people immediately. For security reasons, the military personnel are not allowed to spend the nights at the communities so they travel on a daily basis from Penipe and Pelileo to the slopes of the volcano. In order to encourage residents of these communities to spend the nights at the resettlements, when there is orange alert, the military might even provide transport for people to go back and forth from the resettlement sites in Penipe and La Paz to the communities on the high-risk zone areas. They leave the resettlements around 6 in the morning and return at 5-6 in the afternoon. According to some of the people interviewed in these areas, having that free transport is beneficial as it allows them sleep at the resettlement sites every night during periods of heightened volcanic activity.

Most of us leave when the volcano is very strong, because we have that support when it is like that. There are the military and the police too. […] they take us every day. In the afternoons around 5 or 6 in the afternoon we go to the resettlements and at 6 in the morning they bring us back. 

Josefina from Chacaucó

In recent years people are not asking about the volcano, if it is a clear day and they can see the volcano, they themselves see that it is a bit dangerous and leave this place. Also there is help from the fire fighters and the police who help people evacuate.

Javier from Juive Grande

In addition to evacuation support, the other single most common source of regular assistance for the residents of the most affected areas in the influence zone of Tungurahua has been the provision of animal feed after severe ash falls, mostly for cattle and sometimes for smaller animals such as chicken and guinea pigs. In coordination with the local authorities and the Secretariat of Risk Management, the Ministry of Agriculture distributes green banana and animal feed to households that have registered their animals with the Ministry at the local Parish office. This aid is only received after ash has fallen and only in areas determined to be most affected. This is a contentious point, as it is up to the provincial and local authorities in coordination with the Secretaría de Gestión de Riesgos to determine which communities have been most affected and thus who will get the aid.

Although the decision to distribute aid is based on a number of factors, availability, assessment of the damage, local authority intervention, it is possible to say that the high risk zone as stipulated on the hazards map for Tungurahua does influence the decision on where the aid is actually distributed. For
instance, communities that are not located on the high-risk zone, such as Santa Fe de Galán or Pachanillay, which also get important amounts of ash on a regular basis, do not necessarily receive aid every time there is an eruption. This was reflected by the survey data, which shows that while 74% of households interviewed in zone 1 reported receiving aid in 2006 only 59% in zone 3 where these communities are located reported it. The difference was larger for zone 4 where only 24% reported receiving aid during or after the 2006 eruption.

In addition to determining where the aid is to be distributed, there are a lot of problems and conflicts generated around the amount of aid that people get and who is entitled to receive it. For example, eligibility to receive animal fodder is mostly tied to residence and actually owning cattle registered at the local Parish office. This is very contentious because while households that live in both the resettlements and the rural communities receive the aid on a regular basis, those who moved to the resettlements and permanently live there don’t. This causes tensions between families and neighbours of the resettlements and elsewhere, particularly amongst those who do not receive the aid because they do not use or have land in the rural areas and those who do.

Quantity of animal feed is also an issue given that different households have different quantities and types of animals. While some argue that those with many animals are in a position to buy emergency food for themselves, others say that the aid should be the same for all regardless of the number of animals they own. At the end, most people receive the same amount of aid, regardless of the quantity of animals they have. This means that animal fodder makes a bigger impact on those who have less animals. The animal feed distributed during emergencies is mostly for cattle and possibly pigs, smaller animals like chickens and guinea pigs cannot be fed with the same foodstuffs. At the end those who have few cattle and pigs benefit the most from this type of emergency assistance.

The Ministry of Agriculture through other institutions used to support us, they would send trucks full of plantain, but little by little it seems they have gotten tired, or that that budget has finished. They said they would not give us anything else, but they are still giving us things. After all, it has been 14 years, and any institution would get tired, don’t you think? And even when they do support us, let’s say I have 10 cows, they give you a sack of feed. How am I going to sustain my 10 cows? With one sack of plantain, what am I going to do? Is it really that they don’t have more money or they are not interested in supporting us? Imagine, with a 22 litter bucket of molasses, which one can go and buy it for 8 dollars in Riobamba, they give it to us for sharing between three farmers. For three farmers to divide it between them, that is not support any more…

Antonio from Pungal de Puela
They give animal food to everyone on the list. If they are going to give two buckets of plantain, everyone gets the same, regardless if they have less or if they have more animals. For instance I have 10 cows, and two buckets are not enough for a week. If a person has one bull, perhaps feeding it, little by little, I suppose they would benefit, but when one has more animals, it is not enough.

Irene from Anaba

Aid distribution is very complicated because there are people who for instance have 20 cows and another person has two. Why should the one that has more cows get more, if in theory he/she is wealthy? That is when problems arise. Help however does not come specifically for the one that has 20 or the one that has 2 cows. So for instance if there is 100 sacks of animal food that need to be distributed between four communities, how is it distributed? The one that has 2 and the one that has 20 cows get the same. So the one that has 20 says what do I do with one sack of food? And the one that has 2 is able to feed his/her animals for 3 or 4 days.

Mercedes From Cotaló

Several people interviewed mentioned that given that the investment made by the state on aid is very high, particularly on animal fodder distributed most times there is an eruption that affects crops and pastures, the state might not be able to sustain this level of support for a very long time. Additionally, some recognised that although the state makes an important effort to distribute aid during periods of volcanic emergencies, aid is not always used in the best way. As the people quoted below maintain, in various occasions aid has not reached those in most need and sometimes those who have received it have not used it. Finally, several interviewees noted that residents in the rural communities around the volcano have become dependent on this aid, and expect it every time there is an eruption. These issues around aid have a direct effect on community relations and on the ability of the community to participate in group activities or work parties such as mingas. In the following passages residents of different communities explain these ideas in detail.

That is what I say, that we can’t wait anymore, we should also realise that the government can also get tired of looking for resources for this, for that, because not everyone knows how to properly use the support we get. Many persons that received the animal fodder, threw it on the fields like manure, they don’t use it. In other worlds, it is a bad investment. We should make sure that the animals learn to eat this type of food, the silage, the plantain, at least give it to the pigs.

Javier from Juive Grande

Before people used to participate in the mingas and meetings, the volcano has thought us to be divided, and most of all materialist, it is because of all the help we have gotten and now we want more and more…

Ana from Manzano

People have gotten used to the support. Is as if they constantly have their hand open, waiting to get charity, as if they were disabled. I am saying this because when we call people to come and participate in the...
Another source of conflict in terms of aid is the actual list of residents of each community. Some of the interviewees mentioned that there are more people on the lists of community members than people actually living in these places. This has a particular bearing on who is to benefit from homes in the resettlement sites, and aid such as food and other basic products that also arrive to the affected areas.

There is a lot of fighting, it is very complicated, aid is a social problem. For instance here [Cotaló] except for the centre of the parish, all the other communities are ‘cabildos’ [organised communities] and each has a list of residents who have to pay a monthly fee and contribute to the cabildo. When in the past there used to be more aid and food, even people who were not part of the community would ask to be included in the list. But when the food rations stopped, people began to leave the ‘cabildos’. For instance there is a community where there were something like 100 residents included in the list, and after a few years when the aid was reduced 50 left. Yet when ash fell and there was aid, all 100 came to ask for the help. Those who had stayed and contributed to the community council and organization said: ‘What did they contribute with, why should they get aid? When did they contribute with the fees or attend a minga?’ It is a complex issue, especially during emergencies when it is not possible to exclude people.

