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Cultural Responses to volcanic hazards on Mt Merapi, Indonesia

Donovan, Katherine Helen Mary

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Cultural Responses to volcanic hazards on Mt Merapi, Indonesia

By

Donovan, K. H. M.

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Cultural responses to volcanic hazards on Mt Merapi, Indonesia

Katherine Donovan

Abstract

Over the last decade an interdisciplinary science has evolved in order to reduce the impact of natural hazards by incorporating social sciences into physical hazard studies. This science has revealed that a community's ability to anticipate, cope with and recover from the impact of natural hazards relies upon that society's vulnerability. The concept of vulnerability has conventionally focussed on certain key social statistics such as wealth, age and gender, yet there is another element of vulnerability: the component of culture. In this study culture refers to the oral histories, taboos, ceremonies and legends that are created in order to explain, understand, accept and even mitigate against potential hazards.

Using qualitative data collection methods, including semi-structured interviews, participatory workshops and ethnographic observations, this research explores cultural vulnerability at Mt Merapi, Central Java, Indonesia. Over a million people live within 10 km of this potentially dangerous volcano. In 2006 a lava dome collapse created a series of pyroclastic flows that killed two local people, yet despite the imminent danger local people reportedly refused to evacuate because of their cultural attachment to the volcano. After a 5 month ethnographic survey carried out in 2007 it was concluded that traditional beliefs and broader socio-economic characteristics were intricately intertwined causing evacuation failure and therefore increasing the local population's vulnerability.

Informants from the two primary settlements, Batur and Pelemsari on the southern flank, told of supernatural creatures that apparently control and warn of eruptions. In addition the informants discussed other forms of warning signs and taboos and without these warnings the villagers saw no reason to evacuate especially if it meant abandoning their livestock. Findings from this initial research indicated that traditional beliefs and a failure to evacuate appeared linked and varied due to geographic location around the volcano. Therefore in 2009 a wider survey was undertaken to explore this relationship and examine the potential to map cultural intensity, failure to evacuate and subsequently vulnerability. Results from this survey were mapped using a Geographic Information System (GIS) and indicated that the traditional beliefs at Mt Merapi had a complex relationship to local vulnerability and that these beliefs could be incorporated within a more conventional risk map.

Additionally a re-assessment of the existing hazard map found that the smaller more frequent dome collapse eruptions have a more widespread impact than the existing map suggests. This also concluded that Mt Merapi's eruptive style is diverse, ranging from large Plinian eruptions through to smaller more frequent events, such as in 2006, indicating that a larger Plinian eruptive style requires a separate hazard and risk map.

Recommendations from this research include the design of a holistic risk map for the Mt Merapi region incorporating all elements of vulnerability including culture and the extension of existing hazard zones in the northern and southern regions of the volcano. In addition to designing a culturally sensitive education programme, in order to raise the hazard awareness in isolated regions. This research demonstrates the need to incorporate all elements of vulnerability into risk assessments in volcanic regions and investigates how cultural vulnerability can have a major impact on disaster management.

Volcano

When thunderous roars that shake the land
Hurl rocks out of the fires of hell,
And through the air with mighty force
Until they shatter on the ground
Crushing all below;
When molten lava from the mountainside
Erupts and spews across the land
Like glowing streams of blood,
While flames of blazing orange
Lick the sky, and choking smoke
Whirl round in clouds of burning dust,

Then offer up a red bull-calf; placate this god of fire.

Iain Mackay

(www.poemhunter.com/iain-mackay/)

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- Interview transcripts for 2007 field season.
- Interview transcripts for 2009 field season.
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One academic paper has been published from the thesis (a copy of which can be found at the back of this thesis) and the author has also co-written a chapter in an academic text book for Earth Sciences. Several additional papers have been prepared for publication.The author will also be contributing to a new text book entitled The Encyclopedia of Natural Hazards to be published by Springer Publishing.

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Chapter 1: Introduction.

It must have been immediately clear to the population that they were now, with the lava spurting from the artery above them, in the greatest danger. The elders made their decision. Some men ran to the balé bandjar to get their gamelans and mount them on carrying poles, two men to each instrument, two men for the gongs, the big and the little. The drums and cymbals could be managed each by one person. Others ran to the temple and unlocked the shed where the ceremonial banners and spears were kept, and brought out the gods' palanquins. There was not time to decorate them, except with cloths thrown over them. People came hurrying from their houses, in clean clothes, hastily put on but correctly draped and knotted. Quickly the procession was organised, banners and spears first, then the palanquins and their parasol-bearers, followed by the members of the gamelan orchestra and those who wished to carry offerings or merely to accompany the procession. Some carried lanterns, for although the light from the volcano was considerable; clouds of thick black smoke were sagging down and blotting it out. It is said that when all was ready, the village headman looked up at the mouth of the crater immediately above them, a loud mouth spitting blood-red destruction, and said, "If our god wills us to die in this manner, it is not fitting for us to wait. We must go at once and meet him".

The drummer slapped his drum, the heavy mallets hit the gongs and the gamelans tinkled. Boys carrying the spears ran forward importantly, and the file set off as to a festival, towards the incandescent tide flowing down. There was never discovered any trace of them, nor of their gamelans, though in a near-by kampong some people were found dead inside their houses and their cattle dead in the yards. Those people who ran down from the village to a place of safety told the story of the suicide procession. There was hardly a survivor who didn't have a relative or friend walking out to welcome death and honour the god. They had seen them go, accompanied by their music. (The 1963 eruption of Mt Agung. Indonesia, Mathews 1965: 158).

1. 1. Rationale.

In 1963 on the island of Bali, Indonesia, over 1000 people died as they prayed in temples and marched towards burning lava and pyroclastic flows expelled by Mt Agung. Some bodies were found still grasping the instruments they were playing whilst others were found kneeling, praying for deliverance. The eruption had not begun unexpectedly or without warning. Earthquakes and smaller eruptions had preceded the main event and yet these desperate people had chosen to walk towards the volcano rather than instinctively running. To them Mt Agung represented the home of deities and they believed the eruption was a sign that these deities were descending the mountain and out of respect the villagers prepared to meet their gods. Their cultural beliefs were so strong that they died trying to fulfil them.

In 2006 Mt Merapi, on the neighbouring island of Java, began to show signs of unrest. Despite efforts to evacuate the local residents some reportedly refused to evacuate, believing that they had not received the traditional warnings from the spirits that they believed to live on the volcano. It appeared that the tragedy at Mt Agung could occur again at Mt Merapi volcano situated in one of the most densely populated regions in the world. Although the 2006 eruption was relatively small and short lived the circumstances of evacuation failure and the events at Mt Agung in 1963 encouraged me to undertake this research, and in so doing to attempt to understand the motivation of local cultures at Mt Merapi.

Despite the ferocity of certain hazards some local residents of Mt Merapi refuse to take the recommended pro-active steps to protect themselves. It is necessary therefore to have a better understanding of the motivating characteristics of at-risk communities. Although the monitoring of volcanoes remains absolutely vital, assessments of vulnerability, and therefore risk, are widely incomplete. Risk assessments that are carried out appear to be partial incorporating only selected indicators of vulnerability, such as population density, access to services, age, wealth and other conventionally measureable social demographics. Yet individuals are motivated and influenced by many varying emotional, physiological, and cultural factors. These factors are often difficult to quantify and so are not considered important, despite various examples of their dominant influence. However if these cultural motivations were better understood then emergency managers could target educational or other mitigational efforts in order to improve community resilience.

1.2. Aims.

Culture[1] is an extremely influential element of vulnerability to natural hazards and yet it is relatively understudied and is hardly ever taken into consideration during conventional risk assessments. Cultural reactions to hazards are not constrained by political boundaries, inextricably tied to wealth or prosperity, or born from scientific knowledge or reason; it is a social characteristic that can intensify, direct and motivate them during times of stress. Culture, in turn, can be shaped by physical surroundings and in particular the extremely symbolic and dualistic nature of volcanic hazards tends to influence the development of localised volcanic culture. As the opening extract taken from Anna Mathew's travel book 'The Night of Purnama' exemplifies, residents in volcanic regions often form a relationship with the volcano, an attachment that goes beyond the economic attractions of fertile soils to the symbolic power. The size and visible dominance of certain volcanoes provides inspiration and the danger of an eruption invokes respect and wonder. These emotional reactions create a distinctive culture related directly to the volcano and it is these specific responses that will motivate a particular community in times of danger. In Indonesia it is these motivations that have apparently caused at-risk communities to be, paradoxically, both more resilient and more vulnerable to natural hazards. It is therefore important that these motivations are better understood and taken into consideration during pro-active emergency planning.

The primary aim of this thesis is therefore to examine the role of culture during a crisis and to promote its incorporation into risk reduction strategies. This overriding aim can be subdivided into five broad goals:

- To examine the influence of culture with regard to local people's reactions during a volcanic crisis.

- To investigate whether culture makes a specific community more or less vulnerable.
- To design a methodology of data collection and analysis in order to examine volcanic culture.
- To propose a framework in order to incorporate influential cultural characteristics within a risk assessment.
- To recommend practical applications of cultural studies within social volcanology.

1.3. Bridging the gap: the objectives and thesis structure.

In order to better understand the cultural dimensions of geological hazards it was essential for me to bridge the gap between sciences, becoming both a physical and social researcher. Volcanology has conventionally focussed on vital monitoring and physical mitigation yet after the Nevado del Ruiz disaster in 1985, when over 25000 people were killed by a relatively small eruption in Colombia, volcanologists have begun to diversify their risk reduction efforts (Voight 1990a; b). Recently, some physical scientists have begun to investigate the social impacts of volcanic disasters marrying their hazard knowledge with social science methods to produce holistic studies in volcanic regions. The publication of socially focused academic papers within the *Journal of Volcanology and Geothermal Research* have risen from an average of 1 per year between 1998-2007 to 30 papers in 2008 alone, indicating a growing desire to expand the discipline of volcanology. In this thesis social research will be referred to as social volcanology, a subject that focuses on the interaction between volcanic hazards and society. Social volcanology is the foundation for this project and provides a bridge between disciplines conventionally separated by the restraints of academic structure. This thesis will contribute to this growing interdisciplinary field and provide practical recommendations for emergency planners and researchers aiming to carry out social volcanology research.

Carrying out an interdisciplinary project provides an opportunity to explore other disciplines, use different methods and initially unfamiliar theories. Interdisciplinary projects therefore have distinctive challenges and tackling these issues is part of the projects evolution and motivations. In light of this, the thesis is presented in chronological order to provide an insight into the development and progression of the research. In this sense it represents a journey into interdisciplinary research.

1.3.1. Thesis structure.

Initially the thesis introduces the underpinning literature on risk, as well as the concepts of geoculture and social volcanology. Chapter 2 firstly discusses the current risk and disaster management literature, defining key terms that will be recurrent throughout the thesis. Secondly, the chapter discusses geoculture, highlighting the importance and influence of specific cultures that have arisen out of an interaction with certain geological events. The core of the thesis presents a case study at Mt Merapi volcano, Central Java, Indonesia, investigating the cultural characteristics of the local people and how this influences their actions during a crisis. Chapter 3 explores the case study field site, discussing the key volcanic and social elements that make Mt Merapi such a distinctive volcanic region and a suitable choice for this study. The last section of chapter 3 introduces the two main settlements studied and details the social background of each region. Chapter 4 explores the theoretical and practical aspects of conducting the social data collection and analysis, including the key methods used and the complex nature of social enquiry in a Javanese context. Chapter 4 represents a transition from the theoretical discussions of the research to the practical application of methods and analysis of the data collected. Chapter 5 therefore highlights the key findings that emerged from the analysis. Each influential theme related to the geoculture at Mt Merapi is discussed in detail providing an insight into the lives of Javanese who live on an active volcano.

Chapters 6 onwards explore how the information gathered from Mt Merapi can be practically applied in disaster risk reduction and explores the possibility of using a Geographic Information System (GIS) to collate both hazard and social information to produce a more holistic assessment of risk. Chapter 6 focuses on demonstrating how GIS can be used to map volcanic hazards at Mt Merapi to improve existing official hazard maps, whilst Chapter 7 uses the findings from a second broader survey at Mt Merapi to map culture and patterns of evacuation failure. Chapter 8 initially outlines the limits of and recommendations for social volcanology research and suggests how this project can have practical application in vulnerable regions. The final chapter reviews the overall aims of the research and highlights the most important findings whilst emphasising the importance of interdisciplinary research.

Footnotes:

[1] For this study the term culture refers to the customs, beliefs and oral histories of those living in geologically hazardous regions and specifically focuses on those living in a volcanically active region of Central Java, Indonesia.

Chapter 2: Holistic natural hazards research incorporating both social and physical sciences.

2.1. The challenge: Holistic natural hazards research.

This chapter provides a review of previous and current research in disaster management and demonstrates how, over the last 20 years, disaster management and geological hazards studies have begun to incorporate social sciences and social theory. The key interdisciplinary literature in the natural hazards discipline is examined exploring the growth of concepts and terminologies such as vulnerability, resilience, and hazard perception. This reveals that despite over 30 years of social references in disaster studies there are still elements of society that are not considered when managing hazard prone regions. From this literature it becomes clear that an effective risk reduction strategy demands a new type of scientist, one whose research incorporates both the social and physical causes of disaster. In light of this, the final part of this chapter gives an insight into the current work on the synthesis of culture and geological hazards and the gaps in these studies that this project negotiates.

Disasters occur at the interface of society and nature (Oliver-Smith 1996, Hewitt 1997). Therefore a disaster does not occur unless a hazard interacts with society resulting in death and destruction. For example, the 2004 Indian Ocean tsunami is only regarded as a disaster because many thousands of people were killed and buildings destroyed. The 1985 mudflow from Nevado del Ruiz volcano (Colombia) would have occurred largely unnoticed if it had not killed 23000 people living in its path (Scarth 1999), and in 2001 the Gujarat earthquake would have only interested seismologists if it has not impacted upon 50 million and killed 20000 people living in this highly seismic region of India (Wisner *et al.* 2006). These people died because of global social inadequacies. The impact of each of these hazard events could have been greatly reduced if the social complexities of each region had been considered in collaboration with physical hazard investigations. If action had been taken when Nevado del Ruiz showed signs of activity, a year before the disaster, and the Colombian government not had been absorbed by corruption, limited resources and civil unrest, 23000 people could have been saved (Hall 1990). Kelman (2003) notes that the lack of enforced building codes killed thousands during the Gujarat earthquake, while a simple knowledge of tsunami precursors could have saved thousands along the Indian Ocean coastline (McAdoo *et al.* 2006). These terrible events clearly show that there is more to a disaster than just the occurrence of a hazard event; it is the preventable loss of lives and elements of value that cripple a country and have a global resonance. It is therefore apparent that in order to mitigate against disasters the scientific community and governments need to explore both the physical and the social dimensions in equal measure.

2.1.1. Accepting the challenge.

In 1983, when discussing the incomplete nature of disaster studies, the geographer Kenneth Hewitt suggested that physical hazard research had stagnated, arguing that by only focussing on '...information that centres the problem upon natural extremes and damaging events, they easily miss the main sources of social influence over hazards' (Hewitt 1983:7). His remarks came after a period in the 1970s and 80s when quantitative physical hazard research was shifting to a more holistic approach, incorporating both social and physical sciences (e.g. White and Haas 1977: Burton *et al.* 1978; Hewitt 1983; Alexander 1993; Merriman and Browitt 1993; Burton *et al.*1993; Chester 1993; Bell 1999; Smith 2001; Wisner *et al.* 2006). That shift gained some momentum when the United Nations designated the 1990s as an International Decade for Natural Disaster Reduction and called for dialogue between scientists, social scientists and the at-risk community. From that decade emerged a number of key texts [such as '*Natural Hazards*' by Tobin and Montz

(1997), '*At Risk: Natural Hazards, people's vulnerability and disasters*' by Blackie *et al.* (1994), '*Environmental Hazards: assessing risk and reducing disaster*' by Smith (2001)] that emphasised the need for interdisciplinary research by bridging the gap between social and physical sciences. In the latest edition of '*At Risk*', Wisner *et al.* (2006:5) suggested that 'the natural and the social cannot be separated from each other: to do so invites a failure to understand the additional burden of natural hazards, and it is unhelpful in both understanding disasters and doing something to prevent or mitigate them'. Traditionally disasters have been seen as the physical world impacting upon society, and hazards as elements of the physical environment harmful to humanity and caused by extraneous forces (Burton and Kates 1964). Subsequently the interaction between both the physical hazard and the social, economic and political environment has been recognised and some intrepid publications have attempted to bridge the gap between the social and physical sciences. The forerunner of these include White's groundbreaking collection of field studies aimed at 'gaining a greater knowledge of the processes by which people do, in fact, cope with hazards in nature' (1974:3). However before we can delve into texts, case studies and research (such as Murton and Shimabukuro's work on human adjustment to volcanic hazards in Hawaii (1974:151) or Baumann and Sims survey (1974:25) into cross-cultural response to hurricanes) it is essential that the terminology used in these and other studies is explained and discussed.

2.1.2. Vulnerability, hazard and risk.

A key reoccurring concept in the literature was and still is 'vulnerability', the elements that cause a person or society to be at increased susceptibility to and therefore increased risk from hazards. For example, Gaillard (2008) details the main factors of vulnerability to include income, location, access to health care and social capital. Such elements of vulnerability interact with potentially damaging physical events (the hazard) to determine the resulting loss (the risk). Over the last 30 years the definitions of vulnerability, hazard and risk have lacked consistency. This is demonstrated by Table 2.1, outlining definitions for the most widely used terms in disaster management.

The contradictory definitions of hazard, provided in Table 2.1, exemplify the complexity and differing understandings of terminology in disaster management. Within this project hazard refers to a natural phenomena that has the potential to cause harm to man and/or the environment. This definition takes the key elements from the range of definitions in Table 2.1, yet attempts distinguish between the phenomena (e.g. a hazard) and the disaster event (e.g. the interaction between a hazard and an object of value) as discussed in section 2.1.

Smith (2001:25) concludes that the concept of vulnerability has been refined over time but still has no 'fully acceptable' and 'discipline free' definition. Within this project vulnerability will refer to aspects of society that can increase a society's (an individual's or group's) exposure to the impact of a hazard and reduce a society's ability to recover from such an impact. There are many elements that can make a society more or less vulnerable and as Figure 2.1 indicates, conventional indicators of vulnerability have mostly focussed on wealth, health and power, whilst culture is neglected. Culture is an aspect of vulnerability that has a global influence, regardless of wealth, health or development.

Term	**Definition**	**Source**
Natural Hazard	Interaction of people and nature by the coexistent state of adjustment in human use system and the state of nature in the natural events system.	White (1974)
	Natural processes or phenomena occurring in the biosphere that may constitute a damaging event.	ISDR (2004)
	The probability of occurrence within a specified period of time and within a given area of a potentially damaging phenomenon.	Bell (1999), Varnes (1984)
	The potential interaction between humans and extreme natural events...constitutes a threat to society.	Tobin and Montz (1997)
	Those elements of the physical environment harmful to man	Burton and

	and caused by forces extraneous to him.	Kates (1964)
	As some rapid, instantaneous or profound impact on human beings and their environment upon the socio-economic system.	Alexander (1993)
Vulnerability	The characteristics of a person or group in terms of their capacity to anticipate, cope with, resist and recover from the impact of a natural hazard.	Wisner *et al.* (2006)
	The degree to which a system, or part of a system, may react to the occurrence of a hazardous event.	Timmerman (1981)
	The relative inability to cope with the resulting stress *(imposed by a hazard)* expressed as resilience or reliability.	Smith (2001)
	The degree of loss to a given element or set of elements at risk resulting from the occurrence of a natural phenomena of given magnitude.	UNDRO (1982), Alexander (1993)
	The conditions determined by physical, social, economic, and environmental factors or processes, which increase the susceptibility of a community to the impact of hazards.	ISDR (2004)
	Means not lack or want but exposure and defencelessness. It has two sides: the external side of exposure to shocks, stress and risk; and the internal side of defencelessness, meaning a lack of means to cope without damaging loss.	Chambers (1995)
Risk	Risk the compound function of the natural hazard and the number of people, characterised by their varying degrees of vulnerability to that specific hazard, who occupy the space and time of exposure to the hazard event. (Wisner *et al.* 2006, describes Risk as disaster).	Wisner *et al.* (2006)
	The exposure of something of human value to a hazard and is often regarded as the product of probability and loss.	Smith (2001)
	The probability of harmful consequences, or expected losses (deaths, injuries, property, livelihoods, economic activity disrupted or environment damaged) resulting from interactions between natural or human-induced hazards and vulnerable conditions.	ISDR (2004)
	The probability of harmful consequences, or expected loss of lives, people injured, property, livelihoods, economic activity disrupted (or environment damaged) resulting from interactions between natural or human induced hazards and vulnerable conditions. Risk is conventionally expressed by the equation: Risk = Hazard x Vulnerability.	UNDP (2004)

Table 2.1: Various definitions for hazard, vulnerability and risk.

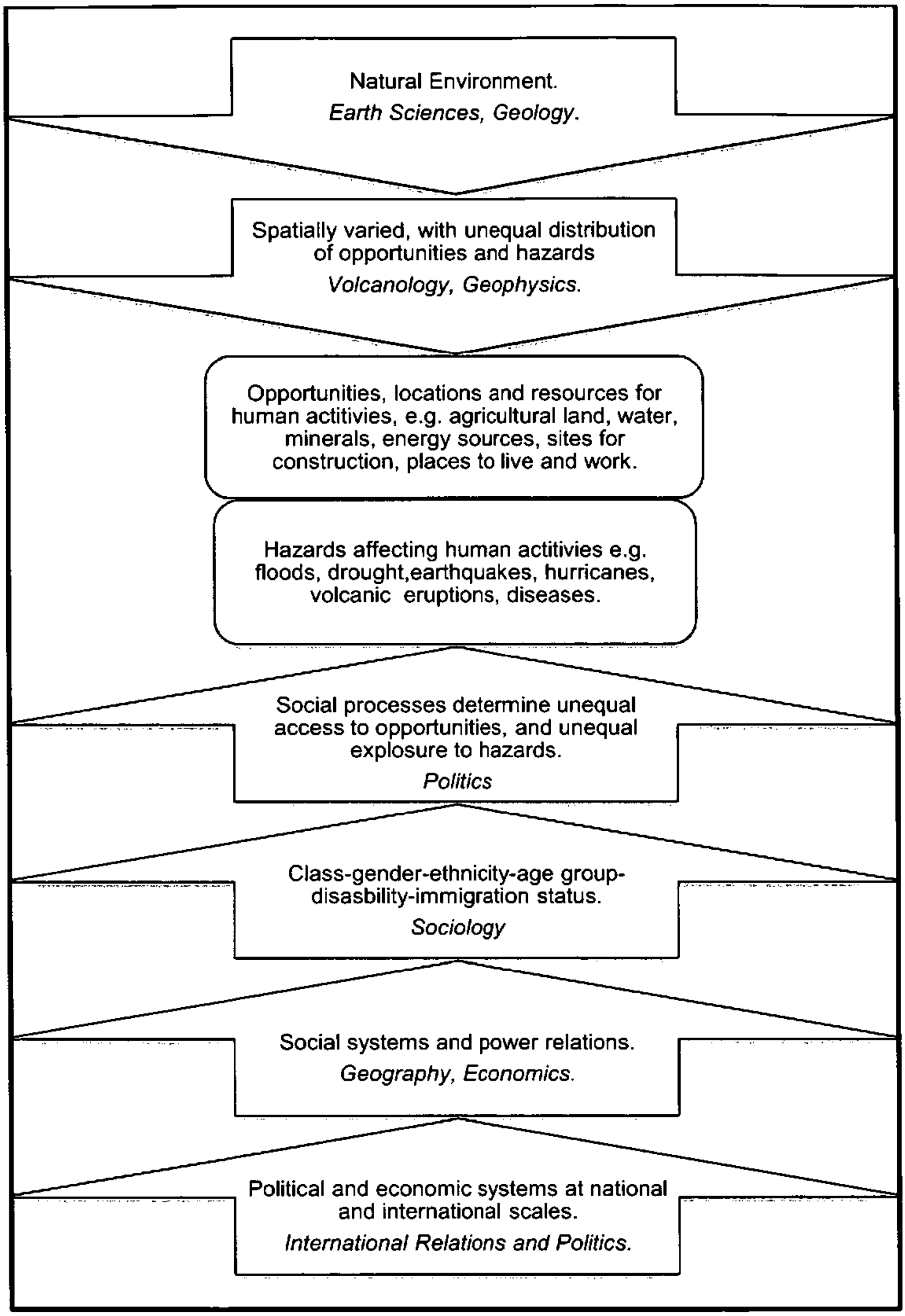


Figure 2.1: Various elements that make society more vulnerable and hazards converge to create risk. Source: Wisner *et al.* (2006).

2.1.3. Cultural Vulnerability: the lost element of risk.

As Crang (1998:1) suggests, defining culture is 'almost unfeasibly difficult'. This is further confirmed by Geertz (1973) who lists ten definitions of culture given by Kluckhon's *Mirror for Man*. These definitions include intangible aspects of culture such as 'the total way of life of a people', and 'a way of thinking, feeling and believing'. Culture is therefore difficult to define because as Crang (1998:3) notes it is 'part of our everyday lives'. Whilst Jackson (1989:2) notes that culture 'refers to the codes with which meaning is constructed, conveyed, and understood'. So in effect, culture is everything that makes life meaningful, it is religion and belief systems, it is art, it is emotions, it is economics and politics, it is 'western', it is indigenous, it is all aspects of society. Indeed, it was the need to explore the 'mosaic of different people with different customs and beliefs' that was the starting point of cultural geography (Crang 1998:14).

It is crucial to understand that culture is dynamic and influenced by varying power relations. Mitchell (1995:103) suggests that culture is sometimes used to explain 'action, behaviour, resistance or social formations in a way that economics or politics cannot', and although this research is based on the principle that culture can explain actions and behaviour, it is clear that economics and politics are also integral to and immersed within culture (Duncan and Duncan 1995). This complexity exemplifies the difficulties associated with defining and investigating culture, and how necessary it is to remain inclusive when studying aspects of culture. In other words, although this research focuses on just one aspect of culture, namely, customs and beliefs, it might also be necessary to incorporate elements of politics or economics.

Jackson (1995:573), in his 'reply' to Mitchell's article argues that 'Mitchell is in danger of eroding any sense of the materiality of culture'. Whereas Cosgrove (1995:575) also in reply to Mitchell's article contends that culture is a 'process of differentiation from 'nature' through wilful intervention. In other words, 'culture' is all that is not 'nature', and yet it is nature that shapes culture. This is evident in cultural reactions to nature's most violent expressions such as hurricanes, volcanic eruptions, or floods. Such events have forged the culture. For example, the 79AD eruption of Mt Vesuvius, Italy, had a large impact on the popular imagination and European cultural identity (Allison 2002). Equally, the Christian Bible is full of natural disaster narratives, such as 'Noah's flood' (Genesis 6-9), that have greatly influenced various cultures (Dynes 2003). Natural disasters are often interpreted as divine punishments and lead communities to develop and change their reactions and perceptions of the hazard (Casimir 2008).

From this brief review of the literature relating to the term culture it is clear that this is a complex and extensive subject area. Culture encompasses all aspects of society it influences and is influenced by the actions of that society, whilst also being shaped by nature, especially extreme natural events.

To begin to understand certain cultural reactions to natural hazards, such as traditional belief systems or customs and ceremonies it necessary for a researcher to explore previous case studies and historical events. Yet in the case of cultural reactions to hazards there is relatively little literature. White (1974) collected certain field based studies on hazard perception and provided an early example of interdisciplinary work. Certain case studies within this collection reveal that vulnerability goes beyond the conventional factors repeatedly theorised. Baumann and Sims (1974) interviewed 360 American citizens that had recently been affected by hurricane activity and showed that during a hurricane more interviewees prayed rather than making practical preparations to safe guard their welfare; in fact, 64% felt fear, anxiety and concern towards the consequences of a hurricane, as opposed to a desire to take precautions. This shows that certain reactions are related to emotion and culture instead of the more conventional quantifiable elements of vulnerability.

Murton and Shimabuko (1974) explored volcanic hazard perception in Hawaii and from conversations with local at-risk communities concluded that their reaction would be predominantly influenced by beliefs (88% interviewed would respond to a volcanic eruption by praying and 31% would create offerings to Pele, the spiritual goddess of Hawaii) and experience (36% believed they had enough experience of volcanic hazards and therefore they believed they would know what to do if they were threatened in the future and that there was no need to prepare in advance).

Disregarding human reactions to hazards has been shown to be detrimental. During the Nevado del Ruiz mudflow disaster in 1985 panicked residents congregated near to the river, the traditional meeting place, yet the river was channelling a 6 m wave of rock and water that subsequently killed the residents of Armero (Voight 1990a, 1990b, Scarth 1999). Equally, amidst the eventual mass evacuation of New Orleans during Hurricane Katrina there were still hundreds of residents who refused to move out of the stricken city exclaiming that they 'loved' the city and would not leave it (Buncombe 2005). At Mt Kelut (in 2007) and Mt Merapi (in 1994 and 2006), Indonesia, local residents refused to obey official orders to evacuate because of their traditional beliefs (Schlehe 1996, Agence France-Presse 2007). Clearly, cultural affectations and reactions to hazards are an essential facet of vulnerability so exploring these aspects is essential for a truly holistic disaster management.

2.1.4. Risk perception.

Despite a lack of focussed scientific publications these apparently unquantifiable emotional and cultural reactions to hazards have been partially examined through the study of hazard and risk perception. Studying how people perceive their own risk has become increasingly important in risk communication and emergency planning (Haynes *et al.* 2008). As Gaillard (2008:315) notes 'risk perception is different from the simple knowledge that a hazard exists... instead refers to the possibility people give that a hazard will affect them'. Encouraged by the work of Solvic (1987, 2000), Beck (1992); Pigeon *et al.* (2003) and Adam *et al.* (2004) on social risk theories, risk perception research has been taken on by volcanologists and hazard scientists such as Johnston *et al.* (1999); Gregg *et al.* (2004); Gaillard and Dibben (2008); Haynes *et al.* (2008) and Paton *et al.* (2008) who have surveyed volcanic hazard perceptions. These recent publications have a practical element that differs from previous risk-perception literature whose range was traditionally limited to 'documentary analysis' and 'retrospective accounts' (Haynes *et al.* 2008:259). Practical publications drive interdisciplinary risk subjects and although theoretical frameworks are extremely important it is the more 'hands on' approaches that underpin the ethos of topics such as *social volcanology*. As Geertz (1973:5) states, ' if you want to understand what a science is, you should look in the first instance not at its theories or its findings, and certainly not at what its apologists say about it; you should look at what the practitioners of it do'.

Paton *et al.* (2008) carried out a risk perception and preparation study involving the residents of the volcanic region of Auckland, New Zealand. This study noted that residents' risk perception and therefore actual preparedness, surprisingly declined after an educational initiative (communicating the risks of living on an active volcanic field). The local people appeared to see this educational initiative as having increased their knowledge and added to their experience, consequently improving their safety. Because of this, their perception of risk decreased and they saw little or no need for additional preparations. When questioned about what they had learned from the programme only 6% of the interviewees could accurately list essential items required during an eruption, although 41% previously thought that they could do this if required. The same study also reported a transferring of risk to the civic authorities or other community members; pro-active authorities or community leaders were seen as being 'in charge' or 'handling the situation' and therefore the local people transferred their personal safety into their hands. Trust, it seems determines whether an individual listens, absorbs and acts upon the information they receive in educational programmes. If the civil authorities or scientists are not trusted then inevitably the risk communication will break down (Barberi *et al.* 2008). This appears to be the current concern at Mt Vesuvius, Italy, where local residents were found to have a high risk perception yet unfortunately a low level of trust in the scientists, government and even the emergency plan (Barberi *et al.* 2008). A lack of trust in the government can form in response to past political upheavals and instability, or past false alarms and hazard mismanagement such as occurred during the 1976 eruption of La Sourfriere, Guadeloupe, when confrontation between scientists and local authorities led to a false alarm and severe economic problems (Fiske 1984).

Like Paton *et al.* (2008), Gregg *et al.* (2004) also explored risk perception as a driving mechanism for preparedness in research focussed on the residents of Mauna Loa and Hualalai volcano in Hawaii. By surveying residents Gregg *et al.* (2004) were able to understand the hazard knowledge, levels of preparedness and perception of volcanic risk of the subjects. They concluded that despite access and attendance to educative programmes the residents still had a low hazard knowledge and preparedness, regardless of a high awareness. Additionally, individuals in Auckland and Hawaii in both studies perceived themselves as being less vulnerable than others that shared the same hazard-scape; this overconfident assumption is termed 'unrealistic optimum bias', a characteristic that Drabek (1986) also recognised his research surveying of hurricane victims (Gregg *et al.* 2008, Paton *et al.* 2008). This over confidence leads to a decrease in preparation because the more vulnerable that people perceive themselves to be, the more likely they are to take preventative action. It is worth noting that according to Palm (1998) this optimism may be limited to certain cultural groups, specifically European or American. Finally, Paton *et al.* (2008) also suggested that although previous experience can increase risk perception it can also be detrimental to hazard preparedness. This concept is referred to as 'normalisation bias' and means that because they coped with the previous eruption or hazard they will be able to do so again, this diminishes their motivation to prepare and reduce their risk.

So far, the aspects that make a society more or less vulnerable according to risk perception are aspects that seem 'chosen', yet in reality the indicators are not voluntary because they are the result of 'social, economic and political forces beyond their control' (Gaillard 2008:316). These elements of society are the motivation that causes a community to live in potentially dangerous locations and it is also these elements that mediate culture. Gregg *et al.* (2004) and Murton and Shimabukuro (1974:193) also identified that ethnicity shapes hazard and risk perception in Hawaii. They conclude that 'a modern study of Hawaiian culture and spiritual beliefs regarding volcanism and its influence on decision making, preparedness and mitigation is long overdue'. So, what if, like some Hawaiians, people generally are motivated by their cultural beliefs? And how can their risk perception be improved without eroding their culture?

Does the answer lie in tackling their every day risks such as poverty, marginalisation and political neglect? There are many scientists, academics and politicians who appropriately and reasonably believe that reducing risk should focus on improving livelihoods. This contention takes us back to the key texts of Alexander (1993), Burton *et al.* (1993), Smith (2001), Wisner *et al.* (2006) and opens up this literature review to the fields of development studies. In order to contain this broadening review we shall remain focussed on the sustainable livelihoods approach that relates directly to disaster management, risk reduction and natural hazards.

2.1.5. Reducing risk means improving and creating sustainable livelihoods.

> Disasters do not just happen …they result from failures of development which increase vulnerability to hazard events. (Department for International Development (DFID) 2005:3).

This quote from a DFID report entitled '*Disaster risk reduction: a development concern'*, epitomises the ethos of sustainable livelihoods approach to disaster reduction. It is clear that natural hazards unequally affect those who are poor and vulnerable and the majority of those people are living in developing countries (Figure 2.2). In order to reduce the impact of natural disasters it is absolutely necessary to address the larger economic and political issues.

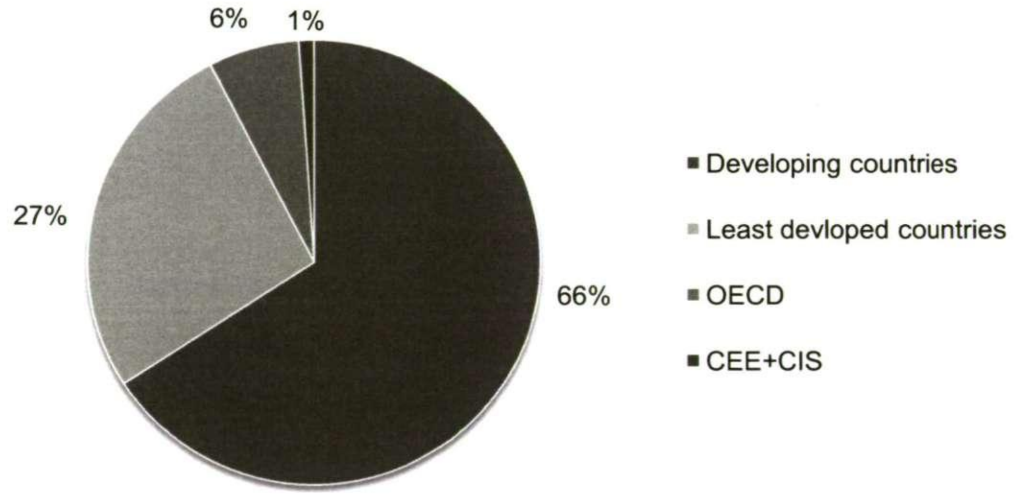


Figure 2.2: The uneven distribution of deaths resulting from natural hazards from 1991 – 2005. OECD – Organisation for Co-operation and Economic Development (member states are all developed countries), CEE+CIS – Central and Eastern Europe + Commonwealth of Independent States. Source: ISDR (2006).

Figure 2.3, extracted from the DFID report, demonstrates the 'vicious spiral' of disaster risk reduction and development failure. Demonstrating how aspects of social vulnerability, development and disaster impact are intrinsically linked. But research on vulnerability and resilience could positively change aspects of this diagram such as, 'failure to include risk assessments in development projects and planning' and 'failure to engage the community in risk management'. Examining vulnerability and resilience and applying the results to emergency plans could reduce fatalities, especially in volcanic regions. A sustainable livelihoods approach deals with 'umbrella issues' within society that although are largely beyond the scope of this project constantly shape and interact with cultural vulnerability, risk perception and subsequently reactions to hazards and therefore need to be understood.