Mercedes from Cotaló

Long term projects

It is important to note that most of the aid described here has been provided during periods of emergency and that only a few projects have targeted preparedness and long-term coping mechanisms. There are a few initiatives to support farmers storing animal fodder during periods of volcanic quiescence so that they are prepared to face the consequences of ash emissions. Yet in the three places were these initiatives were identified, Juive Grande, Manzano and Santa Fe de Galán, residents are struggling to maintain the machines they received from the Ministry of Agriculture. This machinery is used to make grass bales with the purpose of having animal food during emergency periods. Other small-scale initiatives to support local agriculture have been reported, such as a recent project in some of the communities in Chimborazo, through which farmers received organic fertilizer and seeds. Yet these are small and focused initiatives that are not reaching everyone. Similarly to other aspects of disaster risk reduction, aid in Tungurahua has focused on saving and protecting lives rather than sustaining livelihoods in the long-term. Despite the fact that aid is helping people cope with the immediate effects of volcanic eruptions, it is not necessarily...
contributing towards resilient livelihood strategies. By mostly focusing on assistance during emergencies people’s life’s and livelihoods remain vulnerable to long-term exposure to volcanic hazards. Consuelo from Puela explains this in the following passage

There has not been any support from the state to reactivate this town. The truth is that we are living with the ash, with some support we would have gotten used to living with ash, but with jobs and learning to look after ourselves under this conditions. But we did not get any type of support, on the contrary, the politicians have behaved terribly. What they did is take away the people from this village, take them to another place and give them small houses for them to live in. What are they doing there? They don’t have anything to do, they don’t even have space for their animals.

Although this statement needs to be carefully read, as the resettlement homes have actually benefited people, it is interesting in the sense that it highlights the difficulties people have encountered in sustaining their livelihoods outside the rural areas and the lack of long-term projects and support for the communities on the slopes of the volcano. Arguably the state should not encourage people to live in areas of high volcanic risk, yet this specific case is referring to Puela, a town that according to the hazard map is on the same zone as Baños. The point here is not simply to challenge or criticise the support and aid people have received over the years, but to examine the effects and implications of that support on people’s livelihoods in the long term.

It is possible to say that aid has been focused on emergency periods and that although subject to different degrees, it has served as a support for people to cope with short-term effects of volcanic eruptions. Although significant, this support has not always been enough, and as noted by some of the local residents, it has had negative effects on community cooperation and perhaps created dependency on short-term aid from the government (with possible development of clientelism and coercive electoral support). Furthermore, few projects with the aim of encouraging people to develop coping mechanisms to long-term effects of volcanic hazards, particularly exposure to ash, have been applied. This has had a direct impact on local residents’ ability to become resilient or less vulnerable to volcanic hazards overtime. The next section briefly summarises some of the knowledge transformation processes, policies for disaster risk reduction and communication strategies employed in Tungurahua which have become fundamental to sustaining livelihoods in the slopes of the volcano.
Experience, knowledge transformation and disaster risk reduction in Tungurahua

The last section of this report will be looking at how people cope with volcanic hazards in the long term. In order to do that, it will briefly explore how acquired experience and knowledge about the volcano as well as different risk communication strategies influence people’s ability to cope with long-term exposure to volcanic hazards.

One of the most important characteristics of the Tungurahua case study for the STREVA project is its long-term duration. In terms of WP3 work, long term exposure to volcanic hazards in Tungurahua has allowed us to look at how and what it is that people learn across time that allows them to cope (or not) with living near an active volcano. In addition to the particular knowledge about ash impact on crops and animals discussed earlier in this report, it is important to mention the knowledge and understanding people have acquired about the volcano’s behaviour, its activity and potential for larger eruptions since its reactivation in 1999. Before 1999 residents in the influence zone of Tungurahua had little knowledge and, apart from a few elder members of the communities, no experience of volcanic eruptions and hazard impacts. However since the reactivation of the volcano, as people have experienced different magnitude explosions and types of hazards, they have acquired an important set of knowledge that allows them better understand the volcano and most importantly to know what to do in case of an eruption. Most people are aware of the different hazards and its potential consequences, ash, pyroclastic flows, surges, gases etc. Some of those interviewed have a clear understanding of the volcano’s behaviour and are aware of the fact that it is a volcano with explosive behaviour that is capable of producing larger more dangerous eruptions something that is not possible to predict. Put in a different way, they are aware that the volcano can produce a larger eruption than what they have experienced until now. Experience as explained by Victor is something that gives them an advantage; today they understand more about the volcano and are able to decide when to stay and when not to stay in the area.

It is true that the volcano has affected us enormously. The worst effects were in 1999 because we did not know anything, we did not have authorities or a government, or a governor or a mayor, who knew about the volcano, we did not have information about the volcano. Only after the eruption the government has put effort into this issues of volcanology, seismology. This is recent. [...] Before we did not know, nobody knew about volcanic processes like this one. We are lucky that we can live with this volcano, because it is a strombolian eruption, if it were a plinian, 8 days one month and that would be it, how many decided to stay, how many are going to return? This volcano does not throw everything at once it gives us time. If it was a plinian there would be two three days of eruption and it would be over, everything would be
finished. That is why we have an advantage here; where we have been able to live with the volcano for more than 14 years, just imagine that, 14 years!

Victor from Manzano

However, with the knowledge they have about the volcano, they feel they are able to better cope with less magnitude eruptions and continue with their livelihoods by adjusting and adapting some of their activities (what to plant, what animals and how long to keep them, when and when not to sleep in their homes at the communities, when to evacuate). In short, experience and knowledge is an important element of people’s ability to cope with long-term exposure to volcanic activity.

It is true that we are affected by the volcano, but we are not going to leave. What we do is to make decisions, to understand the volcano. It does throw ash and that affects us, but we have to get used to it, where are we going to go if not? There is ash all over the province, it is true it is less dangerous elsewhere, but still there is ash everywhere. That is why we say that instead of being somewhere else we might as well be here.

Gustavo from Pungal de Puela

We are already used to it. What we do is try to protect ourselves from the ash, but the volcano noises they do not affect us anymore, we do not take them into consideration. It is ash that we are worried about, especially when it falls on our crops, then we have to make sure that there is enough food for the animals, because they don’t eat that grass anymore.

Pedro from Puela

During the past 14 years, knowledge about the volcano has been acquired through personal exposure and different experiences of hazards but also through extensive training and information received from authorities and scientists at different points in time (Mothes et al., 2015). As noted in the following passages, the importance of this knowledge is fundamental for those living in the slopes of the volcano. It has a practical but also symbolic value for the local residents, it is theirs as much as it is the authorities’ and the scientists. This is not to say that people are not respectful of the scientific recommendations, on the contrary they are always seeking to know more about it. What is important to highlight here is that the fact that they know more about the volcano’s behaviour means being able to take a decision for themselves, this is particularly significant in the context of the 1999 evacuation and difficulties experienced as a result of it, when they did not know anything about the volcano and, as a result of this, became very vulnerable and scared.
When the volcano is about to erupt it behaves differently. The movement on the roof of my house is different, it is not like when it is only rumbling and it does not make any movements. But when it is about to explode it shakes in a different way. This is why we are so confident, because we know what it is going to do.

Esperanza from Cusua

People believe different things. For instance when the volcano is quiet and it does not emit any ash, we are good everything is good. But then the cicadas begin to arrive, they come in flocks, and after a little time, the volcano starts again to throw ash.

Carmen from Choglontus

People living on the slopes of Tungurahua, use this knowledge to make decisions about their lives and activities. They decide when and why they stay in the high risk zone and make decisions relating to what to do with their animals and crops. Depending on the activity of the volcano, they might or might not spend the night at their homes in the rural areas. Most of the people interviewed noted that when they feel the volcano is behaving out of the ordinary (more tremors, different types of tremors, more explosions, larger ash plumes) they would not spend the night at the community and if necessary immediately prepare to evacuate the area. This means putting their animals in safe locations and leaving the area.