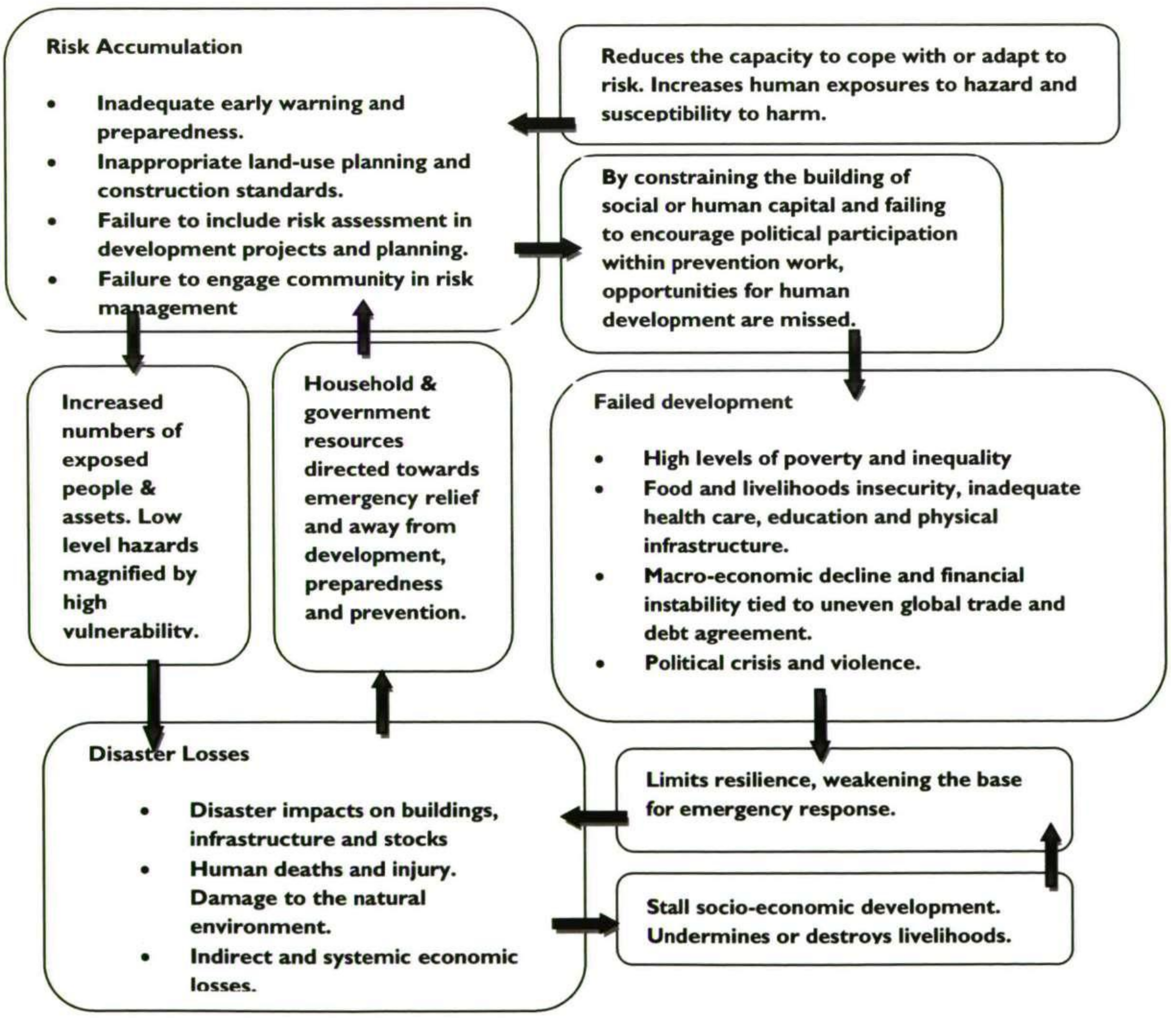


Figure 2.3: The vicious spiral of disaster risk reduction and development failure. Source: DFID (2005).

Chambers (1995:175) defines sustainable 'livelihoods as a living which is adequate for the satisfaction of basic needs and secure against anticipated shocks and stresses'. The shocks and stresses relate in part to the natural hazards that threaten at-risk communities and make them more vulnerable. He describes sustainable livelihoods as a long-term support of the means by which poor people live. Table 2.2 demonstrates that this goes beyond employment, and that in many poverty stricken regions employment is more of an 'aspiration than a reality' (Chambers 1995:195).

Element of sustainable livelihoods	**Description**
Natural Resources	Sustainable management of natural resources, especially common property resources, and equitable access to them for the poor.
Redistribution	Of private and public livelihood resources to the poor.
Prices	Marketing, prices and prompt payment for what poor people sell, and terms of trade between what poor people sell and what they buy.
Health	Accessible health service for the prevention of disease and for prompt and effective treatment of disabling accidents and disease.
Restriction and hassle	Removal of restriction on livelihood activities otherwise used to hassle and exploit the poor.
Counter-seasonality and safety nets	For poor people at bad times, mitigating seasonal stress and enabling them to conserve their livelihood assets.

Table 2.2: Elements of sustainable livelihoods Source: Chambers (1995).

Although improving livelihoods is of course an essential concept, in reality it relies heavily on the implementation and distribution of funds by the governments and authorities. Wisner (2001) demonstrates this with an investigation into the livelihood and mitigation improvements in El Salvador after Hurricane Mitch in 1998. He shows that although the government were provided with international aid and planned to do a variety of livelihood improving actions, in reality little was done to permanently re-house those whose homes had been destroyed, and promised reforms to the health service never occurred (Wisner 2001). He believes it is actually against human rights to allow deaths to occur from an avoidable harm in extreme natural events. Wisner (2003:2) proposes that the causes of poverty and disaster risk are 'often identical and overlap' and have 'five general threads' governance and democratization; civil society participation; asset building and social protection; public health and quality of life; human rights and conflict management. Bad governance leads to unequal distribution of hazard information, and corrupt aid-dependant states may actually welcome natural disasters that attract foreign financial support (Wisner 2003). Encouraging participation within development and risk reduction has been strongly encouraged by various NGOs (Benson *et al.* 2001), including global UN/ISDR with projects such as the recent ISDR (2008) '*Gender Perspectives: Integrating disaster risk reduction into climate change adaptation*', to national and local projects such as Yayasan IDEPs '*Disaster risk reduction capacity building community disaster management education programme*' in Indonesia (IDEP 2004). Participatory initiatives have also been explored by volcanologists and hazard scientists (Mercer *et al.* 2008). Cronin *et al.* (2004a, 2004b, 2004c) used participatory methods to support the development of community based mitigation initiatives on Vanuatu volcanic Island and Savo volcanic island. These methods will be examined in detail within chapter 4.

Kelman and Mather (2008) take a positive look at how living in volcanic regions can actually create and improve sustainable livelihoods. By taking advantage of volcanic resources such as fertile soils, tourism or mining, the local people can become more resilient and are more likely to willingly evacuate knowing that their livelihoods are sustainable even after an eruption. In other words, more resilient communities can survive and recover from extreme geophysical events (Tobin 1999). Seeing volcanic eruption products as a positive aid to sustainable livelihoods is exactly what many societies do. These communities have moved to exploit volcanic by-products and as Gaillard (2006) found at Mt Pinatubo, indigenous societies were able to recover from an eruption because of their diverse livelihoods. Tobin (1999) therefore, suggests 'living' with hazards may be the only realistic solution in creating a more resilient and therefore less vulnerable community.

Indigenous communities that are dependent on volcanic products for their livelihoods have inevitably developed a broad knowledge that could enable them to identify signs of impending disaster (Mercer *et al.* 2007). Traditional belief systems and indigenous knowledge develops from past hazard experience and so some influential geological events are recorded through oral histories and can be used as an additional resource to examine the geological settings. These resources are elements of Geomythology (Chester 2005, Cashman and Cronin 2008). Learning from these cultures is therefore essential in understanding people's motivations and actions during a disaster. The following section provides an insight into cases where culture has influenced, both positively and negatively people's reactions to geological hazards.

2.2. Geoculture.

This section introduces and explores the limited literature associated with what I term 'geoculture', this includes concept of geomythology, the use of traditional hazard warning signs and cultural reactions to extreme geological phenomena. Understanding deep-rooted local culture should be considered to be crucially important if responses to disasters are to be successful (Chester 2005). Vulnerable communities need to be identified and a better understanding of their religious and cultural perspectives on the social construction of disasters is required. This idea was affirmed following the International Decade for Natural

Disaster Reduction (1990-2000) and the consequent International Strategy for Disasters Reduction when the consensus was that an awareness of local culture was essential for effective disaster management and that it should not be dismissed as ignorance, superstition and backwardness (Chester 2005). An understanding of indigenous culture is now considered especially important (United Nations 1999).

2.2.1. Geomythology.

Vitaliano (1968) pioneered research relating oral histories, myths and legends to actual geological events, and referred to this as geomythology. It is the study of oral traditions that perpetuate memories of prehistoric geological events including volcanic eruptions (Chester and Duncan 2007). Geomythology enables interdisciplinary scientists to study the traditional beliefs of at-risk communities not only to understand not only the social complexities and perceptions of a hazard, but also to improve existing geological records. This is because many myths and legends do have a basis in reality and may be used as a historical explanation for geophysical events (Cashman and Giodarno 2008). Extreme events influence and shape culture and are often integrated with the community memory for generations (Cronin and Cashman 2007). Cultures are in part forged from myth and a famous example of this can be found from the work of Piccardi *et al.* (2008) into the existence of the sacred chasm of the Oracle of Delphi. The mythological gas inhalation of the prophetess could have related to geothermal gases that rise through seismic faults and could relate to a period of seismicity along the Delphi fault. Equally Piccardi's study shows that by exploring the myths and legends of indigenous communities with extensive oral histories can also provide insights into past volcanic activity. Whilst Ludwin *et al.* (2005) uses geomythology to examine the incidence of large earthquakes produced by the Cascade subduction zone. Native American stories were used to estimate the dates of recent seismic events. They found that nine stories had sufficient detail to estimate that coseismic subsidence and marine inundation had occurred in 1701. This date complements radiocarbon dating of dead trees, presumed to have been killed because of an abrupt change in land level due to a seismic induced rupturing of the ground that resulted in a flooding of their roots with sea water.

Nunn (2001, 2003) also explores the relationship between myths and natural phenomena, focussing on volcanic eruptions, uplift and subsidence of islands, and seismic activity. He goes into detail about certain Pacific islands and their related coseismic and aseismic events that have been incorporated into myth. These myths explain how the 'gods' have "fished up" or "thrown down" islands into the Pacific, the stories explain the "birth" of that island. These Pacific myths have links to actual geological events such as volcanic eruptions or atoll uplift. Nunn (2003) suggests the myths may be recalling uplift of limestone atolls experienced during human occupation or represent the creation of new land from a volcanic eruption. Some myths note that the land was visible below the sea level before fishing up occurred, these could relate to underwater volcanoes that occasionally breach the surface during eruption phases such as the Empedocles volcanoes off southern Sicily (Cohen 2007). In addition this idea can also be compared to those islands fished up that then disappear again below the sea surface through wave erosion e.g. Falcon Island which has disappeared and reappeared at least five times in recorded history (Nunn 2003). The 'throwing down' process in islands myth seems to describe the creation of only volcanic islands, indeed all the islands linked with this myth have all experienced volcanic activity during the human record. Nunn (2001) believes that the "throwing down" myths correspond descriptively to the ejection of pyroclastic flows and ballistics. Nunn (2001) argues that these stories may have travelled with the local people as they migrated through the Pacific therefore the stories have become diffused and relate to regions previously occupied.

Although there is a limited literature on geomythology it is a growing field and in 2008 a special publication of the *Journal of Geothermal Research and Volcanology* incorporated a section on anthropology and volcanoes. This section focussed on oral histories that record and can aid the mitigation against volcanic hazards (Cashman and Cronin 2008, Rodolfo and Umbal 2008, Swanson 2008, Viramonte and Incer-Barcero 2008). Often oral histories are developed from direct contact or observation with events; some communities not only record these events but also learn from them developing their own warning systems and mitigation techniques. As Chester and Duncan (2007) suggest working with communities to develop a greater knowledge of past extreme geological events and learn how they mitigate local hazards is key to effective disaster management.

2.2.2. Traditional warning systems.

Myths can have a protective role as many oral histories are retold as a way of warning future generations about local hazards. In Seattle a series of sandstone boulders (traditionally called *a'yahos*) are believed, by Native Americans, to be haunted and if stared at can cause the ground to shake. These historical artefacts and related myths were thought to be just part of the region's cultural history, yet in the 1990s geophysical images of the region identified a hidden fault traversing Seattle. These fault lines can be traced on the surface by both the sandstone boulders and other legend sites related to shaking. It was therefore discovered that the seismic threat was identified and preserved in Native American culture long before scientists uncovered the physical evidence. The Native Americans had also placed their own warning system in the area for the haunted boulders identified the fault line and the myth dissuaded people from settling or going into these regions (Krajick 2005). Myths and oral histories like this example from Seattle can alert geoscientists to previously unidentified hazards. Sadly, these stories are rarely recorded or taken seriously. For example, in 1986, a large amount of carbon dioxide was released from the Lake Nyos, Cameroon and this cloud of suffocating gas enveloped those villagers living on the slopes and valleys of the volcano and killed 1700 people. No physical evidence of an event like this remains in the geological records, and yet existing local stories of haunted lakes that rise, sink or blow up would have provided a forewarning, if they has been taken seriously (Nelson and Evans 2006). If this geomythological record had been correctly interpreted the carbon dioxide hazard at Lake Nyos could have been identified and mitigated against prior to the 1986 disaster (Krajick 2005).

Rodolfo and Umbal (2008) detail the prehistoric eruption of Mt Pinatubo in Philippines through oral histories and myths. Despite centuries of repose the Aytas people recorded the previous eruptions within their legends and warned of future eruptions concluding their stories with an ominous warning, by saying "But now, you do not see smoke coming out of the Pinatubo mountain… and many believe that the terrible monster is already dead; but I think that he is just resting after his exertions, and that someday he will surely come out of his hiding place again" (Rodolfo and Umbal 2008:6).

So far, the case studies above have not provided a clear example of the mitigational power of oral histories, myths and legends. However, McAdoo (2006) explains how a massive tsunami in 1907 created a moral story developed by the people of Simeulue Island, Indonesia. A children's lullaby explains that after prolonged shaking you must go to higher ground, and so on 26th December 2004 and again on March 28th 2005 the community self-evacuated to avoid earthquake triggered tsunamis. Out of 78128 Simeuluen people, less than 1% died during the catastrophic 2004 Indian Ocean tsunami, in contrast other regions that were hit that lost between 50-100% of residents resulting in the deaths of over 280000 people (Lay *et al.* 2005). It is worth noting however that those killed in Thailand, Sri Lanka, India, the Maldives and Somalia would not have felt the triggering earthquake and as McAdoo *et al.* (2006) suggests, would have benefitted from a technical early warning system. Fitz and Kaligeris (2008) and McAdoo *et al.* (2008) also write about how indigenous knowledge saved residents on the Soloman Islands in 2007 from a tsunami.

Shaw *et al.* (2008) recently published a document in conjunction with the UN/ISDR documenting cases where indigenous knowledge (IK) has assisted disaster reduction. They describe IK as 'the methods and practices developed by a group of people from an advanced understanding of the local environment, which has formed over numerous generations of habitation' (Shaw *et al.* 2008:9). In this report they suggest that indigenous knowledge has three uses within disaster management:

- Indigenous practices and strategies can aid mitigation.
- The incorporation of IK strategies and practices encourages the participation of the community and empowers its members.
- IK can improve project implementations, providing information about the local context.

The report contains case studies from the Asia–Pacific region including earthquake safe indigenous housing in Kashmir, India (Khan 2008) to volcanic warning signs at Mt Mayon, Philippines (Cerdena 2008). On Mt Mayon, the local people have many traditional precursors including rivers running dry, low rumbling sounds, and strange animal behaviour. This community trust their own indigenous precursors so much that they say that they take very little notice of what the government have to say.

2.2.3. Natural reactions to natural hazards.

There are other reactions to geophysical hazards that seem to have cultural roots, rather than being developed through experience or moral message, extreme events prompt an emotional or religious reaction. Chester (2005) argues that many actual and potential victims of hazards continue to explain their losses in spiritual terms. This reaction is related to theodicy, which is defined as any attempt to reconcile religious belief with the reality of human suffering (Chester and Duncan 2007). In times of disaster or stress many people turn to religious explanations as a coping strategy and this can be seen by reading any media article on any major natural disaster. Even the post-Hurricane Katrina disaster was interpreted by some religious conservatives as an act of God punishing America for its sins (J-B 2005). Equally, the eruption of Mt St Helens was also by some attributed to an act of God. Some residents described the eruption of Mt St Helens as a biblical event and that they felt like falling to their knees (Anon 1980) and local radio preachers exclaimed that the eruption was a warning from God towards the blasphemers and drunkards of the region (Chester and Duncan 2007, Chester 2005). In the same way, the 1991 Mt Pinatubo eruption was seen by some of the local Aeta people as a sign of nature's rebellion against a corrupt government (Dvorak 2007). Similarly, one legend explains how Mt Momtombo, in Nicaragua, shook every time the Spanish priest approached its flanks, and the Aztecs believed this was in defiance against the conquistadors (Dvorak 2007).

Theodistic coping strategies appear to occur regardless of socio-economic boundaries, and therefore examples of such beliefs are from a variety of countries both developed and developing. Chester *et al.* (2008) has collated a collection of case studies noting the religious reactions to volcanic activity at Mt Vesuvius and Mt Etna, Italy. The residents of both volcanoes have reacted to lava flow hazards by placing saintly relics in front of the lava flows and holding religious ceremonies on the volcano's flanks. In 2001 the Archbishop of Catania, Sicily, held mass in Belpasso in an attempt to halt a threatening lava flow from Mt Etna during which he exclaimed "the warmer our prayer the cooler the lava" (Chester and Duncan 2007:208, Chester *et al.* 2008:225).

Gillard and Paton (1999) carried out an analysis in Fiji, also exploring the influence of religion on stress reactions to natural disasters. They carried out open-ended interviews with Christians, Muslims and Hindus on the island. Their results indicated that 94% of

Christian Fijians would expect their church to offer assistance after a hurricane event, while expectations for the Muslims and Hindus were lower. In fact it was the Hindus and Muslims who are expected to assist their Mosques and Temples. Despite this difference all of the groups interviewed said that their faith had helped them cope after a disaster. Gillard and Paton (1999:1) suggest that religion impacts upon vulnerability and it is therefore necessary that future projects investigate:

> the ethnocultural experience of traumatic events evaluating similarities and differences between cultures, defining the nature of the constructs that underpin the interpretation of this experience and the expression of reactions, and the use of these findings to develop culturally-appropriate measurement instruments and intervention procedures. (Gillard and Paton 1999:1).

These case studies demonstrate that there is a need to fully understand the local people, immerse oneself within their culture and experience their hazard associated customs.

2.3. Summary.

Haynes *et al.* (2008) describes how the judgements made by at-risk communities rely upon the balance between the risks they face and the benefits associated with taking or living with those risks. For the many people who chose to live in volcanic regions, the benefits of rich, fertile soils outweigh the risk of an eruption. Yet, as the case studies above show, if perception of risk is initially biased (because of educational programmes, government interventions, previous experience, false assumptions of preparedness, confused hazard knowledge, cultural beliefs and emergency plans) then the judgement that motivates them to live in dangerous places is problematic. The risk therefore may not outweigh the benefits in the long term. Kelman and Mather (2008) and Tobin (1999) suggest that by living with the hazards, especially in volcanic regions, can help communities to diversify their incomes, develop a sustainable livelihood and subsequently reduce their risk by being more resilient, but Wisner (2001, 2003) reminds us that without government support improving livelihoods is unrealistic in corrupt and aid dependant states. It seems that a synthesis between these approaches is required in order to follow the sustainable livelihoods approach whilst fostering an increased risk perception and hazard awareness. In order to do this research needs to focus on examining how a community can become more resilient. Yet it is also important to remember that some communities may already be resilient through the application of their traditional mitigation techniques born through experience (Becker *et al.* 2008).

In order to understand at-risk communities and therefore improve mitigation plans, Kelman and Mather (2008), Cronin *et al.* (2004a, b) (Chester (2005) Chester and Duncan 2007) and others suggest that it is important to explore the culture that is shaped by factors of physical and psychological development, experience and indigenous coping mechanisms. Improving livelihoods and 'educating' communities is not going to be effective if the culture is strong enough to motivate people's reactions or lack of reaction. Understanding the cultural reactions to hazards is therefore essential and yet there is a lack of related practical research and is often dismissed in risk reduction strategies.

Pidgeon *et al.* (1992), Cronin *et al.* (2004a, b), Paton *et al.* (2004, 2008), Haynes *et al.* (2008), Mercer *et al.* (2008), Berberi *et al.* (2008), conclude that two-way discussions between scientists, authorities and the public are crucial for risk communication and motivating communities and individuals into pro-active preparations for natural hazards. And although these studies used a combination of qualitative and quantitative methods it was often the qualitative discursive participatory methods that produced an increased insight into the risk perceptions and reactions to hazards than the more constrained quantitative surveys. For as Geertz (1973:22) reminds us, 'the locus of study is not the object of study, Anthropologists do not study villages; they study in villages'. In the same sense this research project does not study a volcano, but on a volcano. And that volcano is Mt Merapi in Central Java.

Chapter 3: A natural laboratory: The geological hazards and society of Indonesia and the primary field sites at Mt Merapi volcano, Central Java.

3.1. A natural laboratory.

This chapter introduces the main field sites in both a geological and social context. The first half examines Indonesia's geological setting and justifies why Indonesia is a significant location for the study of natural disasters. Subsequently it focuses on Java, not only the cultural and political hub of Indonesia but the volcanic heart of this geologically active nation. Finally, the volcanic hazards and eruptive history of Mt Merapi are considered.

The second half discusses the social environment and volcanic culture of Indonesia, Java and Mt Merapi. It also discusses the general characteristics and daily lives of those living on Mt Merapi, concluding with a brief introduction to the two main settlements chosen for the main data collection, namely Pelemsari and Batur.

3.1.1. Tectonic setting and related geohazards.

Consisting of more than 17500 islands (6000 inhabited) spreading over 1 919 440 sq km the Indonesian archipelago is a diverse country linking the continent of Asia to Australia. The islands are divided into four political regions; the Greater Sunda Islands (Java, Bali, Kalimantan, and Sulawesi); the Lesser Sunda Islands; Maluku and West Papua (Lamoureux 2003). Figure 3.1 demonstrates the extent of this nation and notes the various volcanic chains that line three major subduction zones. These zones have been created by the convergence of the Indo-Asian plate with the Eurasian Plate at a rate of 70 mm a^{-1}, forcing a subduction of the Eurasian Plate along various deep trenches, such as the Sunda trench off the islands of Java and Sumatra as illustrated in Figure 3.2 (Hutchinson 2005).

The 3000 km Sunda subduction system is considered one of the most active plate margins in the world and has formed an island arc consisting of dangerous active volcanoes (Hamilton 1988, Petersen *et al.* 2004).

The subduction process also causes frequent seismic activity along the arc that in turn have the potential for causing secondary hazards such as landslides and tsunamis (Figure 3.3). Frequent small to moderate earthquakes plague the islands and cause local destruction and fatalities, whilst occasional large earthquakes have a regional impact. In December 2004 a mega-thrust earthquake (M_w 9.3) off the coast of Sumatra caused a devastating tsunami that radiated across the Indian Ocean killing 227 000 people. In March 2005 the Sunda mega-thrust ruptured again causing an M_w 8.7 earthquake (Telford and Cosgrove 2007, McCloskey *et al.* 2008). Although Grevemeyer and Tiwari (2006) suggest that these very large earthquakes are unlikely to occur along Java, the secondary hazards can be devastating over an extremely large region.

In addition to volcanic and seismic hazards, Indonesia also suffers from hydrometerological hazards such as wildfires, drought, landslides and floods. El Nina related droughts and La Nina related floods devastate this country, whilst tropical cyclones from the eastern south Indian Ocean and the eastern Pacific Ocean threaten Indonesia each year (MoE 2007).

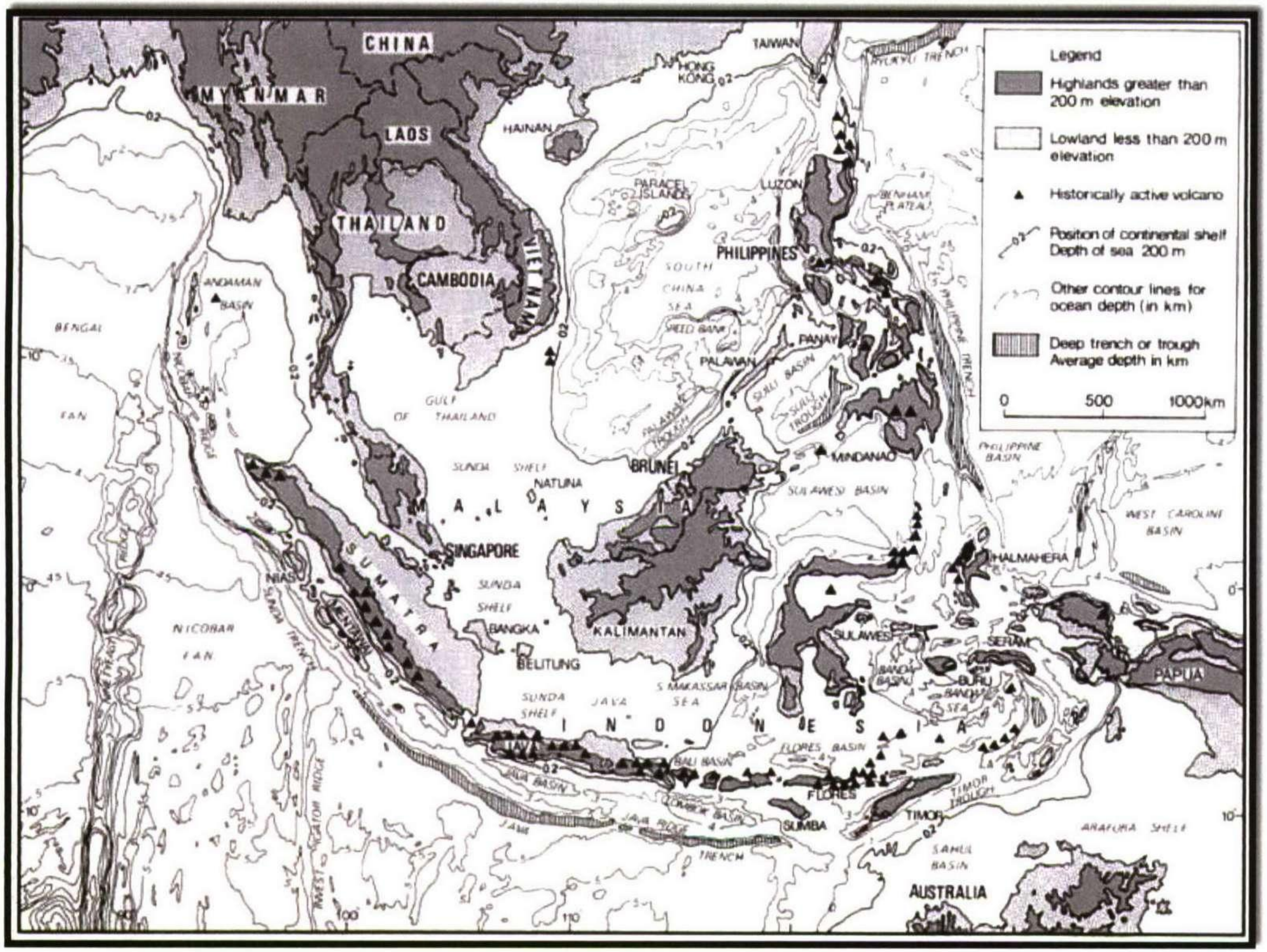


Figure 3.1: The major physiographic features of Southeast Asia. Source: Hutchinson (2005).

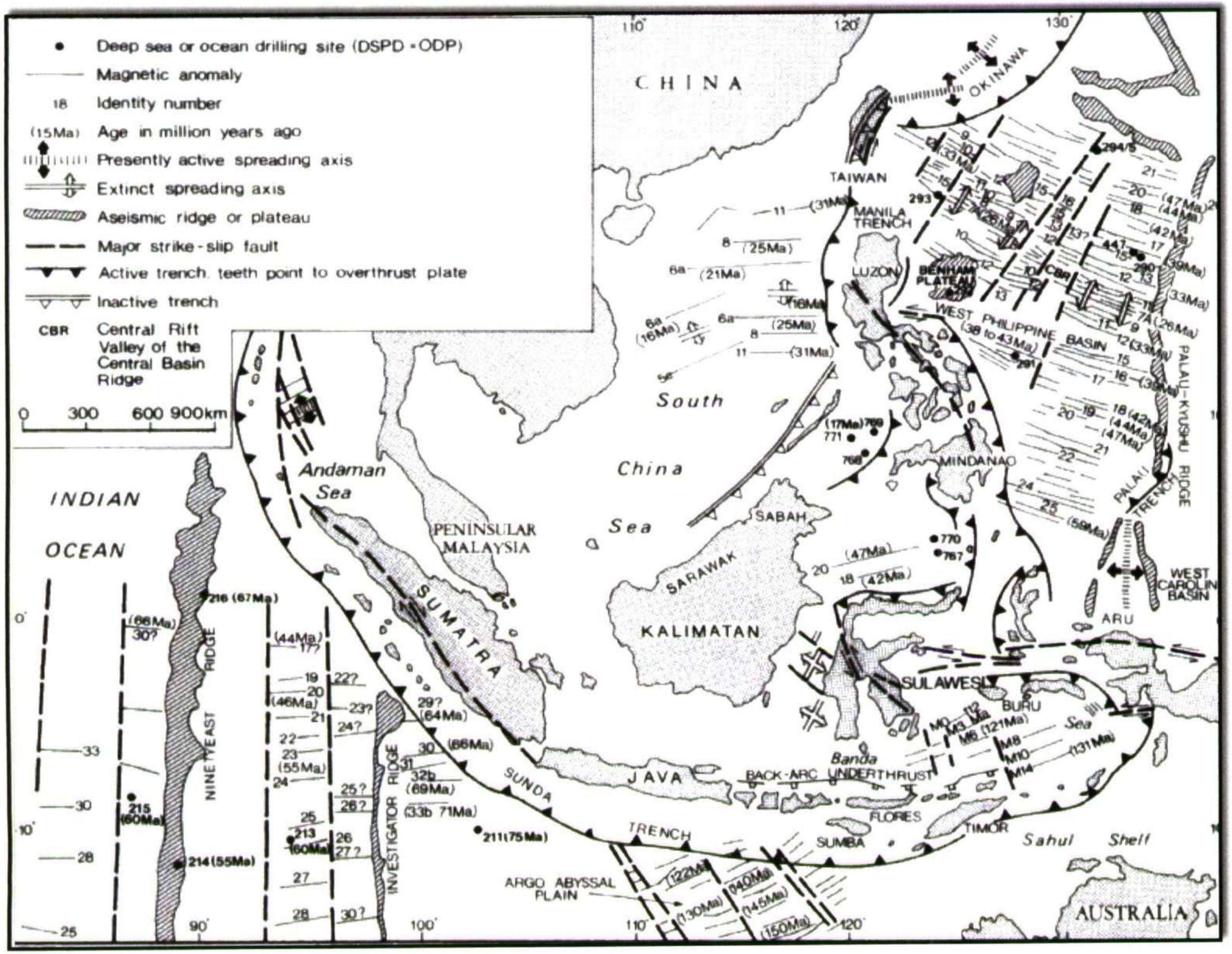


Figure 3.2: The major tectonic setting of Southeast Asia. Source: Hutchinson (2005).

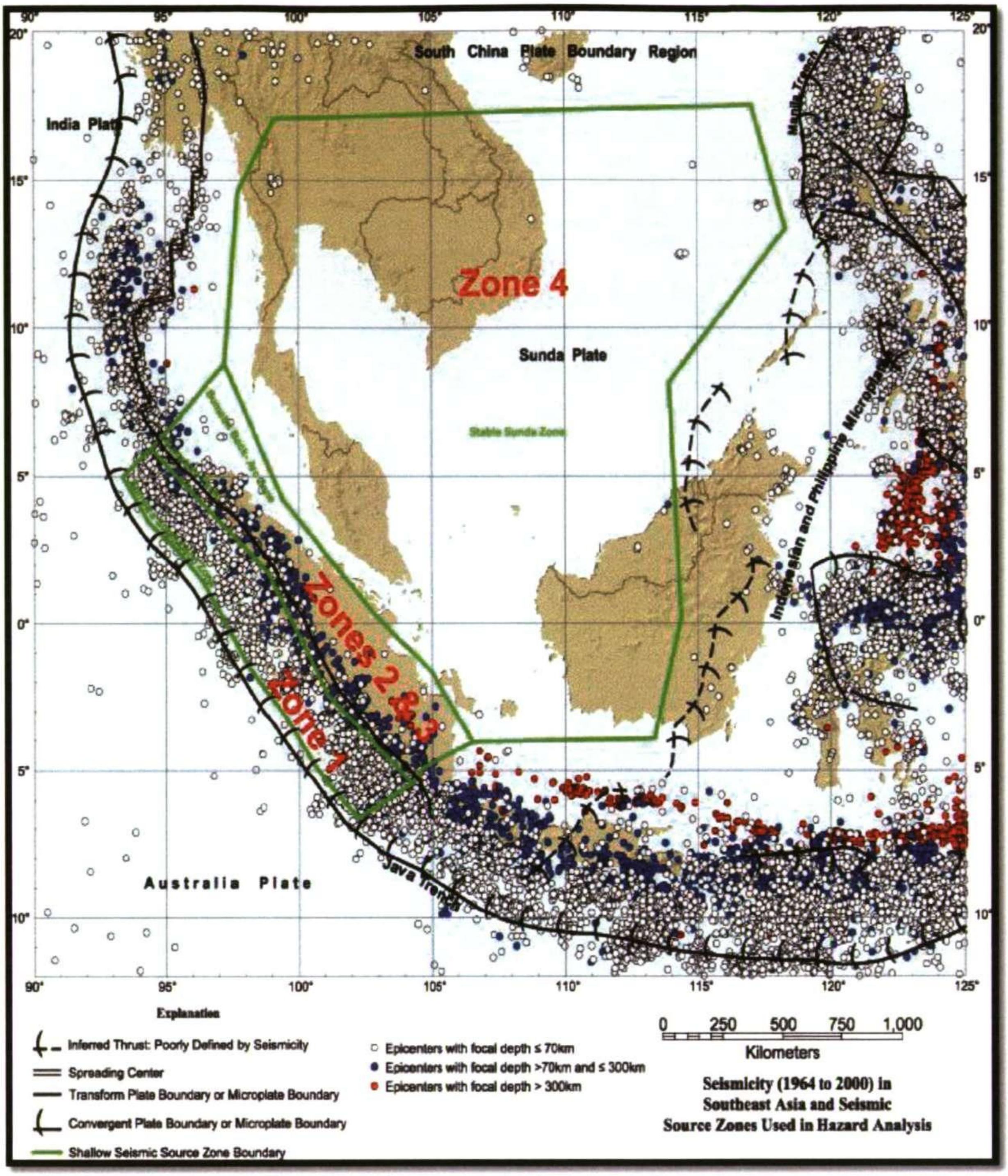


Figure 3.3: The location and depth of earthquakes that have occurred in Indonesia between 1964 and 2000. Source: Petersen *et al.* (2004).

3.1.2. Volcanism of Indonesia.

Although the number of global fatalities related to volcanic eruptions in the last 20 years (shown on Figure 3.4) seems relatively low it is the potential impact of a moderate to large volcanic eruption that could be devastating in a highly populated country such as Indonesia. Indonesia has the largest number of active volcanoes in Southeast Asia (totalling 71 out of 90) and is considered one of the most volcanically active countries in the world (Figure 3.5); in combination with being one of the most densely populated countries, there is a potential for high impact, widespread volcanic disaster (Verstappen 2005, Suryo and Clarke 1985).

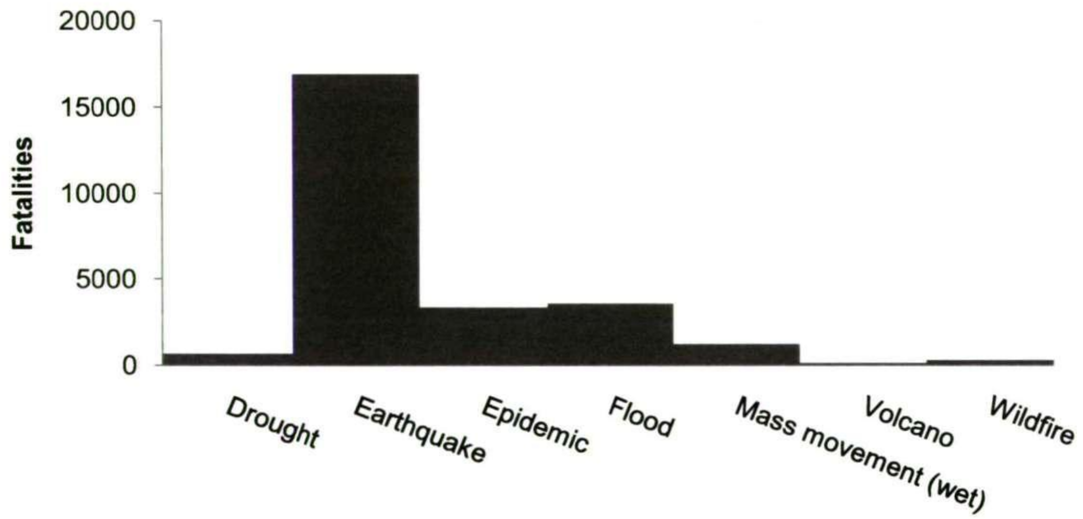


Figure 3.4: The number of causalities from various natural disasters from 1990-2009. Source: Centre for Research on the Epidemiology of Disasters - CRED EM-DAT (2009).