We are calm here, but when we see that the volcano starts rumbling harder, we leave voluntarily, by ourselves.

Josefina from Chacauco

Yes we are used to it, and have the experience. Now everyone knows and if they see anything unusual they leave. People leave before they are told to do so […]. When people feel something, you would see the buses in the afternoons full of people going to sleep in Penipe. When they feel something is going to happen they also put their animals closer to their home in safer areas.

Carmen from Choglontus

When the Geofisico [Observatory] tells us that we should leave, we go to sleep in Penipe, otherwise we stay here most of the time. Even when the volcano is uncovered and we can see how it throws fire, we stay here, we are used to it. Sometimes when it stops doing it, and when it stops rumbling and making noises, we miss it. Then again, it starts throwing ash and it will perhaps bother us for 15 days more or less, and then it stops.”

Maria from Choglontus
This was also reflected in the data from the survey where a high percentage of households in zone 1 or the most exposed to volcanic hazards evacuate before an official notice from the authorities or *vigías*. 26% said they always evacuate before a notice, and 36% said they do it occasionally. This means that 62% have or are willing to evacuate on a voluntary basis.

![Evacuation before official notice](image)

*Figure 20: Evacuation before official notice zone 1*

Moreover, as exemplified by the figure below, data from the survey shows that what makes most people evacuate in zone 1 is either a similar activity to what they experienced in 2006 (24%) and/or general heightened volcanic activity (58%).

![What makes people evacuate?](image)

*Figure 21: What makes people evacuate zone 1*
Although people base their decisions on a combination of their experiences, information from authorities/scientists and mostly on what they can see and feel their interpretations can also be inaccurate, and deceiving, particularly in some cases when the volcano has not shown any signs of unrest and has erupted very suddenly. This was the case during the February 2014 eruption, which despite the advance notice made by the IGEPN, the volcanos’ surface activity caught most people by surprise and left some communities like Cusúa ‘trapped’ in between two pyroclastic flows. Put in a different way, experience and knowledge is an important element of people’s ability to cope with long term exposure to volcanic activity of the same magnitude as they have experienced until now (VI 1-3) and crucially to maintain their livelihoods. This is not the same as to say that their lives are not at risk, most importantly if a larger explosion/eruption occurs. In this light, we are not suggesting that there is no risk to life for local residents because they know more about the volcano. On the contrary, they are aware that although technology and experience allows them to know more about the volcano, it remains unpredictable. Thus, this section is trying to argue that knowledge about the volcano empowers people, as it becomes an important basis to make decisions about their livelihoods and about their lives. Clearly, as explained in the previous passages, people are aware of the risks involved in living near an active volcano such as Tungurahua, yet, with that knowledge in mind, they are willing to accept that risk. How much risk and uncertainty they are willing to take differs from family to family and is mediated by opportunity elsewhere, attachment to land (discussed earlier in the report) and the different emergency risk communication strategies put in place in the area, which are discussed in the next section.

Disaster risk reduction and Emergency Risk Communication (changes and transformation)

Disaster Risk Reduction (DRR) and Emergency Risk Communication in Tungurahua has changed dramatically since the reactivation of the volcano in 1999 (Mothes et al., 2015; Ramón, 2009; Stone et al., 2014). As noted in previous passages, both the knowledge about the volcano and the emergency assistance plans were precarious and incomplete at the beginning of this volcanic cycle. As a result of this lack of preparedness and knowledge, many of the decisions taken by the authorities and residents in 1999 have had long term effects on people’s livelihoods and lives (Lane et al., 2003; Tobin & Whiteford, 2002a, 2002b; Vieira, 2003). What is important to highlight in term of this report is how DRR management has improved and is helping people cope with volcanic hazards today. This section will therefore look at changes in the communication systems between scientists, authorities and local communities, with a focus on the vigía
system and the way they are viewed by the communities. For more detail on DRR policies overtime in Tungurahua see STREVA WP4’s research on the topic.

One of the key elements of DRR in Tungurahua is the communications between scientists, authorities and local residents. WP3 research focused on how the communities view this relationship and how it has changed over the years. Most of the reports from the experience of 1999 coincide that the information they received was not very clear and that it focused on the worst possible scenarios that could take place in Tungurahua. In addition, civil defence showed videos that included the 1985 eruption and disaster of Armero, Colombia. This technique did have an immediate effect on many of the local residents who decided to evacuate voluntarily after viewing the videos. Yet in the long term, and given that the eruption of Tungurahua did not match the descriptions given by the authorities at the time, it only served to create resentment against decision-makers. A song written by a Baños resident clearly depicts this sentiment, as one of its phrases states: “Expertos en desastres, mucho se creyeron ya, con solamente haber mirado lo que hace otro volcán”. (With only seeing what another volcano had done, experts in disasters they thought they had become). In the following passages, different members of the communities on the slopes of the volcano talk about their first encounters of volcano emergency risk communication.

The impact of the 1999 evacuation on our community has been very tough. People were filled with anger, of something, let’s not say hatred, but total stress. This was the result of not being able to return to our homes the way we had thought we would. We thought that we would leave, the volcano would erupt and we would be back a week after. But it was all a lie, to make us get out of here [Runtún] and then we were not allowed to return. That process lasted from October 1999 until January 2000 […]. The impact of the evacuation was particularly bad because of the bad way in which it was administered by the authorities at the time. Because they would tell us, and even show us some videos, they came to show us some videos of what happened in Colombia to fill us with terror. They would tell us that the same thing is going to happen here because we are under the same conditions. […] People began to get scared, but this was because they would not inform themselves about what had happened in previous eruptions. So some left voluntarily, others only left after the military came to force us out of here.

Magdalena from Runtún

They came to tell us that we had to leave. They scared us, because they showed us videos of red avalanches coming down. That is what traumatised us, and we left without knowing what was going to happen.

Maria from Choglontus

They showed us a video of how the volcano erupts, what comes out and how the heat and flames go down. That was so that we would become afraid and get out of here.

Silvio from Cusúa
Today there is more information about the volcano. When the activity began, people were very afraid, there was erroneous information of what would happen, and that the volcano would kill people [...] It was ugly the way they made us leave, evacuate. The impact of arriving to another place, town, and then to see that nothing extraordinary had happened with the volcano was very strong. The evacuation impacted people more than the volcano. After they showed the videos we did not know what was going to happen. The information was rushed and rough, it only made us afraid.

Rocío from Chamana

As a result of the negative experience of evacuation, and the fact that the volcano did not erupt as it had been announced in October 1999, confidence in the authorities and scientist was very low at the beginning of the current eruptive cycle in Tungurahua. It has taken many years for this relationship to build and for people to come to terms with what happened in 1999 (Mothes et al., 2015). Although some interviewees noted that they could receive more training they also noted that communication and information has improved dramatically since 1999. In particular they are satisfied with the vigía system and the information they get from the scientists. The role of the authorities during emergencies, particularly in deciding when to recommend evacuations is still criticised. This mistrust could be understood as long-term effect of the 1999 evacuation, where residents in the slopes of the volcano and Baños de Agua Santa are still sceptical of evacuating. Gaining trust in the authorities and the scientist has taken many years and has required innovation and openness in the communication system (Mothes et al., 2015). As result, local residents look for different sources of information during emergencies before taking any decision. This was reflected in a varied response in terms of who people trust the most for information about the volcano to make a decision during an emergency. The overall results for the four zones show that: 19% of households trust in their families and friends for information, 10% in scientists, 9% in the vigías, 14% in the Parish authorities and 18% don’t trust in anybody for information.
The numbers change when looking at the different zones. For instance in zone one, where people are most exposed, 12% of households trust the most in their families and friends for information during an emergency, 9% in scientists, 17% in the *vigías*, 12% in the Parish authorities, 7% in God and 25% in nobody.
Currently, in addition to communication between scientists and the authorities, there is a direct communication link between scientist and residents of the communities on the slopes of the volcano. This communication process is mediated by the vigías, who have gained a central role in DRR in Tungurahua (Biggs et al., 2010; Stone et al., 2014). The vigías, who are in direct contact with the observatory have a lot of responsibility in terms of DRR in Tungurahua and play a significant part in allowing people to maintain their livelihoods, particularly in the slopes of the volcano. Although the vigía system was originally set in motion to help and improve the scientific observations with observations made closer to the volcano, vigías have acquired many other responsibilities (Stone et al., 2014). Most importantly, they provide support and information to community members during emergencies as well as during periods of prolonged volcanic activity. According to a vigía they feel a lot safer now that they have contact with the scientists.

As vigías our first responsibility has been to observe the volcano. The machines can detect things but there are some things that they can’t see. They are machines that is why we also need to be here. So when the volcano becomes angry, they [scientists at the observatory] are checking all of it on the computers, but what if they don’t see it just then? Because they are looking for it, there are many seismographers around here, there are something like 20 here. It is well monitored, so until they find the seismographer that sent the signal, an emission is already out, red ash is out, red ash falls, black ash falls. So that is the advantage for us, we have access to the scientists 24 hours a day. I feel a lot safer now, because if there is anything unusual, I just ask for information, and they give it to us.

Vigías also play another vital DRR role by helping evacuate people during emergencies. In more than one occasion vigías, who are local to the area, have played a fundamental role in locating people and helping them (or convincing them) to evacuate. Although it is the police and the local authorities who are in charge of evacuation, vigías receive information from the observatory long before the authorities are able to make a decision, so most of the times they have taken the responsibility of supporting people to evacuate. This has happened even before there is an official notification to evacuate the areas. In the following passage residents from the slopes of the volcano and vigías talk about the importance of this system for their communities.

When the volcano becomes active, people come to our house and ask about the volcano. Or when we see them, we let them know about the volcano, because they trust in us. Here my uncle, who is also a vigía, has a car and when things get bad we use that car to evacuate people. It is difficult for people to walk […] so when the Gofísico [Observatory] tells us ‘you need to be prepared, there might be some changes’ we let people know that it is possible that we might evacuate. ‘Arrange everything so that we can go’. People get ready, they put their animals closer to their homes, far away from the rivers, they get ready, and in the afternoon we leave. Other times we spend hours making trips from here to Penipe, because there are people who don’t want to leave […]

Female vigía from Chimborazo Province

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That is what the *vigía* does, we like to give that service, and help people evacuate, so that nobody stays behind, even better if we can do it beforehand, given that there are events that give us signals. So we evacuate the animals, get ready. We suffer more for the animals that for us…

Male *vigía* from Tungurahua Province

The *vigías* are very important for us. They are a guide because through them we are able to know when the volcano gets dangerous. They also come and take us away. He [*vigía*] takes us all out, not only me, he takes everyone in the community to Penipe […] He knows where we all live

Maria from Choglontus

It is possible to say that new, more participatory communication strategies, as exemplified by the *vigía* system, are not only decreasing vulnerability to people’s lives in Tungurahua, but also decreasing vulnerability (or increasing resilience) in terms of livelihoods in Tungurahua. At the core of this strategy lies the fact that the relationship between scientist and local communities has significantly improved (Mothes et al., 2015). Today, many of those who live near the volcano not only respect scientific recommendations, but are seeking for this information during and after emergencies. For more detail on the importance of the *vigía* and early warning system see Stone et al. (2014).
III. SUMMARY OF FINDINGS

At the outset of this report, it was noted that Tungurahua is a particularly interesting case to look at volcanic hazards given the time span of more than 14 years of volcanic activity. This has allowed WP3 to look at the different aspects of vulnerability as they change over time. The following list summarises the most important observations presented in this report.

**Empirical findings:**

- **Livelihoods** in Tungurahua have been severely affected by exposure to volcanic hazards over a period of more than 14 years. The most significant impact has been caused by ash.
- Given that most people that live near the volcano base their livelihoods on agriculture this has been the most affected activity.
- Local farmers have gained significant knowledge about ash impacts on crops and animals, which they are using to cope with long-term exposure to volcanic ash.
- Although farmers have recovered from some of the worst impacts of volcanic hazards and developed some important forms of adaptation to volcanic ash, their livelihoods remain vulnerable to ash and other volcanic hazards.
- Other livelihoods such as tourism have also been affected by volcanic activity. While tourism in Baños de Agua Santa (zone 4) has recovered, tourism in the communities closer to the volcano has not (parts of zone 1 and 3).
- Other livelihoods such as commerce and small business have been affected, particularly in zone 1, or in the communities closer to the volcano. In the long run some activities such as tourism and mining have benefited from volcanic activity.
- Population and residence patterns have been severely affected in the influence zones of the volcano, particularly in zone 1.
- Resettlements have not been successful in attaining full time residence in these locations. Dual residence, resettlement-community is still very common.
- Lack of livelihood opportunity and attachment to land are the main factors influencing dual residence patterns.
- Community cooperation, at the rural communities and the resettlement sites has been affected. Difficulties securing attendance to meetings and other communal work activities.
• **Services and infrastructure** have also been impacted by Volcán Tugurahua. Schools and health centres have closed in zone 1. Residents of these areas have to access services outside the high-risk zone at the resettlement sites or larger towns.

• Declaration of High Risk Zone: it has a direct effect on service provision, state investment in the area, credit for local farmers and residents and land prices.

• Health has also been affected by the volcano. Most people have reported increase in respiratory illnesses and stress related to evacuation and long-term exposure to volcanic activity.

• Other impacts: in addition to volcanic hazards, livelihoods in Tungurahua are vulnerable to other impacts, particularly: increased food prices, increased prices of agricultural inputs, and decrease in crop prices.

• **State and non-state assistance** to residents of the area is available during emergencies. Assistance, particularly for those living in zone 1 and 2, has changed as a result of access to houses in resettlement sites.

• Apart from the resettlement homes, assistance has only focused on short-term emergency aid.

• Experience and knowledge about the volcano is an important element of sustaining livelihoods in the long term in Tungurahua. Local residents are well informed and take decisions concerning their safety and livelihoods using this knowledge.

• Despite an increase in knowledge about the volcano and ways in which to cope with volcanic hazards, this report shows that livelihoods and people are still vulnerable to volcanic hazards.

• DRR has improved significantly over the years and is essential for people to maintain their livelihoods in the slopes of the volcano.

• The *vigía* system is central to emergency communication, evacuation and trust in scientific information.

**Overall assessment:**

• Volcanic hazards continue to pose a threat to life and to impact on agricultural and other livelihoods around Tungurahua volcano, but there has been a learning process through which people working and living there understand better the hazard and its warning signs, and have adapted partially to the impacts of ash fall on crops.

• Resettlement initiatives have helped to reduce people’s exposure to volcanic hazards, but have not resulted in a complete resettlement process, and have themselves exposed people to other wellbeing stresses.

• Although many people’s lives and livelihoods in Tungurahua are less vulnerable to the current magnitude of volcanic hazards, this does not necessarily hold for risk of larger eruptions.