The majority of volcanoes in Indonesia are stratovolcanoes; that is conical mountains with more than one evolutionary stage (Verstappen 2005, Francis and Oppenhiemer 2004). These volcanoes produce activity that includes caldera forming eruptions, fissure-formed eruptions that can range in activity from steam eruptions through to ignimbrite-forming eruptions (Verstappen 2005). These different volcano types produce a variety of potentially devastating hazards ranging from locally destructive pyroclastic flows to widespread ashfall. For example, since 1900, 100617 Indonesians have been directly affected by just 10 volcanic eruptions and experienced some of the world's most fatal eruptions such as Mt Kelut volcano that killed 5000 people in 1919 and Mt Agung that killed 1565 people in 1963 (CRED EM-DAT 2009).

Pre-1900 Indonesia played host to some of the largest global eruptions on historical record. The largest was the caldera forming eruption of Tambora in 1815 that created a 6 km wide crater and killed an estimated 60 000 people. Tambora is recorded as the largest explosive eruption to occur within the last 10 000 years, with 50km^3 of volcanic material erupted in just 24 hours (Self *et al.* 1984). If this event occurred today an estimated 200 000 people living within 50 km of the volcano would need to evacuate and the area within 100 km would experience ash fall between 50 and 100 cm in depth (Simpson *et al.* 2008). Other large eruptions such as the 1883 eruption of Krakatau volcano, west Java, not only killed 35 000 people but captured the popular imagination resulting in the Hollywood film Krakatoa: East of Java (1969) and the BBC production Krakatoa: the last days (2006), as well as causing worldwide atmospheric changes (Self 1992).

Java is the most volcanically active island in Indonesia with only two of the top ten most fatal volcanic eruptions have taken place outside it (Table 3.1). In fact, twenty of Indonesia's most active volcanoes are situated on the island of Java, which also has a high population density with over 800 people per km^2 (Suryo and Clarke 1985, Whitten *et al.* 1996).

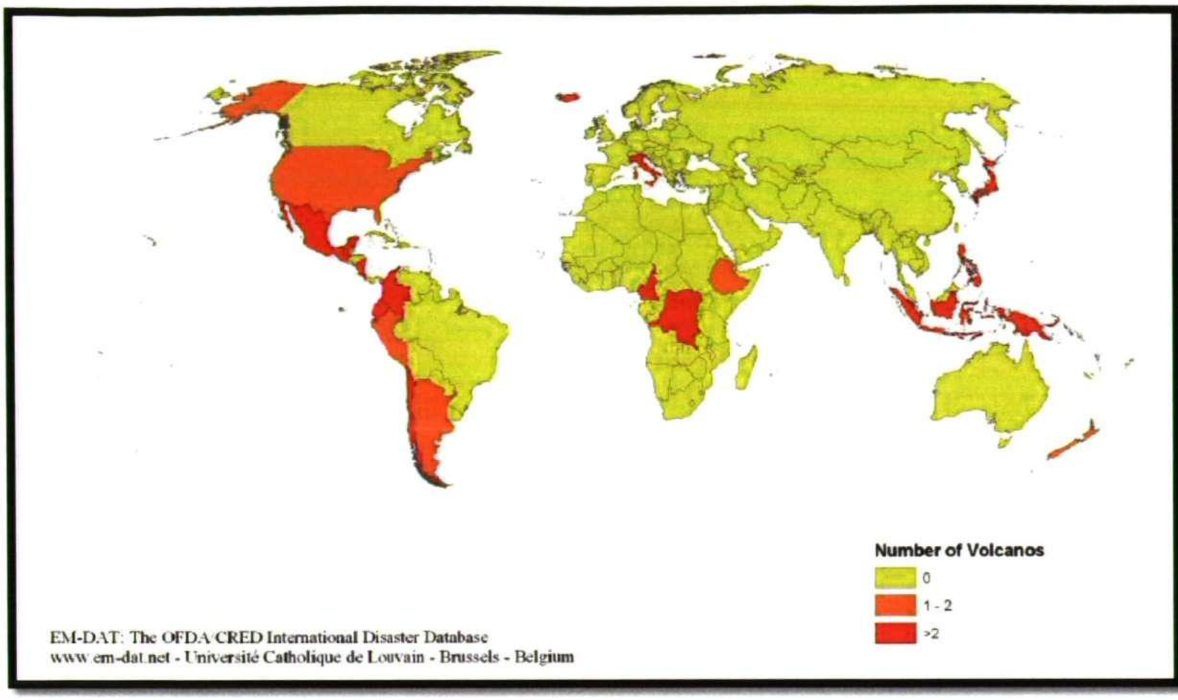


Figure 3.5: The most volcano disaster prone countries. The key refers to the number of volcano related disasters to occur between 1974 and 2003. Source: CRED EM-DAT (2009).

Name	Year	VEI	Type	Deaths
Krakatau, Sunda Strait, Java	1883	6	Caldera	10 000 +
Kelut, Java	1586	5	Stratovolcano	10 000 +
Tambora, Sumbawa Island	1815	7	Stratovolcano	10 000 +
Kelut, Java	1919	4	Stratovolcano	5110
Galunggung, Java	1822	5	Stratovolcano	4011
Merapi, Java	1672	3	Stratovolcano	3000
Awu, Sangihe Island	1711	3	Stratovolcano	3000
Papandayan, Java	1772	3	Stratovolcano	2957
Awu, Sangihe Island	1856	3	Stratovolcano	2806

Table 3.1: The top ten most fatal volcanic eruptions in Indonesia Source: NGDC (2009).

Out of these twenty volcanoes there are two that are currently considered extremely dangerous: Mt Kelut (Kelud) and Mt Merapi. It is Mt Merapi that is the most continuously active of all Javanese volcanoes and it has consequently been monitored by scientists since 1918 (Neumann van Padang 1960, Suryo and Clarke 1985).

3.1.3. Mt Merapi: Location and Eruptive history

Mt Merapi volcano is located in Central Java (110°26'30'', 7°32'30'') and dominates the skyline of Yogyakarta city, to its south, and Solo (Surakarta) city, to its east. The smaller city of Muntilan flanks the volcano to the west, whilst to the north a saddle of land links Mt Merapi with the large volcanic edifice of Mt Merbabu. An important trading route runs over this saddle linking Solo to Muntilan and providing a lifeline for those living on the northern flanks.

The volcano is divided between two provinces, Central Java and Yogyakarta Special Province, and four districts: Slemen to the south, Magelang in the west, Boyolali in the north and Klaten in the east (Figure 3.6). In total there are over 1000 settlements surrounding the volcano, ranging from large cities of over 500 000 people through to small rural hamlets with between 200 and 500 residents (Whitten *et al.* 1996). The land around the volcano is divided again at a lower administrative level between villages, and again at hamlet level.

Mt Merapi is considered by leading volcanologists as being in a continuous state of eruption, experiencing a range of volcanic styles from effusive lava dome collapse events to large explosive eruptions (Thouret *et al.* 2000, Voight *et al.* 2000a). Mt Merapi was declared a decade volcano by the International Association of Volcanology and Chemistry of the Earth's Interior (IAVCEI) identifying it as a high risk volcano and suggesting that it should have research priority.

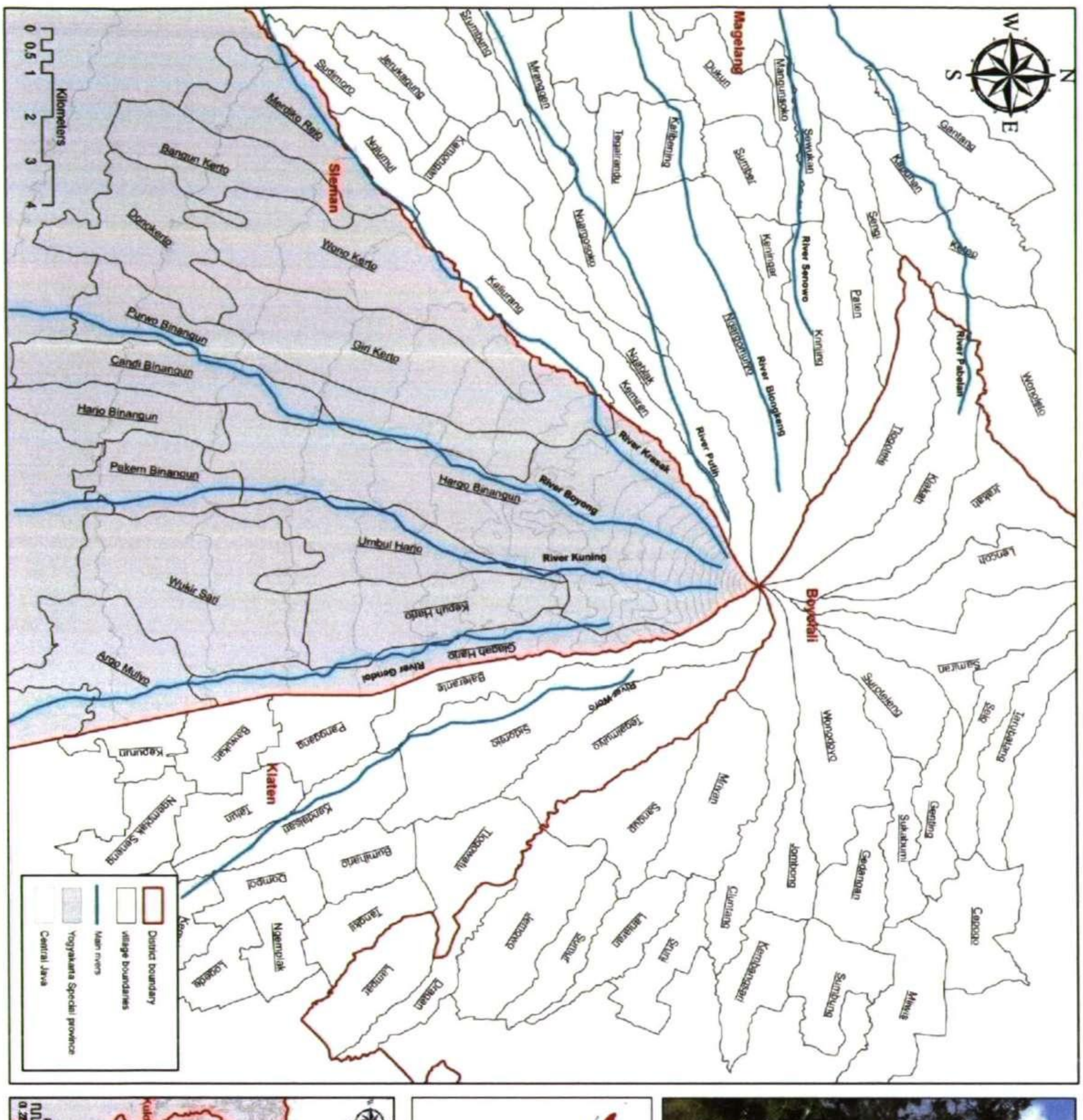


Figure 3.6: Location map for Mt Merapi with photograph inset taken by author from the southern flank of the volcano.

The subsequent international and national research efforts have focussed on an understanding of the volcano's physical characteristics and potential impacts (Blong 1999). Research findings from various projects carried out on Mt Merapi during the International Decade for Natural Disaster Reduction (1900-2000), (Jeggle 1999), have been collated in a special publication of the *Journal of Volcanology and Geothermal Research* Volume 100, published in 2000. This comprehensive publication examines Mt Merapi's historical activity, seismicity, gas emissions, lahars, and pyroclastic flows as well as re-appraising the existing hazard assessment at the volcano.

Mt Merapi is actually a relatively new volcano, growing within the remains of an older ancient volcano called Old Merapi (a ridge of Old Merapi exists on the eastern side of the volcano) (Plate 3.1). The last collapse of Old Merapi, and the initial growth of New Merapi (Mt Merapi), occurred around 1900 ^{14}C y BP (Newhall *et al.* 2000). New Merapi inherited violent characteristics from Old Merapi and between the 9th and 19th centuries, eruptions produced large pyroclastic flows that have travelled over 20 km from the summit. In addition large edifice collapse events (similar to that at Mt St Helens in 1980) have shaped the surrounding landscape (Newhall *et al.* 2000).

During the last 200 years Mt Merapi has produced two styles of eruption (see Figure 3.7). Throughout the 1800s large explosive events (VEI 3-4), such as the 1822 and 1872 eruptions, devastated the surrounding region. Whilst in the 1900s eruptions have been less explosive with dome collapse events that have produced smaller pyroclastic flows and lahars, such as the most recent event in 2006 (Voight *et al.* 2000a, Newhall *et al.* 2000).

Despite observations and recordings for eruptions at Mt Merapi since 1768 Voight *et al.* (2000a) suggest that it is only since the 1924 that monitoring of the volcano identified useful precursors to an eruption. In 1924 Mt Merapi received it's first seismograph and a systematic recording of fumerole temperature recording also began. By 1982 a seismic network was emplaced allowing precise identification of foci (Voight *et al.* (2000a). Table 3.2 demonstrates the substantial array of monitoring that has been used at Mt Merapi and the monitoring techniques that continue today.

Date	Monitoring technique	Comments
1924	• Temperature recording at fumeroles • First seismograph	
1930s	• Tilt monitoring	
1945	• Sound monitoring	
1961-1965	• Electromagnetic instruments emplaced	Removed due to high costs.
1970 - present	• Gas geochemistry of fumeroles	Variations of H2O/gas, C/S and Cl/S ratios recoded before and during eruptive events.
1982	• Seismic array	Joint USGS-VSI project
1980s - present	• Flank electronic disatance measurements (EDM) • Global Positioning System (GPS) • Gavity measurements	Flank and summit networks
1990s	• Seismic array updated -	Digital recodings and processing software, real-time amplitude monitoring, seismis spectural amnplitude monitoring systems.
1990s	• Infrasonic monitoring	
1990s	• Electronic tilt monitoring	Has operated continuously since 1992

Table 3.2: A summary of monitoring efforts at Mt Merapi since 1924. Source: Voight *et al.* (2000a)

The variety of monitoring techniques have identified certain geophysical indicators of an eruption including dome growth, earthquakes, rock avalanches, increased gas emissions, changes in gas geochemistry and small steam explosions. Despite this knowledge the existing database does not provide sufficient information to provide reliable forecasts (Voight *et al.* (2000a). Voight et al. (2000a) also suggests that precursors for larger eruptions (VEI 3 +) may not differ from those observed before a smaller eruption if observed and interpreted at all.

Eruptive style and direction have substantially influenced settlement patterns around the volcano. For example, there are no settlements in the higher western regions of Mt Merapi as they were mostly destroyed in the 1822, 1872, 1930 and 1961 eruptions (Voight *et al.* 2000a). These are some of the largest events to occur during the last 200 years, yet, smaller locally damaging events occur every 2-3 years (Figure 3.7).

Plate 3.1: View of Mt Merapi in foreground and Mt Merbabu behind, taken from the eastern flank of the volcano. Here the somma ridge can be observed encasing the cone of the new volcano. This image demonstrates the high population density surrounding the volcano as the villages that creep up the eastern flank are clearly visible. Source: National Geographic Society 2008.

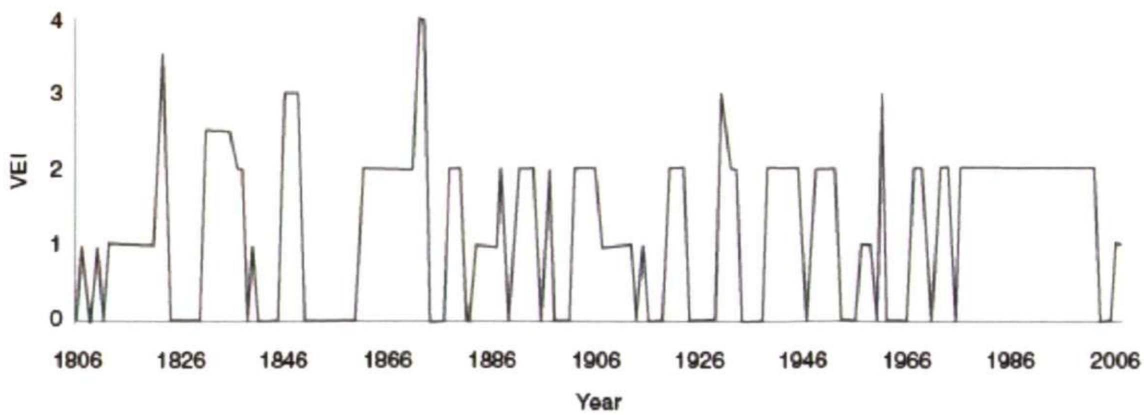


Figure 3.7: The last 200 years of eruptive history at Mt Merapi. Source: Donovan (In press), derived from Voight *et al.* (2000a) and the Global Volcanism Programme (GVP n.d).

In 1822, a sudden onset explosive eruption destroyed 80 settlements and after 8 days of rain, hot lahars travelled over 20 km down the valleys draining the volcano. Van Dijik (1876, cited in Voight *et al.* 2000a), describes the mountain as being surrounded by columns of fire. In 1872 the largest recorded eruption (VEI 4) in the last 200 years devastated a wide area around Mt Merapi and, during 5 days of violent explosive activity, the existing dome was completely destroyed. Although there are written records and descriptions of these eruptions it was not until the 20th century that more complete recordings were taken by the Vulcanological Commission of the Dutch East Indies established in 1918. Today it is known as the Vulcanological Survey of Indonesia (VSI), part of the Center for Volcanology and the Mitigation of Geological Disasters (Neumann van Padang 1960).

A devastating eruption took place at the end of 1930 and unlike the 1822 and 1872 eruptions, precursory signs were recorded. Earthquakes shook the area for nearly a year before lava broke out and avalanched down the flanks in November 1930. In December the situation grew even worse when pyroclastic flows travelled 6-11 km downhill, and although by January 1931 the eruption had reduced in violence, during the following September rainfall remobilized material to produce large lahars. It is estimated that this eruption emitted 23 million m^3 of material covering 20 km^3 that engulfed 13 settlements (Voight *et al.* 2000a). The evacuation and monitoring measures implemented during and after the 1930 eruption, noted by Neumann van Padang (1960), demonstrates the sophistication of mitigation measures active at Mt Merapi during this time. Regular expeditions to the summit were made to record the changes in dome growth and these were recorded as hand drawn sketches and then later photographs of the summit region. Despite this, after Indonesia's Independence in 1949, those who lost their homes in eruptions between 1950 and 1988 were forced to join the government's transmigration scheme.

Local people were moved to less populated islands, and in the case of the Mt Merapi refugees these were mainly relocated to Sumatra (Rigg 1991).

The 1930 eruption was followed by another similar eruption in 1961 that was probably less destructive because settlements had already been destroyed in the previous larger eruptions. The 1961 eruption was characterised by frequent yet small pyroclastic flows (run outs of 3.5 km), although there was a larger flow that travelled 6.5km and destroyed part of the village region of Gendang in the southwest (Voight *et al.* 2000a).