• DRR policies in the area, (high risk zone, emergency assistance and resettlements) have focused on saving lives rather than sustaining livelihoods. Need to focus on post-emergency periods and recovery.
Analytical implications for other case studies:

- Importance of analysing vulnerability to livelihoods and lives, and how vulnerability as revealed by ‘outcome’ unfolds and transforms during the course of time.

- An approach that considers prolonged periods of time and gives equal analytical weight to emergencies and periods of volcanic quiescence is essential to understand the vulnerability to lives and livelihoods. Need to understand vulnerability in times of crisis and times of relative volcanic calmness.

- Importance of understanding dynamics (especially in situations in which a volcano has a prolonged phase of activity):
  - Changes in people’s life trajectories during the high-risk phase, that may be negative, positive or variable through time;
  - Structural social, economic and political changes associated with the volcano or with wider societal changes;
  - Dynamics of the hazard itself and of assets exposed to risk
References:


Appendix:

1. Survey Tungurahua
2. Project Information Sheet
Appendix 1. Survey
<table>
<thead>
<tr>
<th>DATOS GENERALES SOBRE LA ENCUESTA (Versión Enero 2014)</th>
<th>Notas del Supervisor/ Encuestador</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. ENCUESTADOR.</td>
<td>FECHA (aaaa/mm/dd)</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>2. LUGAR</td>
<td></td>
</tr>
<tr>
<td>Comunidad:____________________ Dato Referencial:____________________</td>
<td></td>
</tr>
<tr>
<td>3. ACEPTACION Y CONSENTIMIENTO ENCUESTADO</td>
<td></td>
</tr>
<tr>
<td>4. RESULTADO DE LA ENCUESTA</td>
<td>1 = Completa</td>
</tr>
<tr>
<td></td>
<td>2 = Incompleta</td>
</tr>
<tr>
<td>5. VERIFICACION</td>
<td></td>
</tr>
<tr>
<td>SUPERVISOR__________________________________________</td>
<td></td>
</tr>
<tr>
<td>Fecha (aaaa/mm/dd)_______________________________</td>
<td></td>
</tr>
<tr>
<td>Firma</td>
<td></td>
</tr>
</tbody>
</table>
### A. INFORMACIÓN BÁSICA DEL HOGAR (Enumerar miembros del hogar)

| A.1 | ¿Cuál es la relación con usted? |
| A.2 | ¿Qué género? |
| A.3 | ¿Cuántos años tiene? |
| A.4 | Esta persona duerme aquí |
| A.5 | ¿Dónde duerme esta persona? |
| A.6 | Que ocupación tiene actualmente |
| A.7 | Desde 1999, ha cambiado de ocupación |
| A.8 | ¿Cuál era su ocupación anterior? |
| A.9 | ¿En qué año? |
| A.10 | La actividad del volcán contribuyó al cambio |

#### RELACIÓN CON EL ENCUESTADO
1 = Esposo/a/ Pareja  
2 = Hijo/Hija  
3 = Yerno/nuera  
4 = Nieto  
5 = Madre/Padre  
6 = Hermano/hermana  
7 = Sobrino/sobrina  
8 = Suegro/suegra  
9 = Cuñado/cuñada  
10 = Abuelo/Abuela  
11 = Otro familiar  
12 = No es familiar

#### DUEÑE EN EL HOGAR
1 = Todas las noches (ir A.6)  
2 = Parte de la semana (ir A.5)  
3 = No duerme aquí (ir A.5)  
0 = No sabe/no se acuerda/no quiere contestar

#### DUEÑE EN EL HOGAR
1 = Fuera del país  
2 = A otra provincia en Ecuador  
3 = A otra localidad en la misma provincia  
0 = No sabe/No se acuerda

### B. MIGRACIÓN

| B.1 | ¿Algún miembro de este hogar ha migrado permanentemente fuera del hogar? |
| B.2 | cuáles son los miembros que migraron (utilizar opciones A.1) |
| B.2 | ¿A qué lugar migró el miembro del hogar y en qué año aproximadamente? |
| B.3 | ¿Esta persona aporta al hogar? |

| B.1 Y B.3 |  |
| 1 = Si | 2 = No |
| 0 = No sabe/no se acuerda |  |

#### LUGAR AL QUE MIGRO
1 = Fuera del país  
2 = A otra provincia en Ecuador  
3 = A otra localidad en la misma provincia  
0 = No sabe/No se acuerda
### C. TIPO DE VIVIENDA

<table>
<thead>
<tr>
<th>C.1</th>
<th>C.2</th>
<th>C.3</th>
<th>C.4</th>
</tr>
</thead>
<tbody>
<tr>
<td>¿Qué tipo de vivienda (s) tenía este hogar (dos respuestas posibles)?</td>
<td>al inicio de la erupción en el 1999?</td>
<td>después de la erupción del 2006?</td>
<td>actualmente?</td>
</tr>
<tr>
<td>C.1 C.2 Y C.3 TIPO DE VIVIENDA</td>
<td>0= No se acuerda/no sabe</td>
<td>1= Casa de cemento/bloque/ladrillo/losa</td>
<td>2= Casa de adobe/teja</td>
</tr>
<tr>
<td>C.4 En caso de evacuación a qué lugar/vivienda ha evacuado o evacuaría?</td>
<td>0= No se acuerda/no sabe</td>
<td>1= Albergue temporal</td>
<td>2= Vivienda propia fuera de zona de riesgo (especificar lugar)</td>
</tr>
</tbody>
</table>

### D. REASENTAMIENTOS

<table>
<thead>
<tr>
<th>D.1</th>
<th>D.2</th>
<th>D.3</th>
<th>D.4</th>
</tr>
</thead>
<tbody>
<tr>
<td>¿Le han ofrecido una vivienda en un reasentamiento?</td>
<td>¿Aceptaron la casa en el reasentamiento?</td>
<td>¿Qué miembros del hogar viven ahí la mayor parte del tiempo?</td>
<td>¿Por qué no aceptó la vivienda en el reasentamiento?</td>
</tr>
<tr>
<td>Si = 1 (ir a D.2) No = 2 (ir a E) No sabe/ no se acuerda = 0 (ir a E)</td>
<td>Si = 1 (ir a D.3) No = 2 (ir a D.4)</td>
<td>1= Esposo/a/ Pareja</td>
<td>1= No abandono/ arraigo a la tierra</td>
</tr>
<tr>
<td>2= Hijo/Hija</td>
<td>2= No hay medios de trabajo</td>
<td>3= Yerno/nuera</td>
<td>3= Seguridad</td>
</tr>
<tr>
<td>4= Nieto</td>
<td>4= No abandono de su medio de subsistencia</td>
<td>5= Madre/Padre</td>
<td>5= Muy lejos de sus tierras</td>
</tr>
<tr>
<td>6= Hermano/hermana</td>
<td>0 = No sabe</td>
<td>7= Sobrino/sobrina</td>
<td>1= Esposo/a/ Pareja</td>
</tr>
<tr>
<td>8= Suegro/suegra</td>
<td>2= Hijo/Hija</td>
<td>9= Cuñado/cuñada</td>
<td>2= No hay medios de trabajo</td>
</tr>
<tr>
<td>10= Abuelo/Abuela</td>
<td>3= Yerno/nuera</td>
<td>11= Otro familiar</td>
<td>3= Seguridad</td>
</tr>
<tr>
<td>12= No es familiar</td>
<td>4= No abandono de su medio de subsistencia</td>
<td>13= Todos</td>
<td>5= Muy lejos de sus tierras</td>
</tr>
</tbody>
</table>
### E. ACCESO A LA TIERRA/TERRENO

**E.1.** ¿Este hogar tenía acceso a la tierra (propia o como partidario) antes del 1999?  
**E.2.** SI= 1 (ir a E.1)  
**E.3.** NO= 2 (ir a H)  
**E.4.** 0= No se acuerda/No sabe  
**E.5.** 1= Cultivar la tierra  
**E.6.** 2= Cultivar como partidario  
**E.7.** 3= Pastaje para animales  
**E.8.** 4= Agroindustria (especificar)  
**E.9.** 5= Otro (especificar)  

<table>
<thead>
<tr>
<th></th>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td><strong>E.2</strong> SI= 1</td>
<td><strong>E.3</strong> SI= 1</td>
<td><strong>E.4</strong> SI= 1</td>
</tr>
<tr>
<td>No= 2</td>
<td>No= 2</td>
<td>No= 2</td>
</tr>
<tr>
<td>No sabe/ No se acuerda =0</td>
<td>No sabe/ No se acuerda =0</td>
<td>No sabe/ No se acuerda =0</td>
</tr>
<tr>
<td><strong>E.5</strong> SI= 1</td>
<td><strong>E.6</strong> SI= 1</td>
<td><strong>E.7</strong> SI= 1</td>
</tr>
<tr>
<td>No= 2</td>
<td>No= 2</td>
<td>No= 2</td>
</tr>
<tr>
<td>No sabe/ No se acuerda =0</td>
<td>No sabe/ No se acuerda =0</td>
<td>No sabe/ No se acuerda =0</td>
</tr>
</tbody>
</table>

### F. CULTIVOS

**F.1.** (contestar si E.2 = 1 o 2)  
**F.2.** (contestar si E.4 = 1 o 2)  
**F.3.** (contestar si E.6 = 1 o 2)  
**F.4.** ¿Cómo calificaría el cambio de la producción agrícola de este hogar desde que empezó la actividad volcánica en el año 1999 hasta la actualidad?  
1 = Igual  
2 = Menor  
3 = Mayor  
0 = No sabe/no se acuerda  

### G. ANIMALES

**G.1.** ¿Este hogar ha tenido ganado/animales alguna vez?  
**G.2.** antes del 1999?  
**G.3.** después del 2006?  
**G.4.** actualmente?  
**G.5.** ¿Cómo calificaría el cambio en la cantidad de animales que tiene este hogar desde que empezó la actividad volcánica en el año 1999 hasta la actualidad?  
1 = Igual  
2 = Menor  
3 = Mayor  
0 = No sabe/no se acuerda  

<table>
<thead>
<tr>
<th>G.2 before 1999?</th>
<th>G.3 after 2006?</th>
<th>G.4 currently?</th>
</tr>
</thead>
<tbody>
<tr>
<td>¿Qué tipo de animales tenía?</td>
<td>¿Qué tipo de animales tenía?</td>
<td>¿Qué tipo de animales tenía?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>G.1, G.2 Y G.3 GANADO/ANIMALES</th>
</tr>
</thead>
<tbody>
<tr>
<td>SI = 1 (ir a G2)</td>
</tr>
<tr>
<td>NO = 2 (ir a H)</td>
</tr>
<tr>
<td>1 = Ninguno</td>
</tr>
<tr>
<td>2 = Pequeños (gallinas, cuyes, conejos)</td>
</tr>
<tr>
<td>3 = Medianos (Berregos, cabras, chanchos)</td>
</tr>
<tr>
<td>4 = Grandes (vacas, caballos, mulas, llamas)</td>
</tr>
<tr>
<td>0 = No se acuerda =0 (ir a H)</td>
</tr>
</tbody>
</table>
### I. SERVICIOS PUBLICOS

<table>
<thead>
<tr>
<th>I. COBERTURA DE LOS SERVICIOS PUBLICOS</th>
<th>¿Qué servicios tenía este hogar</th>
<th>I.7 ¿A qué entidad acudiría usted en caso de tener problemas con la calidad del servicio?</th>
</tr>
</thead>
<tbody>
<tr>
<td>I.1 antes del 1999?</td>
<td>I.2 calidad</td>
<td>I.4 y I.6 SERVICIOS TENIA CALIDAD DE SERVICIOS</td>
</tr>
<tr>
<td>Agua potable</td>
<td></td>
<td>1 = Muy bueno</td>
</tr>
<tr>
<td>Luz</td>
<td>I.3 después del 2006?</td>
<td>2 = Bueno</td>
</tr>
<tr>
<td>Atención medica</td>
<td>I.4 calidad</td>
<td>3 = Regular</td>
</tr>
<tr>
<td>Educación primaria</td>
<td>I.5 hoy?</td>
<td>4 = Malo</td>
</tr>
<tr>
<td>Policía</td>
<td>I.6 calidad</td>
<td>5 = Muy malo</td>
</tr>
<tr>
<td>Seguridad Social o Seguro Campesino</td>
<td></td>
<td>0 = No sabe</td>
</tr>
<tr>
<td>Bono de Desarrollo Humano</td>
<td></td>
<td>H2, H3 y H4 MEDIOS DE TRANSPORTE</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0 = no se acuerda/no se</td>
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<tr>
<td></td>
<td></td>
<td>1 = NADA</td>
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<tr>
<td></td>
<td></td>
<td>2= burro/caballo/mula</td>
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<td>3= bicicleta</td>
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<td></td>
<td></td>
<td>4= moto</td>
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<td>5= automóvil</td>
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<td></td>
<td></td>
<td>6= camioneta</td>
</tr>
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<td></td>
<td></td>
<td>7 = camión</td>
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<td></td>
<td></td>
<td>8= otro (especificar)</td>
</tr>
</tbody>
</table>

### H. MEDIOS DE TRANSPORTE

<table>
<thead>
<tr>
<th>H. 1 ¿Este hogar ha tenido medios de transporte alguna vez?</th>
<th>H. 5 ¿Cómo calificaría el cambio en la cantidad de medios de transporte que tiene este hogar desde que empezó la actividad volcánica en el año 1999 hasta la actualidad?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Si= 1 (ir a H2)</td>
<td>1 = Igual</td>
</tr>
<tr>
<td>No= 2 (ir a I)</td>
<td>2 = Menor</td>
</tr>
<tr>
<td>No se/no se acuerda = 0</td>
<td>3 = Mayor</td>
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</tbody>
</table>
### J. APOYOS ADICIONALES PARA MEJORAR LA CALIDAD DE VIDA DE LA POBLACION

<table>
<thead>
<tr>
<th>¿Ha recibido usted alguno de los siguientes apoyos</th>
<th>J.1 1 = Sí 2 = No 3 = No necesita 0 = No sabe</th>
<th>J.2 antes del 1999</th>
<th>J.3 Qué entidad</th>
<th>J.4 después del 2006</th>
<th>J.5 Qué entidad</th>
<th>J.6 hoy</th>
<th>J.7 Qué entidad</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacitación y ayuda para aumentar la producción agrícola/ganadera</td>
<td></td>
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<tr>
<td>Créditos</td>
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<tr>
<td>Vivienda nueva/mejorada</td>
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<tr>
<td>Otros Bonos (especificar)</td>
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<tr>
<td>Apoyo para formar una cooperativa o Asociación productiva</td>
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</tr>
</tbody>
</table>

### K. IMPACTO DE FENÓMENOS VOLCÁNICOS AL HOGAR

<table>
<thead>
<tr>
<th>K.1 Desde la reactivación del volcán en 1999 por cuál de los siguientes fenómenos ha sido afectado su hogar</th>
<th>K.2 Con qué frecuencia?</th>
<th>K.3 En qué años fue la mayor afectación</th>
</tr>
</thead>
<tbody>
<tr>
<td>Caídas de ceniza y cascajo (si = 1, pasar a L)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lahares (si=1, pasar a M)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flujos piroclásticos</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### K.2 FRECUENCIA DE AFECTACION