The most dangerous hazards emitted during an eruption at Mt Merapi are primarily, pyroclastic flows and secondly, lahars. Pyroclastic flows have the potential to devastate and deposit material over a large area in a very short period of time. Subsequently, this material can be remobilized by the heavy rains that saturate the land between October and May, transforming flood waters into torrents of volcanic material. Rainfall during these months is often intense with an average of 20mm/hr of precipitation, this in combination with steep slopes, dense drainage patterns and volcanic deposits means that lahars are a common long term hazard that threaten communities traditionally located near river systems (Lavigne and Thouret 2002). Figure 3.8 demonstrates both the intense rainfall and consequent lahar production in the Boyong River, just one of the main drainage systems of Mt Merapi. The seasonal hydrometeorological conditions influence not only lahar production but also social movements. During the rainy season residents are less mobile tending to stay within their homes and village regions, in contrast during the dry season where rainfall is minimal residents are forced to travel further to collect grass for their livestock and sometimes to fill water tanks. Additionally, there are some who work in the rivers throughout both seasons relying on a network of observers and alarms to warn them of lahar activity. Gravel collecting will be discussed in detail in section 3.4.1.

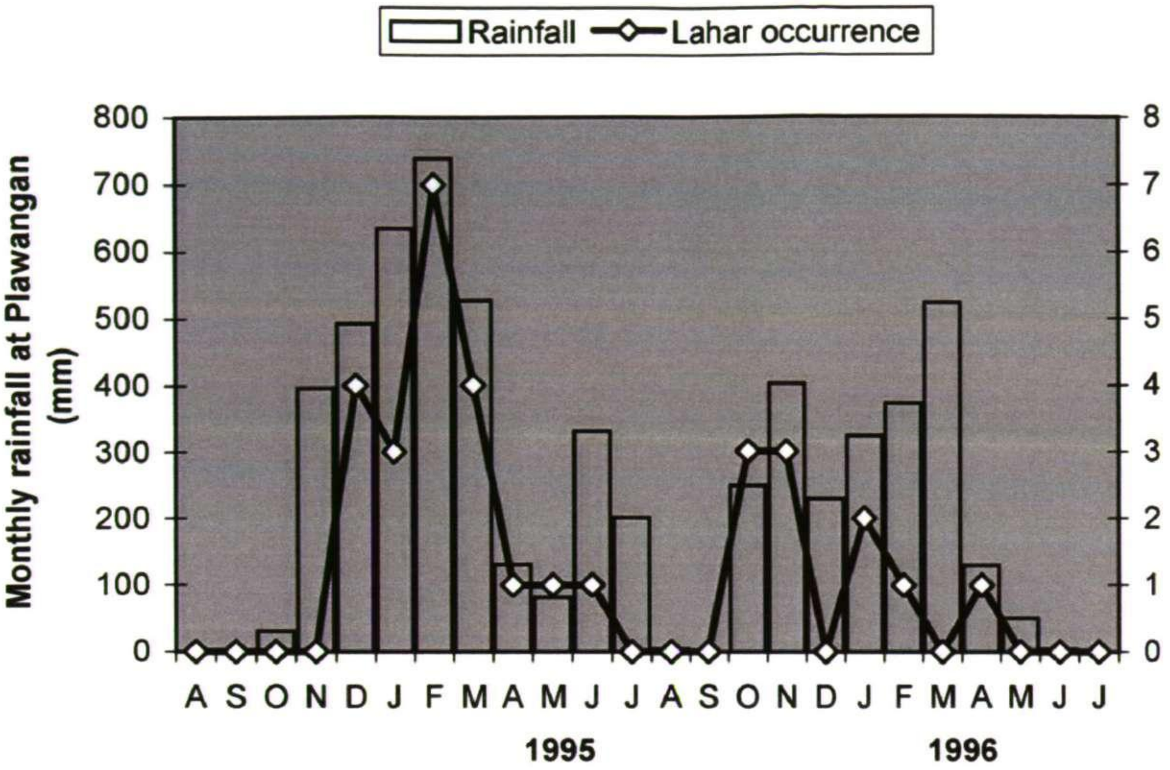


Figure 3.8: The distribution of rain-triggered lahars in the Boyong River after 1994 eruption. Source: Lavigne and Thouret (2002).

Half of Mt Merapi's 80 recorded eruptions have produced pyroclastic flows and over the last 100 years pyroclastic flows have generally travelled in a westerly direction impacting upon the district of Magelang (see Figure 3.9). However, the most recent pyroclastic flow to occur at Mt Merapi, highlighted in red on Figure 3.9, is unusual in relation to the other events because the flow has travelled directly south. This could indicate a recent shift in hazard direction. If this is the case then a region that has not been directly impacted upon for nearly 100 years will now be in increased danger and the concern is that this area will be highly populated and vulnerable as a result of the localised quiescence and inexperienced in regard to hazards and evacuations.

Figure 3.9: The pyroclastic flow paths from 1911- 2006 at Mt Merapi volcano. The most recent event is highlighted in red. Source: Ratdomopurbo *et al.* (2006).

3.1.4. The 2006 eruption.

The most recent period of volcanic activity arguably began in 1972 and since then there have been four subsequent episodes of notably increased activity, in 1984, 1994, 2001 and 2006 (Hort *et al.* 2006). The most fatal eruption was in 1994 when a pyroclastic flow travelled southwest for 6.5 km and killed over 60 people in the settlement of Turgo (Abdurachman *et al.* 2000). Tragically many of those killed had travelled from neighbouring regions to attend a wedding ceremony.

Most recently, in July 2005 Mt Merapi showed signs of increased activity. Volcanic earthquakes in the region increased above background levels and deformation of the summit area became apparent (Charbonnier and Gertisser 2008). In response, the VSI in collaboration with the Merapi Volcano Observatory assigned the alert level at 2 (Table 3.3). In March 2006 a new lava dome began to grow rapidly on the eastern rim of the 1931 crater (see Figure 3.10). By April climbers had been banned and an 8 km restriction zone was put in place around the summit. At the end of April gas emissions at fumaroles and seismicity had increased, whilst the intensifying tremors caused an increase in rock falls from the summit region. Official reports published online by the Smithsonian Global Volcanism Programme (GVP) indicated that by the 24th of April only 600 out of 14000 vulnerable residents had been evacuated (GVP n.d).

Alert level	**Description of activity**	**Interpretation**
1. Akif Normal (Normal activity)	Normal – Monitoring of visual, seismicity and other volcanic event do not indicate changes.	No eruption in foreseeable future.
2. Waspada (Attention)	Increasing activity of seismic and other volcanic events, and visual changes around crater - rock falls, dome growth and seismicity.	Magmatic, tectonic or hydrothermal disturbance no eruption imminent.
3. Siaga (Stand by)	Intensively increasing seismicity with obvious changes at crater, Activity will be followed by main eruption - Increase of activity continues with glowing rock falls, dome growth, increasing seismicity, ground surface tilt, and small pyroclastic flows.	If trend of increasing unrest continues eruption is possible within two weeks.
4. Awas Merapi (Evacuate)	Pyroclastic flows and big eruption.	Eruption possible within twenty-four hours.

Table 3.3: The alert level system for Mt Merapi. The original wording of the alert system given by the Pusat Vulkanologi and Mitigasi Bencana Geologi (Volcanological Survey of Indonesia VSI) has been changed for clarity. Source: Modified from Zschau *et al.* (2003) and VSI (2009).

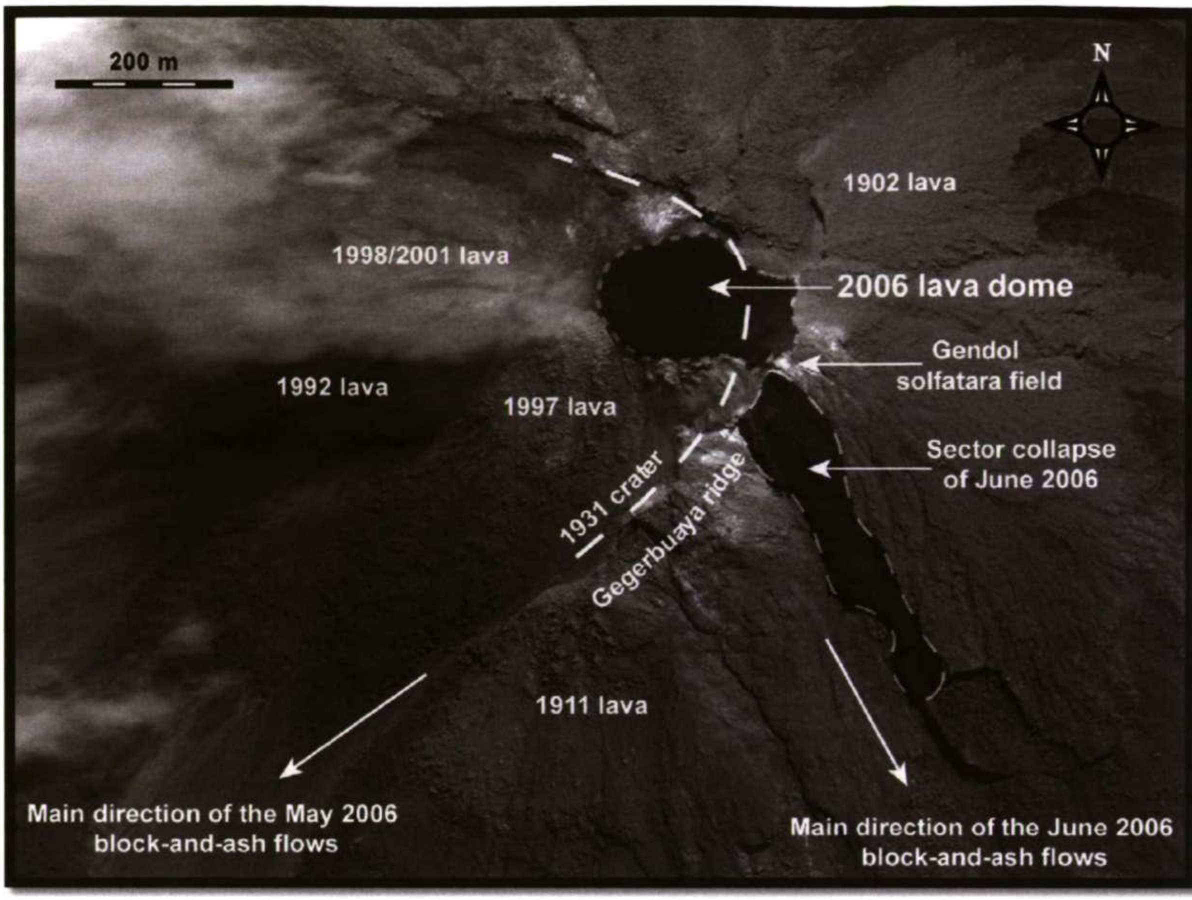


Figure 3.10: A satellite image of the summit region of Mt Merapi, annotations indicate the new 2006 lava dome and the direction of gravitational dome collapse block and ash flow events (pyroclastic flows) in May and June 2006. Source: Charbonnier and Gerisser (2008).

On 6th May an 800 m plume was observed and 18 incandescent avalanches of volcanic material were recorded. The plume increased in height, being estimated by Darwin Volcanic Ash Advisory Centre (VAAC), as reaching 3.7 km on 8th May. As the lava dome continued to grow 26 avalanches were observed travelling 100 m down slope in just one day. On 13th May the alert level was raised to 4 (GVP n.d).

The southern ridge of the 1931 crater (the Gegerbuaya ridge, see Figure 3.10) provided a partial barrier protecting the southern Gendol system from pyroclastic flows (see Figure 3.6 for location of River Gendol) (Charbonnier and Gertisser 2008). Therefore at the beginning of May small to moderate pyroclastic flows (> 4 km run-out) frequently travelled down the south-western river systems culminating in a series of larger pyroclastic flow events that reached 4.5 km down the south-western Krasak River. By the 16th May, in response to this heightened danger, 22000 people had been evacuated and despite a slowdown in growth the lava dome reached a volume of 2.3 million m^3 by 22nd May (GVP n.d, Ratdomopurbo *et al.* 2006).

Following the apparent stabilisation of the lava dome, those living in the north- northwest and southeast were allowed back to their homes; although residents from within 7 km of the summit and 300 m from potential lahar flow paths were not allowed to return. The high lahar risk drainage systems were the Krasak, Bedog, and Boyong (see Appendix 1 for a more detailed map) systems to the southwest and the Gendol in the south (GVP n.d).

However on 27th May a large earthquake (M_w 6.3) struck the Bantul region (just south of Yogyakarta city), killing 5400 people and causing widespread destruction. It is argued that this earthquake may have caused the partial collapse of the Gegerbuayer ridge previously protecting the southern regions and consequently over the days following the earthquake pyroclastic flow activity increased directed primarily towards the Gendol River (Charbonnier and Gertisser 2008, Ratdomopurbo *et al.* 2006). The lava dome's growth had reached 100000m^3 a day by the 8th June and this renewed growth resulted in a partial dome collapse on 14th June. This collapse produced large pyroclastic flows that travelled 7 km along the Gendol River, killing two volunteer observers (Figure 3.11). This fatal event was the turning point in the eruption and by 3rd July activity had reduced sufficiently for the alert levels to be lowered and 14000 evacuated people returned to their homes (GVP n.d).

This eruption made national and global headlines, not because of the hazards, or those who died or the shift in pyroclastic flow direction, but because of an old man in the hamlet of Pelemsari who refused to evacuate, inspiring others to do the same. He quickly became a national hero, amidst political controversy and mystical beliefs. Indonesia is both geologically and politically tumultuous. The environmental, political and cultural characteristics of this diverse country are interconnected as political violence and corruption exacerbate the social impact of hazards, whilst the hazards themselves impact and shape Indonesia's social dynamics.

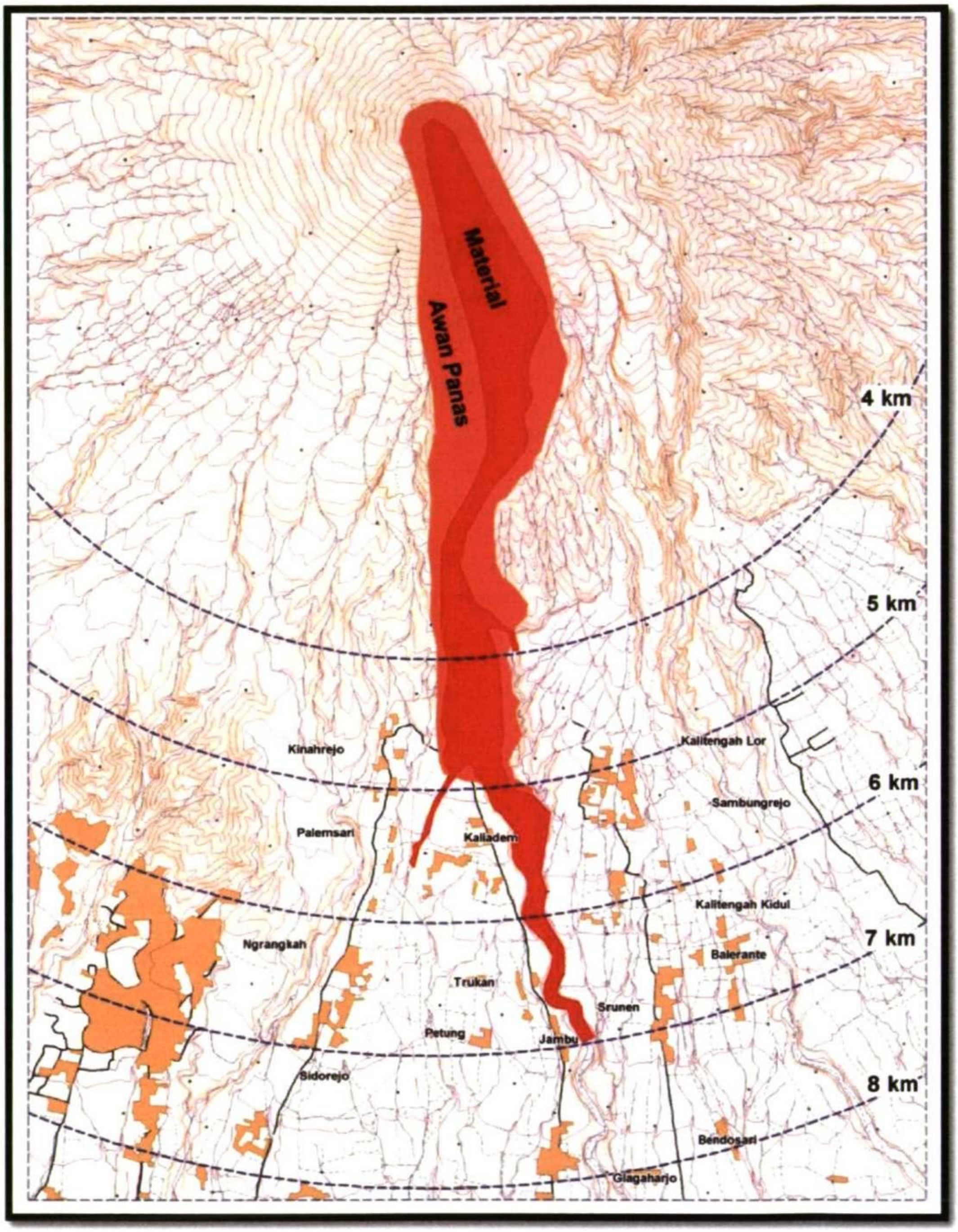


Figure 3.11: The path of the largest pyroclastic flow (awan panas) to occur in 2006 that killed two people. The dark red region represents the pyroclastic material deposited from the 2006 eruption. The deposits were found beyond Jambu. This image was provided courtesy of the Search and Rescue team Yogyakarta.

3.2. Volcanic culture of Indonesia and Mt Merapi.

3.2.1. "Unity in diversity": The Republic of Indonesia.

In the late 1940s, Indonesia was born from the upheaval of war and decolonisation, becoming the largest independent country in Southeast Asia (Sievers 1974, Hugo 2000b). Indonesia is one of the most culturally diverse countries in the world. Although it is the largest Islamic nation it is also home to Christians, Hindus and Buddhists in addition to animistic indigenous religions, described as mysticism (Sieves 1974). This is a nation of great topographic and ethnic complexity, as there are over 60 significant islands and 3000 islets. It is Islam and especially the previous Dutch colonisation that binds this cultural archipelago together as a country (Forshee 2006). There are over 300 languages spoken within Indonesia but the lingua franca of Bahasa Indonesia echoes the nation's motto, "Unity in Diversity", and seems to tie the islands together through a common language with Java at its heart. Although Bahasa Indonesia is the official language of Indonesia most Indonesians retain their own ethno-linguistic subgroup language, and in 1995 only 41% of Indonesians could speak Bahasa Indonesia fluently (Hugo 2000b).

Indonesia's diversity reflects trade and migration from neighbouring regions such as India, China, the Pacific Islands and Arabia (Geertz 1973). Trade with India, in the second century A.D, brought Hinduism and Buddhism to the islands. Now significant Hindu populations are mainly confined to the islands of Bali and west Lombok. Islam was spread through the islands from the late thirteenth century by Arab merchants and traders and by the end of the seventeenth century the majority of the populations of Java and Sumatra had converted to Islam. Today over 80% of Indonesians are 'officially' Muslim although there is a large variation in orthodoxy (Hugo 2000b).