<table>
<thead>
<tr>
<th>K.2 FRECUENCIA DE AFECTACION</th>
<th>1 = Siempre 2 = Casi siempre 3 = Al menos una vez al año 4 = Al menos una vez desde el año 1999 5 = Nunca 0 = No sabe</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 = Siempre</td>
<td></td>
</tr>
<tr>
<td>2 = Casi siempre</td>
<td></td>
</tr>
<tr>
<td>3 = Al menos una vez al año</td>
<td></td>
</tr>
<tr>
<td>4 = Al menos una vez desde el año 1999</td>
<td></td>
</tr>
<tr>
<td>5 = Nunca</td>
<td></td>
</tr>
<tr>
<td>0 = No sabe</td>
<td></td>
</tr>
</tbody>
</table>
### L. CENIZA Y CASCAJO

<table>
<thead>
<tr>
<th><strong>Indique los tres aspectos que han sido más afectados por la ceniza y el cascajo</strong> (solo tres respuestas posibles)</th>
<th><strong>L.1</strong></th>
<th><strong>L.2</strong></th>
<th><strong>L.3</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Cultivos</td>
<td>1 = Muy afectado 2 = Medianamente afectado 3 = Menos afectado 0 = no sabe/no se acuerda</td>
<td>¿Evalúe la afectación?</td>
<td>¿Qué hicieron para recuperarse de la pérdida económica en el largo plazo?</td>
</tr>
<tr>
<td>Animales</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Salud</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Vivienda</td>
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<td></td>
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<tr>
<td>Agua</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Luz eléctrica</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Otro (especifique)</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

### M. LAHARES

<table>
<thead>
<tr>
<th><strong>Indique los tres aspectos que han sido más afectados por los lahares</strong> (solo tres respuestas posibles)</th>
<th><strong>M.1</strong></th>
<th><strong>M.2</strong></th>
<th><strong>M.3</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Carretera</td>
<td>1 = Muy afectado; 2 = Medianamente afectado; 3 = Menos afectado; 0 = no sabe/no se acuerda</td>
<td>¿Evalúe la afectación?</td>
<td>¿Qué hicieron para recuperarse de la pérdida económica?</td>
</tr>
<tr>
<td>Cultivos</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Animales</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Salud</td>
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</tr>
</tbody>
</table>
### N. FLUJOS PIROCLASTICOS Y GASES

<table>
<thead>
<tr>
<th>Indique los tres aspectos que han sido más afectados por flujos piroclásticos (solo tres respuestas posibles)</th>
<th>N.1 1=Muy afectado 2= Medianamente afectado; 3=Menos afectado; 0 = no sabe/no se acuerda</th>
<th>N.2 Evalúe la afectación</th>
<th>N.3 Indique los tres aspectos que han sido más afectados por gases (tres respuestas posibles)</th>
<th>N.4 Evalúe la afectación</th>
<th>N.5 ¿Qué hicieron para recuperarse de la pérdida económica?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carretera</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cultivos</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Animales</td>
<td></td>
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</tr>
</tbody>
</table>

### N.2 y N4 EVALUACIÓN DE LA AFECTACION

<table>
<thead>
<tr>
<th>1= Perdida total</th>
<th>2= Perdida parcial</th>
<th>3= Enfermedad</th>
<th>4= Muerte</th>
<th>5= Otro (especificar)</th>
<th>0= No se acuerda/ no sabe</th>
</tr>
</thead>
</table>

### N.3 RECUPERACION

| 0= No se acuerda/ no sabe | 1= Minga | 2 = Usaron sus ahorros | 3 = Migraron en busca de trabajo | 4 = Pidieron prestado dinero | 5 = Ahorrar/gastar menos | 6 = Trabajar tierra de otros | 7 = Vivir en dos lugares (con familiar) | 8 = Se trasladaron a un reasentamiento | 9 = Se trasladaron a un refugio temporal | 10 = Vender sus enceres |
### O. ACTIVIDADES DE GESTION DE RIESGOS

<table>
<thead>
<tr>
<th>11 = Vender sus tierra/terreno</th>
<th>12 = Vender sus animales</th>
<th>13 = Nada</th>
<th>14 = Seguir trabajando</th>
<th>15 = Otro (Especificar)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salud</td>
<td>Vender sus animales</td>
<td>Nada</td>
<td>Seguir trabajando</td>
<td>Otro (Especificar)</td>
</tr>
<tr>
<td>Vivienda</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agua</td>
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<tr>
<td>Luz eléctrica</td>
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</tr>
<tr>
<td>Otro (especifique)</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>O.1 Relacionado con las erupciones del volcán cuándo le ayudaron</th>
</tr>
</thead>
<tbody>
<tr>
<td>Si = 1  No = 2  No sabe/no se acuerda = 0</td>
</tr>
</tbody>
</table>

| O.2 Fue durante / después de la actividad del volcán |

| O.3 Qué tipo de ayuda le brindaron |

| O.4 Qué organización le brindó la ayuda |

| O.5 ¿Cuál fue la calidad del apoyo de estas entidades? |

<table>
<thead>
<tr>
<th>Durante</th>
<th>Después</th>
<th>Durante</th>
<th>Después</th>
<th>Durante</th>
<th>Después</th>
</tr>
</thead>
<tbody>
<tr>
<td>1999</td>
<td></td>
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<tr>
<td>2006</td>
<td></td>
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<tr>
<td>Otro (Especificar)</td>
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<tr>
<td>Otro (Especificar)</td>
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</tbody>
</table>
**O.3 TIPOS DE AYUDA DURANTE LA ERUPCIÓN**  
1 = Información sobre actividad del volcán  
2 = Alertas sistema de gestión de riesgos (DC- SGR)  
3 = Alimentos  
4 = Refugio  
5 = Medicamentos  
6 = Le dicen qué hacer  
7 = Otros  
8 = No sabe  
9 = NADA

**O.3 TIPOS DE AYUDA DESPUÉS LA ERUPCIÓN**  
1 = Económico (bono)  
2 = Alimentos  
3 = Insumos para las actividades productivas  
4 = Créditos  
5 = Vivienda reparada  
6 = Vivienda nueva (en el mismo lugar)  
7 = Vivienda nueva (reubicada)  
8 = Capacitación sobre cómo protegerse al futuro  
9 = Vituallas  
10 = Otros  
11 = NADA  
0 = No sabe

**O.4 ENTIDADES RESPONSABLES**  
1 = Junta / parroquial  
2 = Gobierno municipal  
3 = Gobierno provincial  
4 = Defensa civil/ SGR  
5 = Otro ministerio/secretaria central  
6 = ONG  
7 = Empresa privada  
8 = La propia comunidad/MINGA  
9 = Voluntarios  
10 = Grupo religioso  
11 = Otro  
0 = No sabe

**O.5 CALIDAD DE APOYO**  
1 = Muy bueno  
2 = Bueno  
3 = Regular  
4 = Malo  
5 = Muy malo  
0 = No sabe

---

**P.1 ¿De 1999 hasta la fecha, como han cambiado sus condiciones de vida?**

**P.2 ¿Si usted tendría la oportunidad de pedir mejoras/cambios para ser menos afectado por el volcán, cuáles serían?**

**P.3 ¿A quién le pediría estos cambios?**

**P.1 CAMBIOS EN LAS CONDICIONES DE VIDA**  
1 = Mejoró sustancialmente  
2 = Mejoró un poco  
3 = Esta igual  
4 = Empeoró un poco  
5 = Empeoró