The hybrid nature of Indonesian culture also reflects the pre-historic migration of Austonesian peoples, then from the Malay Peninsula and Australia. But in recent times the population and culture has been shaped by an immigration of Chinese, Indians, Arabs, Persians, and Europeans (Forshee 2006). Equally, some ethnicities have been destroyed through colonisation and geological events, when for example, the eruption of Mt Tambora in 1815 eliminated the Tambora language group and in 1621 the indigenous people of the Banda Islands were massacred by the colonising Dutch (Forshee 2006).

The Javanese constitute half of Indonesia's population and are the largest single ethnic group in Southeast Asia (Mulder 1994, Forshee 2006). Java is the cultural hub of the nation, and the majority of residents are referred to as Javanese-Muslim, who follow a hybrid religion of Islam, indigenous animist and mystical beliefs, with the latter more dominant in rural regions than urban areas.

In the 8th and 9th centuries Java prospered due to its control of the Straights of Melaka. During this time of prosperity the vast Buddhist monuments of Borobudur and the Hindu complex of Prambanan near Yogyakarta city were built. The Marajapahit, Java's greatest pre-Islamic dynasty ruled over Java from 13th century until it was defeated by Muslim armies in the 16th century and from then on Islam spread throughout the island (Beatty 1999).

Subsequent political turmoil has brought extreme suffering and repression. First, the Portuguese and then the Dutch colonised parts of Indonesia culminating in a bloody Dutch advance on Bali in 1906. During the Second World War the Japanese conquered Indonesia but with their surrender in 1945, Indonesian nationalists proclaimed an independent state and although the Dutch briefly re-colonised the country Indonesia gained full sovereignty in 1949. Sukarno became its first president and his nationalist regime had communist sympathies but in 1965 after a complicated military coup General Suharto seized power.

Following this there was a brutal anti-communist backlash and between 1965 and 1967 hundreds of thousands of suspected communists were killed, totured or imprisoned. In Bali alone 80 000 people were murdered, and overall the estimated death toll reaches half a million (Forshee 2006, Anderson 2008). From 1966 to 1998 Suharto's authoritarian presidency experienced outbreaks of political and religious violence, but despite this Indonesia was one of Southeast Asia's fastest growing economies until the 1997-1998 Asian financial crisis. Indonesia remains a middle income country and the World Bank reports that at the end of 2008 Indonesia achieved its best economic performance since the 1990s (The World Bank 2008). However, corruption, and religious unrest continue to plague the country. In 2002 fundamentalists bombed a nightclub in Bali and in 2003 and 2009 luxury hotels in Jakarta were targeted. After a long and politically tense trial the instigators of the Bali bombings were executed in 2008 (Beaumont 2008).

Natural disasters have widespread political implications in Indonesia. Following the devestating 2004 Indian Ocean tsunami the Free Aceh Movement, that had been fighting the Indonesian government for independence for 30 years, signed an agreement for autonomy in order that the reconstruction of Aceh could go on unhindered by separatist violence (Renner 2006, Gaillard *et al.* 2008).

Disasters are often seen as punishment for political corruption and as one media report claims 'beneath the veneer of modern Indonesia, ancient beliefs are strong. Some Indonesians blame the recent string of natural disasters in the country on a host of supernatural influences...the country's leadership, particularly its president, [is] out of tune with the forces of nature' (VOA news 2006:1). For many Indonesians a harmony and a relationship exists between humans and nature, and this relationship is kept in balance by indigenous beliefs and ceremonies. This is evident in Java, where politics, culture and natural hazards are intertwined (Schlehe 1996).

3.2.2. Volcanic culture at Mt Merapi.

Mt Merapi is one of Indonesia's most active and populated volcanoes and is therefore a symbol of interaction between nature and humanity. This interconnection is expressed through various myths and legends about Mt Merapi (Schlehe 1996).The limited literature on Mt Merapi and its related myths focuses on two themes. One explains the presence of a mystical kingdom at the summit of Mt Merapi where *Muhluk Alus* or unseen creatures and/or *Baureksa* or spirits, live (Dove 2008). This kingdom exists in a parallel dimension that can interact with our dimension by taking people required by the spirits for a certain job (Schlehe 1996, Zielinger de Boer and Sanders 2002). The other theme is a locally well known legend recalling the cosmological relationship between Mt Merapi, the South Seas and the Kraton (the Sultan of Yogyakarta's palace).

According to this legend, Mt Merapi was formed because the island of Java required 'balancing'. There was a large mountain in the west of Java and the deity Krincing Wesi decided to relocate this mountain to the centre of the island in order to maintain balance. He required help and so asked two brothers, Empu Romo and Empu Parmadi, but they refused to help him. Krincing Wesi was so angry by this that he hurled part of the large mountain at the brothers. The rocks he hurled became Mt Merapi and the brothers became the first spirits to live there. With the remainder of the original mountain he created Mt Merbabu, the volcano directly to the north of Mt Merapi (Schlehe 1996). Since then more people have been sent or banished to Mt Merapi. Local people believe that if the spirits require a certain task to be completed they will 'take' a person with the necessary skills to live in the spirit kingdom. For example, if the spirits require a gardener, they will take a resident who is a gardener who will then continue this occupation in the spirit kingdom. This therefore reinforces the idea that the spirits and deities carry out their daily tasks in the kingdom that is similar to our daily reality (Zeilinger de Boer and Saunders 2002, Dove

2008). Eruptions are interpreted as the gods holding ceremonies, a sexual union or a wedding; the eruption can also be seen as a celebration (Schlehe 1996). Although Dove (2008) questions this view suggesting that the villagers of Turgo (partly destroyed by an eruption in 1994) believe the eruptions relate to mundane, everyday activities. Such contrasting beliefs are indicative of myths in volcanic regions where location and experience play a crucial role in developing and shaping the local customs and beliefs (Cashman and Cronin 2008).

The eruption as a celebration relates to the Javanese view that eruptions are beneficial. Eruptions fertilise the land and this is understood and communicated through myths in sexual terms referring to the volcano ejaculating and fertilising the Queen of the Southern Seas, *Ratu Kidul* (Zeilinder de Boer and Saunders 2002). Like the kingdom of Mt Merapi there is also a spirit world in the south sea and the goddess Ratu Kidul, rules. According to Javanese culture the queen is spiritually 'married' to each of the Sultans of Yogyakarta and has a special mystical relationship with the Kraton, and Mt Merapi (Whitten *et al.* 1996). It is this relationship with Ratu Kidul that enables the sultan to rule (Resnik 1997). The 'second divine spouse' of the ruler would visit the sultan at the Water Palace in Yogyakarta on her way to Mt Merapi via the Code River that connects the volcano, the city and the sea (Lavigne *et al.* 2008).

This spiritual connection and the supernatural creatures of Mt Merapi are celebrated during a ceremony called the *Labuhan*. This ceremony is held on Mt Merapi by the Kraton staff and the Kraton's representative on the volcano, known as the caretaker of Mt Merapi, Mbah Marijan. The *Labuhan* story does not correspond entirely with the myth of Dewi Krincing Wesi but rather describes the reason for the *Labuhan* ceremony. Appendix 2 gives the *Labuhan* story in full recorded during the main field season for this research and it corresponds with a version noted by Schlehe (1996). In brief, the Sultan was given an egg, referred to by the villagers as the egg of the world. Afraid to eat the egg, he gave it to a servant to try first. After eating the egg the servant turned into a giant (*Juru Taman)* and he was then sent to Mt Merapi to live and guard the volcano. According to Schlehe's (1996) account, the Sultan became responsible for the army of spirits and the state of the volcano. In particular he was to make sure that lava never flowed towards the Kraton (to the south) and so the people of Yogyakarta believe they are safe as they are protected by the giant called *Kyai Sapujagad.* To appease the creatures that protect the Kraton, the sultan vowed to present clothes and food to the spirits every year. The Kraton staff process to a sacred site on the volcano and present offerings to the creatures for protection, and with a recent increase in volcanic activity since 1994 a renewed interest in this ceremony has ensued (Schlehe 1996).

From this rich source of myths, traditional beliefs and customs about the volcano and the Kraton, the local people have forged a 'culture of hazard' (Dove 2008:333), incorporating volcanic hazard into their everyday lives. They have adopted and adjusted their agricultural and cultural activities to exploit the benefits of an eruption and to cope with the disadvantages. However, Laksono (1988) and Dove (2008) note that the government has tried instead (and to some extent failed) to relocate the at-risk communities. Dove (2008:336) writes that 'the natural and cultural genesis of the view of volcanic eruptions as agents of change, [is] opportunistically embraced by proximate villagers, feared and controlled by the state'. In other words, the local community exploit the eruptions whilst the government view them as negative events.

3.3. Indonesian living: Rural residents of Mt Merapi.

3.2.1. Livelihoods.

The people at most frequent and direct risk at Mt Merapi are those who live and work on the flanks of the volcano. They are mainly farmers and have a traditional lifestyle albeit one that has been shaped by the political upheaval throughout Indonesia's recent chaotic history. The wealth and success of the farmers depend on land ownership and crop type. Those who live on the lower south-western flank on the border between Sleman and Magalang enjoy improved living conditions as they have recently (last 10 years) started to grow *Salak* (*Salacca Zalacca*) that is not only important for the national market but has broken into the export market and is therefore proving to be a valuable cash crop. In the volcano's northern regions, specifically on the saddle between Mt Merbabu and Mt Merapi the slopes are terraced in order to grow vegetables (carrots, chilli and cabbages) and tobacco, whilst in the high eastern regions roses are grown. Figure 3.12 illustrates the diversity of crops and therefore the appeal of living on the fertile ash fed slopes of Mt Merapi. Yet despite the diversity and wealth of crops the local population is still extremely poor and own very little property.

The poorest people live in regions where it is impossible for them to own 'fields' as the land is officially owned by the government. High on the southern flank directly north of Umbulharjo village the land has been forested and although local residents are allowed to collect the grass within the forest, the land cannot be worked. In these settlements, such as Pelemsari, vegetables are only grown in a small plot adjacent to their homes for personal consumption and their main income is reliant on milk production. Most families own at least one cow and spend the day milking and collecting grass for their livestock. The cows are stall-fed and so all the grass must be collected by hand and brought to the animal (see

Figure 3.11). In the dry season grass grows less rapidly and is in short supply, forcing farmers to walk many kilometres further up the volcano to collect grass.

Figure 3.12: The agricultural diversity around Mt Merapi. All photographs are authors own except where noted. Clockwise from the top left corner: Rose fields line a hamlet in the east; women harvesting corn in the southeast sat in front of their brick home; rice fields surround the volcano to the east, south and west; The line of truck removing gravel from the Gendol river; the stall-fed cattle in the high regions; villager from Pelemsari collecting grass for his cow; the Salak harvest in the west (www.peterhemerway.com/salak); chilli harvest in the west (http://news.bbc.co.uk/1/hi/in_pictures /7350548.stm); the isolated hamlet in the high northwest with poor road conditions and more traditional houses; isolated hamlet in Klakah in the northeast the roads have been completely destroyed and access to this hamlet and the hamlet above is only possible on foot. The house shown is a traditional Javanese structure with woven bamboo walls and a heavy tiled roof. A digital copy of this image can be found in Appendix 1.

The bundles of grass can weigh over 40 kg and are carried back on their heads if men or attached with a shawl on their backs if women. Those who own more cows have to make more journeys into the forest every day. Their dairy cows, therefore, represent their sole income and savings.

The volcano does not only provide fertile soils, but the volcanic deposits can be used in construction. The gravel deposits from recent lahar activity in the west and southern flanks is now being collected by hand and sold to construction firms. After the 2006 eruption the Gendol River was a hive of activity with groups of locals taking advantage of this resource (see Figure 3.12 bottom right photograph). This activity also unintentionally reduces the amount of deposit that can be remobilised in the rainy season; therefore the quarrying of gravel reduces the potential lahar hazard down river.

3.3.2. Structure: physical and social.

Traditional homes in rural Java are made from woven bamboo with heavy tile roofs (see Figure 3.12, top left photograph). These homes were designed to be easily and cheaply repaired after the rainy season, and because of this the government refers to them as non-permanent housing. Despite a push since the 1980s to build more permanent concrete structures on the slopes of Mt Merapi it is still possible to find traditional structures. The majority of permanent homes are now made of poor quality concrete but retain the more traditional roof structure. It is the traditional roof structure and the lack of building regulations in rural regions that can cause problems during earthquakes and eruptions. The additional weight of (potentially wet) ash on top of an already heavy tiled roof that is supported by either weak bamboo or non-reinforced concrete walls can cause the structure to collapse, killing those sheltering inside, and even relatively small earthquakes could cause weak buildings to collapse.

The villages are spilt into several hamlets that can be scattered over many kilometres up the volcano so although individual hamlets are usually clustered along roads, the village region can cover a large area. This means that organising a village meeting point easily accessible to most people on foot or by transport might not be straightforward. Here Indonesian regional and village structure aids the organisation and communication between hamlets. In general each hamlet will have a group of representatives consisting of a head of hamlet who oversees the Rukun Tetangga (RT) and Rukun Warga (RW). The RT is a member of the neighbourhood association, the lowest administrative unit above the head of household and RW is the administrative unit just below the head of hamlet; although the number of RTs and RWs and their roles often differ from village to village depending on the individual village organisation. These representatives attend meetings at a village level where the head of village is responsible for attending regional meetings and being in communication with the regional office (see Figure 3.13). Each village has an office where meetings can be held and administrative details are dealt with. The organisation of villages is outwardly efficient and the most important aspects of daily life are recorded, discussed and resulted. This efficient system should aid emergency managers during a crisis to disseminate information and organise evacuations quickly.

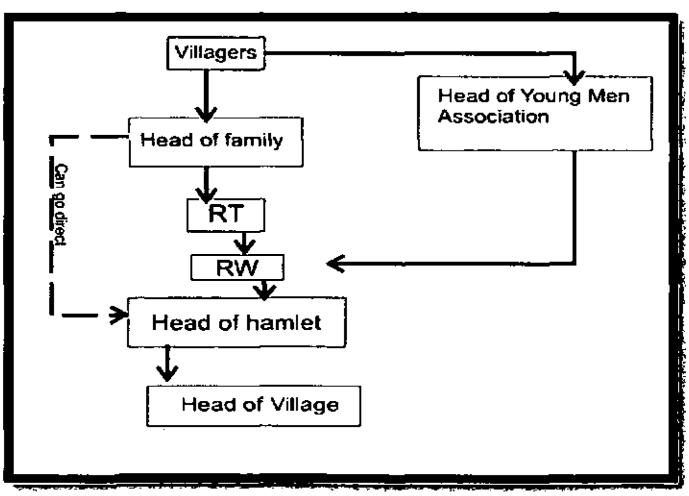


Figure 3.13: Basic community structure for rural hamlets at Mt Merapi (created during the participatory workshops).

Access to more isolated regions can be difficult as although most main roads are surfaced the gravel trucks have destroyed many of the roads making them virtually impossible to pass except on foot (see photograph of Klakah in Figure 3.12). The minor roads are usually single tracks that at times are only passable by motorcycle. A single lahar or flood could easily cut off certain villages as many of the main access and escape routes for isolated settlements have to cross large river systems, especially in the northwest, north and southeast.

3.4. Field sites: Pelemsari and Batur, Mt Merapi, Sleman District, Yogyakarta Special Province.

Pelemsari and Batur were the two settlements identified for this study as these settlements are both located on the southern flank of Mt Merapi and have recent eruption and evacuation experience. Pelemsari was specifically chosen because it is home to Mbah Marjan the apparent spiritual leader at Mt Merapi, whilst Batur acts as a control, a more representative settlement at Mt Merapi. They are within 5 km of each other and yet vary in terms of agricultural practice and economic diversity due to the change in altitude. These two settlements are considerably different yet located reasonably close together providing good comparisons and contrasts.

Table 3.4 provides a summary of the available demographic for Batur and Pelemsari. This social data was recorded within each hamlet by the Head of Hamlet. The data provided here was noted during the 2007 fieldseason from the records available and therefore is not comprehensive for each hamlet.

Data	**Pelemsari**	**Batur**	**Comments**
Population	245	425	
Head of households	79	-	
Men	113	205	
Women	132	220	

Offical religion	Muslim	Muslim	
Children and education levels	Primary (6-12 yrs) – 79 Secondary (12-15 yrs) – 25 College (15-18yrs) - 20	Primary – 238 Secondary -54 College - 35	Batur has its own primary school.
Occupation	Farmer - 52 Abdi Dalem (Kraton staff) – 4	Independent – 58 Farmer – 34 Builder – 9 Reitred government staff – 2 Gravel collector – 25 Services - 19	Given as graph in Figure 3.15

Table 3.4: A summary of available social demographics for both fieldsites. Source: Data was provided by the the Head of Hamlets in 2007.

3.4.1. Batur.

Batur hamlet is located on the banks of the Gendol River approximately 5 km from the summit (Figure 3.14). During the 2006 eruption pyroclastic flows did not reach the hamlet but the resulting deposits were re-mobilized into lahars that filled the Gendol River and in some places scattered material over the river banks (Plate 3.2). No one from this village was killed or injured but the hamlet was officially within the evacuation zone.

The hamlet extends along a reasonably good quality surfaced road that follows the Gendol River north until Bebeng (2 km from the summit, and the area destroyed by pyroclastic flows in 2006 (Figures 3.14 and Plate 3.3). This main road cuts through the village region providing good access to both the higher hamlets and Yogyakarta city, the latter being approximately one hour by motorcycle.