**P.2 MEJORAS NECESARIAS PARA ESTAR MENOS VULNERABLE**  
1 = Mayor ingreso  
2 = Vivienda más segura  
3 = Tenencia de tierra más segura  
4 = Opciones de reconstrucción de vivienda  
5 = Mejoras en el mercado  
6 = Mejoras en las alertas

**P.3 ENTIDADES RESPONSABLE DE LAS MEJORAS**  
1 = Junta / parroquial  
2 = Gobierno municipal  
3 = Gobierno provincial  
4 = Defensa civil/ SGR  
5 = Otro ministerio/secretaria central  
6 = ONG  
7 = Empresa privada  
8 = La propia comunidad/MINGA
### R. PARTICIPACION DE LA POBLACION EN LOS PROCESOS DE DESARROLLO

<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>Reunión comunal</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1 = Sí</td>
<td>1 = Cada semana</td>
<td>1 = No ha habido tales eventos</td>
</tr>
<tr>
<td>Reunión de junta parroquial</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2 = No</td>
<td>2 = Cada mes</td>
<td>2 = Desconocimiento del evento</td>
</tr>
<tr>
<td>Reunión municipal sobre gestión de riesgos</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0 = No sabe</td>
<td>3 = Un par de veces al año</td>
<td>3 = No invitado</td>
</tr>
<tr>
<td>Algún estudio sobre la vulnerabilidad y/o riesgos</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>4 = Un par de veces en la vida</td>
<td></td>
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<tr>
<td>Consulta pública sobre los servicios públicos</td>
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<td></td>
<td>5 = Solo una vez</td>
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<tr>
<td>Manifestación ciudadana</td>
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<td></td>
<td>6 = Cuando son temas importantes</td>
<td></td>
</tr>
<tr>
<td>S. OTROS EVENTOS NO RELACIONADOS CON EL VOLCAN</td>
<td>S.1. ¿Ha sido este hogar afectado en algún momento por alguno de los siguientes sucesos?</td>
<td>S.2 En caso de sí, cual ha sido el impacto de estos sucesos en la economía familiar? (tres respuestas posibles)</td>
<td>S.3 ¿Qué hizo su hogar para recuperarse de estos eventos? (tres respuestas posibles)</td>
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<tr>
<td>Seqúia, lluvias excesivas, peste, mala semilla</td>
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<tr>
<td>Fallecimiento, enfermedad o accidente de un miembro del hogar que aporta con ingreso económico</td>
<td></td>
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<tr>
<td>Crisis económica del 1999</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Muerte, enfermedad o robo de animales</td>
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<tr>
<td>Robo de otros bienes</td>
<td></td>
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</tr>
<tr>
<td>Pérdida de su fuente de ingresos económico/ negocio familiar / trabajo</td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alza de precios de insumos para agricultura/ganadería</td>
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</tbody>
</table>

Elaboración del Plan de Desarrollo y Ordenamiento Territorial municipal

<p>| 4 = No le interesó el tema |
| 5 = Falta de modo de transporte para llegar |
| 6= Por trabajo |
| 6 = Otro |
| 0 = No sabe |</p>
<table>
<thead>
<tr>
<th>Baja de precios de los cultivos</th>
<th>Un deslizamiento u otro fenómeno natural (no volcánico)</th>
<th>Aza de precios de alimentos/productos básicos</th>
<th>Cambio de gobierno central</th>
<th>Una huelga</th>
<th>Otro (especificar)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reducción en asistencia del gobierno o dinero que enviaban familiares del extranjero</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7 = Vivir en dos lugares (con familiar)</td>
<td>9 = Se trasladaron a un refugio temporal</td>
<td>10 = Vender sus enceres</td>
<td>11 = Vender sus tierra/terreno</td>
<td>12 = Vender sus animales</td>
<td>13 = Nada</td>
</tr>
</tbody>
</table>

### T. COMUNICACION EN GESTIÓN DE RIESGOS: CONFIANZA EN MENSAJES

<table>
<thead>
<tr>
<th>(Clasificar en orden de preferencia de acuerdo a la confianza)</th>
<th>T.1 ¿Cuándo el volcán está activo en la información de quién o quienes MAS confía para tomar una decisión?</th>
<th>T.2 Por cuál de las siguientes razones confía en… (mencionar opción 1 de T.1)</th>
<th>T.3 ¿Por cuál de las siguientes razones confía en… (mencionar opción 2 de T.1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amigos y familia</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Científicos</td>
<td></td>
<td></td>
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<tr>
<td>Vigías</td>
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<tr>
<td>Autoridades parroquiales</td>
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<td></td>
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<tr>
<td>Autoridades nacionales</td>
<td></td>
<td></td>
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<tr>
<td>La prensa local / radio</td>
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</tbody>
</table>

**T.2 y T.3 RAZONES PARA CONFIAR**

1 = La información es correcta porque ellos conocen el volcán
2 = Ellos sólo dan mensajes importantes
3 = Ellos conocen su forma de vida
4 = Es su trabajo y deben cumplirlo
5 = No ocultan ni exageran información
6 = Ellos tienen experiencia
<table>
<thead>
<tr>
<th><strong>U COMUNICACION EN GESTIÓN DE RIESGOS: EVACUACION</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>U.1 ¿Cuántas veces ha tomado la decisión de irse antes de que usted haya recibido una advertencia oficial?</strong></td>
</tr>
<tr>
<td>1 = Siempre</td>
</tr>
<tr>
<td>2 = Ocasionalmente</td>
</tr>
<tr>
<td>3 = Nunca</td>
</tr>
<tr>
<td>4 = Otro (especificar)</td>
</tr>
</tbody>
</table>
Esta es una investigación independiente, no tiene conexión alguna con el gobierno del Ecuador. Participar es totalmente voluntario. La información entregada por usted es totalmente anónima, tiene estricta confidencialidad. Los datos de esta encuesta serán usados únicamente para fines de investigación científica. Los resultados de este proyecto serán recopilados en un documento que estará a su disposición. Si piensa que algún tema importante no ha sido incluido en esta encuesta, puede comunicarle al entrevistador. Si después de participar en la entrevista, decide que no quiere que sus datos sean utilizados, puede contactarse con nosotros.
Contactos:
María Teresa Armijos 0999450363
  t.armijos@uea.ac.uk
¿Quiénes somos?
El proyecto STREVA (Fortalecimiento de la Resiliencia en Áreas Volcánicas) está conformado por investigadores de universidades de Inglaterra. Trabajamos a nivel internacional en Ecuador, Colombia y el Caribe. El proyecto es financiado por el Concejo de Investigación del Reino Unido.

¿Qué hace STREVA?
El objetivo del proyecto en Ecuador es entender los efectos de los catorce años de actividad del volcán Tungurahua en las poblaciones de mayor afectación y aprender sobre cómo los habitantes se han fortalecido para sobrellevar y recuperarse de los impactos relacionados a la actividad del volcán.

¿Cuán vendrán a entrevistarle?
Las encuestas empiezan en diciembre de 2013 y terminarán en abril de 2014.

¿De qué se trata esta entrevista?
La entrevista busca que usted nos cuente cuál ha sido su experiencia junto al volcán, inclusive desde antes de su activación en 1999.

¿Qué buscamos?
Transmitir las experiencias de las comunidades que viven junto al volcán Tungurahua a otras poblaciones afectadas por la actividad de los volcanes. Con los resultados obtenidos se realizarán recomendaciones a nivel mundial sobre cómo manejar el riesgo asociado a las erupciones volcánicas.

Le agradecemos anticipadamente por su tiempo y paciencia.

SU EXPERIENCIA AYUDARÁ A OTROS