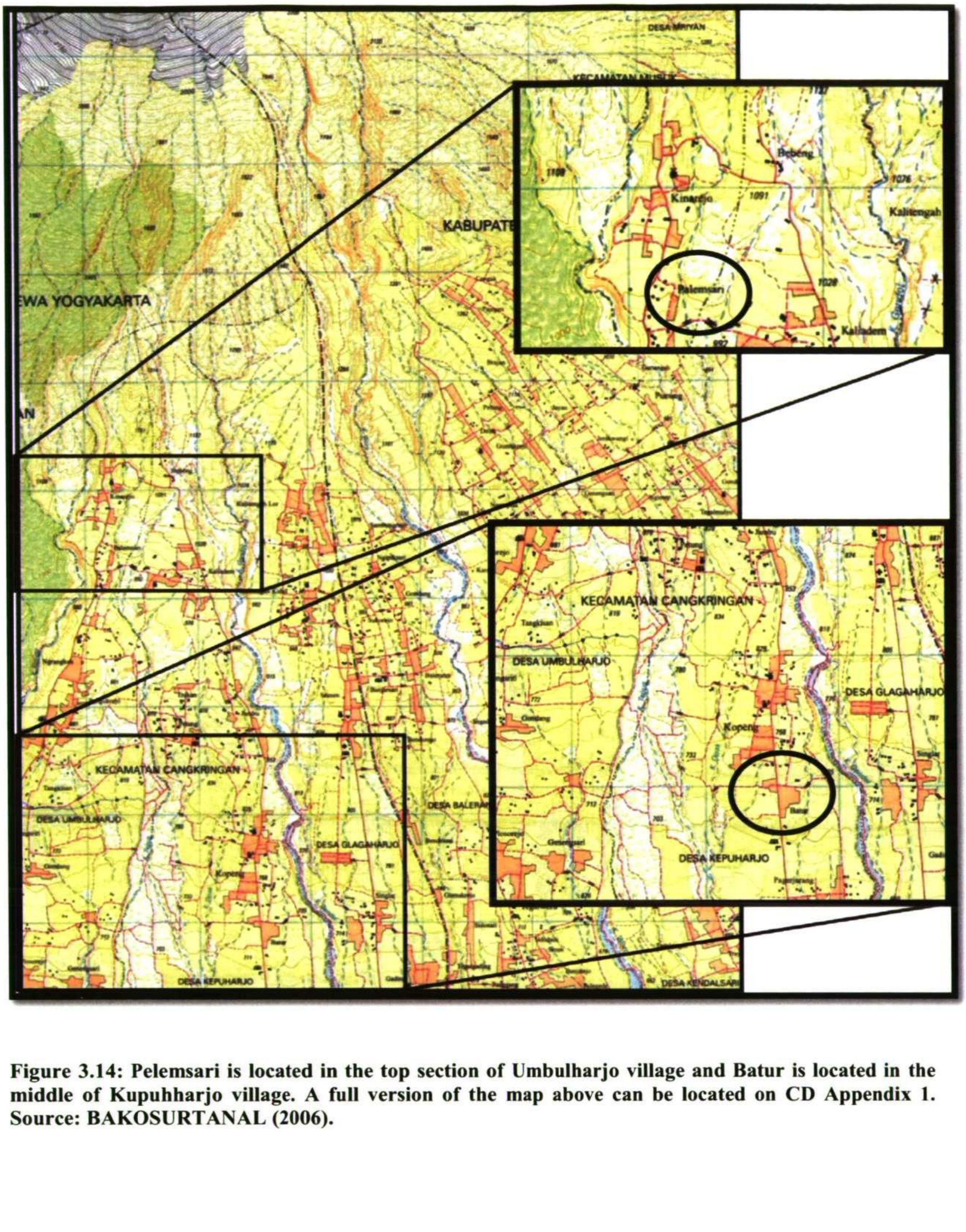


Figure 3.14: Pelemsari is located in the top section of Umbulharjo village and Batur is located in the middle of Kupuhharjo village. A full version of the map above can be located on CD Appendix 1. Source: BAKOSURTANAL (2006).

Plate 3.2: The Gendol River photo taken just above Batur, this photograph shows the vast lahar deposits which clogged the river valley and which provide an income for the Batur villagers. The river banks are approximately 200m high and the deposit is 50m deep.

Plate 3.3: The devastated Bebeng region. The roof of a warung (small restaurant) is visible above the pyroclasic deposits. This area used to be a tourist spot with shops and eateries.

The road is mainly used by the gravel trucks that transport deposits from the Gendol River. The lahars have provided this area and Batur in particular, with a good income, as after the eruption almost all the young men and some women worked shoveling lahar deposits onto trucks. For each full truck they each receive approximately 20000 Rp (£1.00) depending on how many workers fill that truck. They work in teams having their own pitches and each group will have an alliance with certain truck drivers. It usually takes about two hours to fill a truck full of gravel and the work is hot and dangerous with larger boulders precariously stranded on thin pillars of gravel, standing in isolation as the material around has been excavated with picks and shovels (Plate 3.4). After the 2006 lahars over 90% of the young population worked in the Gendol River, yet, a year after the event, most of the 'easier' gravel had been removed and it was becoming much harder to dig out the lower levels. By 2009 trucks had to drive up the river to the Bebeng region to collect gravel and this could take up to one hour. As a result of this the numbers of workers are reducing and those that remain are receiving less pay, some groups being physically unable to fill their trucks and they all are hoping for more lahars during the forthcoming rainy season.

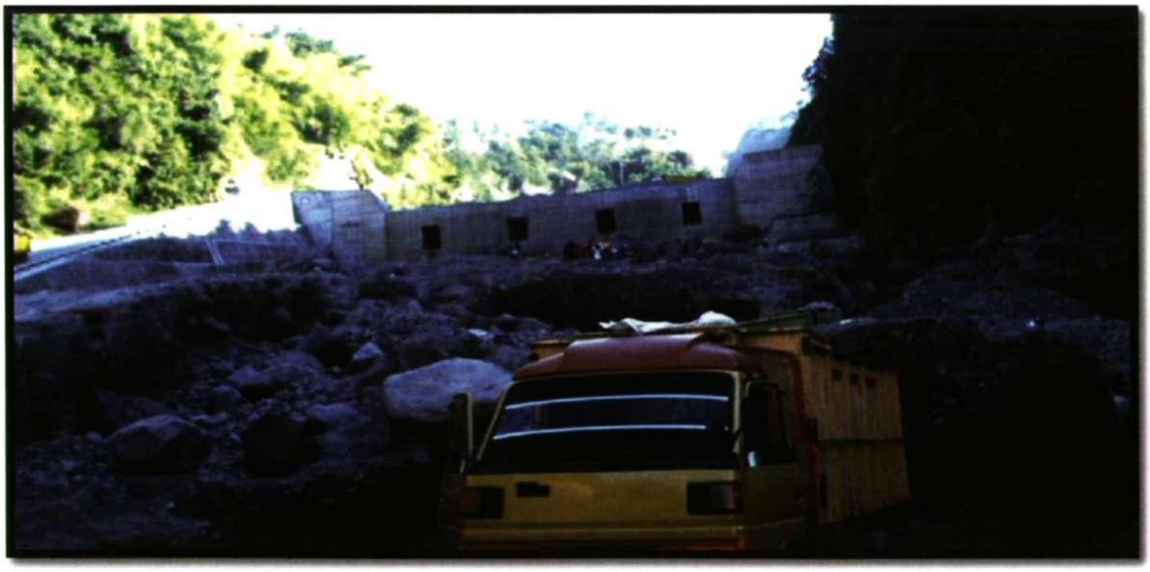


Plate 3.4: A gravel truck is loaded by hand in the Gendol River.

Other than gravel collecting, the temperate climate in Batur, being at an altitude of 750m with annual rainfall between 2500-3000 mm, means that a wide selection of produce can be grown easily and the residents of Batur enjoy a variety of income opportunities. This additional income comes from farming talus (or Taro, *Colocasia Esculenta*), cloves, and coconut to collecting and selling bamboo and other varieties of wood. Although most villagers keep livestock, there is not the reliance upon dairy produce as will be shown for Pelemsari. Figure 3.15 shows the occupational distribution for Batur the majority being farmers or independent (not having a primary occupation but relying on seasonal work). In contrast Pelemsari has no occupational variety as the majority of residents are officially registered as dairy farmers (see Table 3.4).

An insight into the residents' daily lives can be seen in Figures 3.16, 3.17 and Table 3.5 [1]. Here the villagers of Batur have described their daily and seasonal schedule. The women's role focuses on cooking, animal husbandry and caring for children, whilst the men carry out the intensive labour in the river or fields. In order to collect the necessary amount of grass both men and women share this duty, especially if a household has more than two cows.

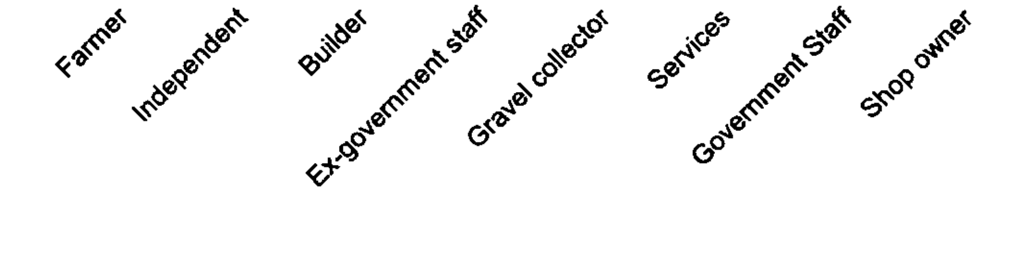


Figure 3.15: The main occupations in Batur from Official government statistics (from 2006).

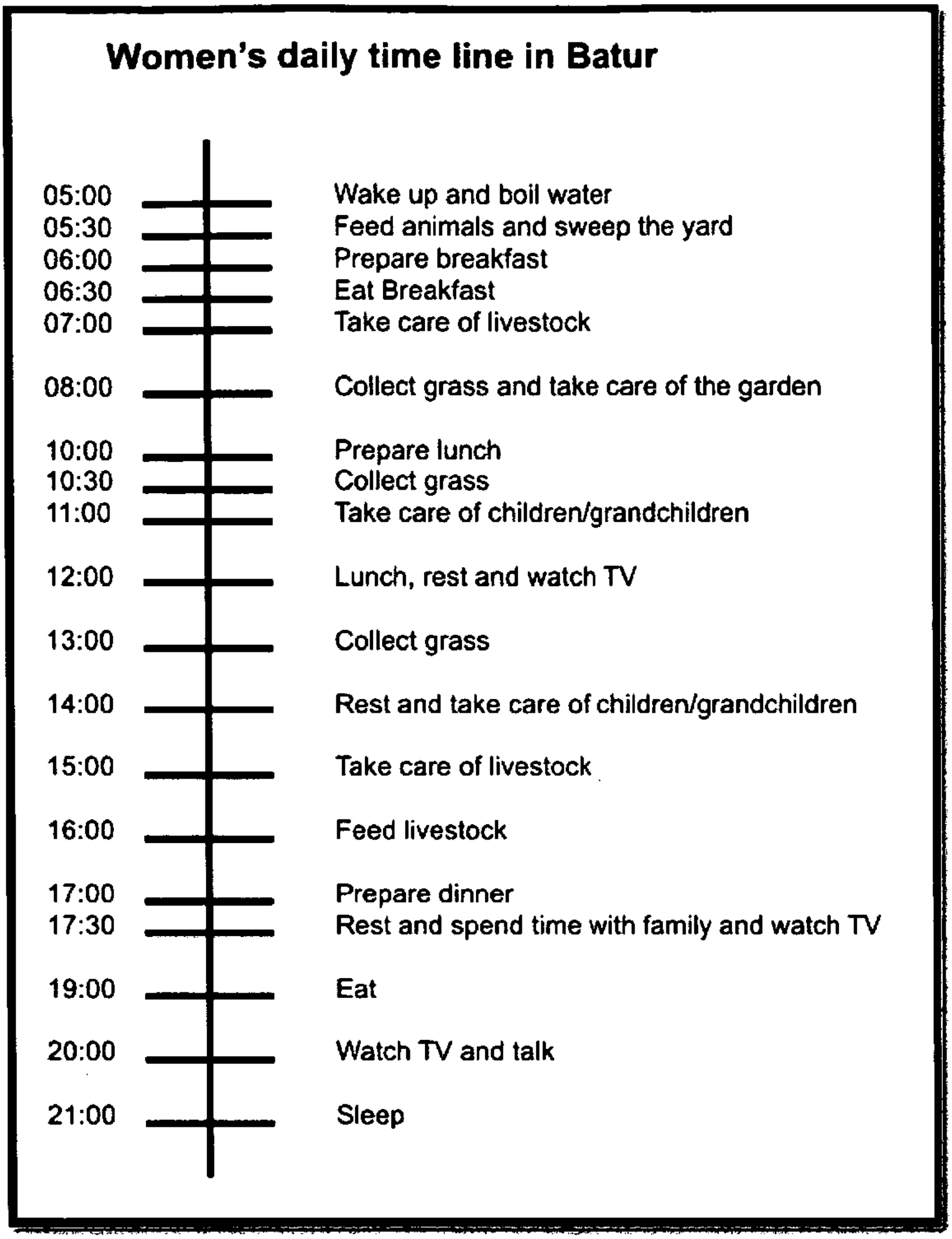


Figure 3.16: Womens' daily timeline (created during the participatory workshops in Batur).

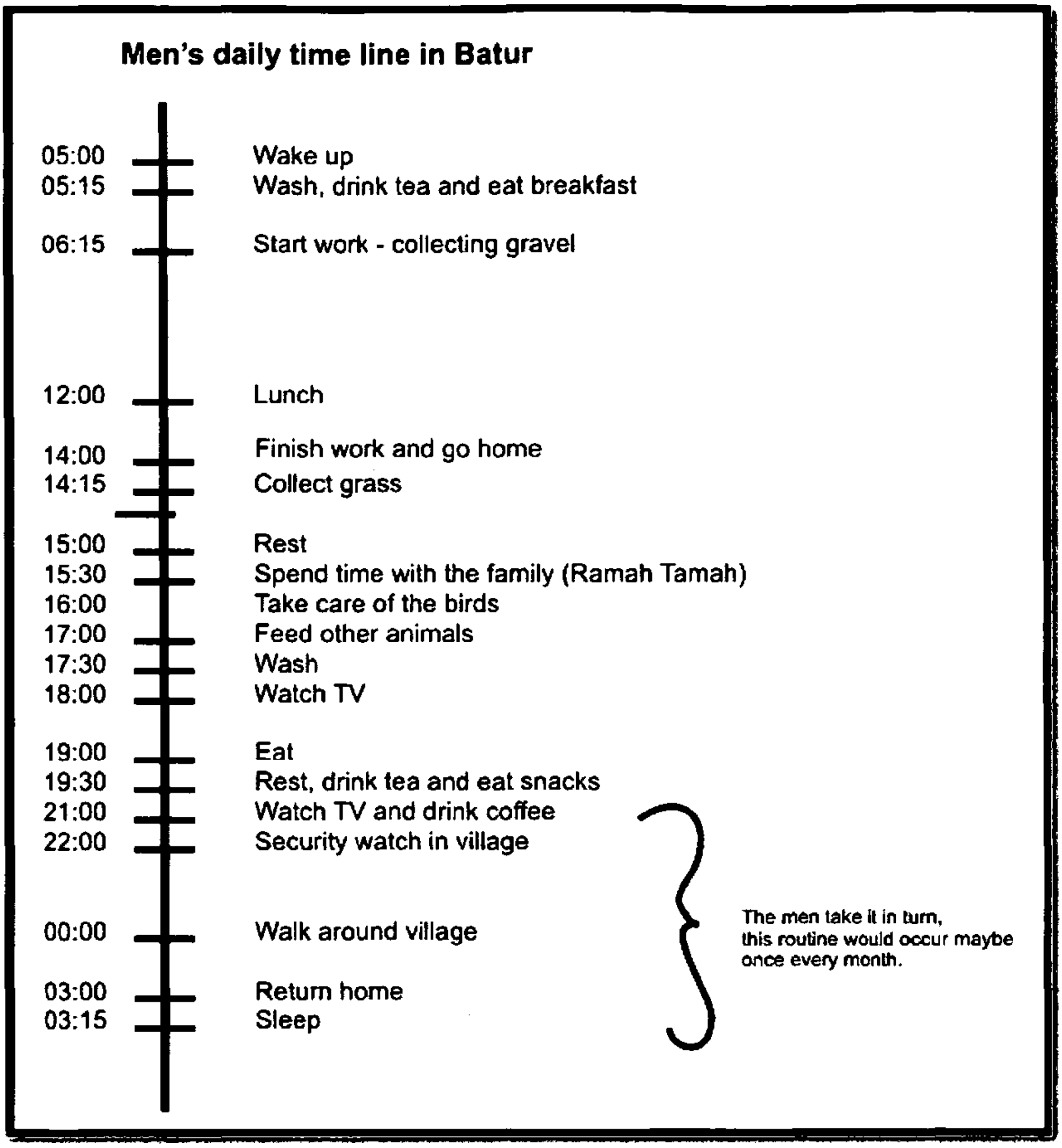


Figure 3.17: Mens' daily timeline (created during the participatory workshops in Batur).

These two schedules do not include a routine for prayer and this demonstrates the variation in orthodoxy in Java. This lack of Islamic routine is in contrast with Pelemsari where the residents seem more orthodox, despite the apparently strong influence of Mbah Marijan and the *Labuhan* ceremony.

Seasonal events	
Rainy Season	***Dry Season***
More than half the farmers in the village have activities in the garden to plant and process the soil, for example digging.	In the mornings they must work to earn money because they cannot plant crops.
After planting, they take a break and have breakfast, then continue to collect grass for feeding the goats and cows.	After finishing the morning work, the continue activities in the garden, such as collecting grass.
Routine activities must be completed before 12:00 because after mid-day it will rain.	There are no worries about collecting grass in the evening because there is no rain.
The villagers do not need to worry about getting grass, there is a lot.	It is difficult to collect grass because the grass does not grow in the dry soil.
It is easy to collect water.	It is difficult to collect water because the water resource is reduced.
The villagers worry that there may be a cold lahar in the Gendol River.	Trees and grass are very dry and therefore causes high fire hazard.

Table 3.5: The most important seasonal events, noted by the informants, for their routines. It focuses on the restricted water and grass supply in the dry season this is similar to the concerns faced by those living in Pelemsari and most regions around Mt Merapi.

3.4.2. Pelemsari.

Pelemsari is located just 2 km from the summit of Mt Merapi near the Kuning River (Figure 3.13). In amongst dense undergrowth the hamlet is scattered along a tarmac road which heads north and then east to Bebeng (Plate 3.5). Pelemsari is a moderately sized hamlet with 245 residents and 79 houses, located in the northern most region of Umbulharjo village. North of Pelemsari is Kinarejo; this separately marked small cluster of houses is part of Pelemsari and therefore has been included within the Pelemsari field site.

Plate 3.5: Pelemsari is clustered along this tarmac road that leads to Bebeng region and would have, before 2006, linked with the road going through Batur.

The residents of Pelemsari appear less wealthy than those further down the volcano since they have less land and less opportunity for agricultural diversification. Consequently they are mostly dairy farmers. The land north of the hamlet is government-owned forest and most residents own a very small portion of land on which they grow talus or other root vegetables mainly for their own consumption. The villagers do not own large enough plots of land to allow the animals to graze and so the farmers must hand cut the grass and carry it home to the cows (see Figure 3.12). As indicated in Figure 3.18, the villagers spend approximately seven hours a day collecting grass from the slopes of Mt Merapi to feed their cattle that are permanently tied up in small sheds next to their homes. As Dove (2008) describes, it takes an hour to cut the grass and then another to carry the 50-60kg bundle back to their stall-fed cattle. During the dry season the villagers must walk far up the volcano to collect fresh grass.

The hamlet is the home of Mbah Marijan who became famous during and after the 2006 eruption (he earned enough money through television appearances to build a new mosque). According to Figure 3.18 most of the residents of Pelemsari perform the necessary Islamic prayers throughout the day probably following Mbah Marijan who in combination with his traditional duties is a practicing Muslim. In contrast to the more Islamic tendencies of this hamlet it also hosts the annual *Labuhan* ceremony with members of the village (who are also honorary staff of the Kraton of Yogyakarta) organizing the event under the guidance of Mbah Marijan. Details of this ceremony are discussed in chapter 5 but it is a traditional Javanese ceremony to appease the supernatural creatures who according to the villagers live on the volcano. It is a ceremony that combines Javanese animistic beliefs with Islamic prayer, an example of the religious blend found at Mt Merapi and throughout Indonesia.

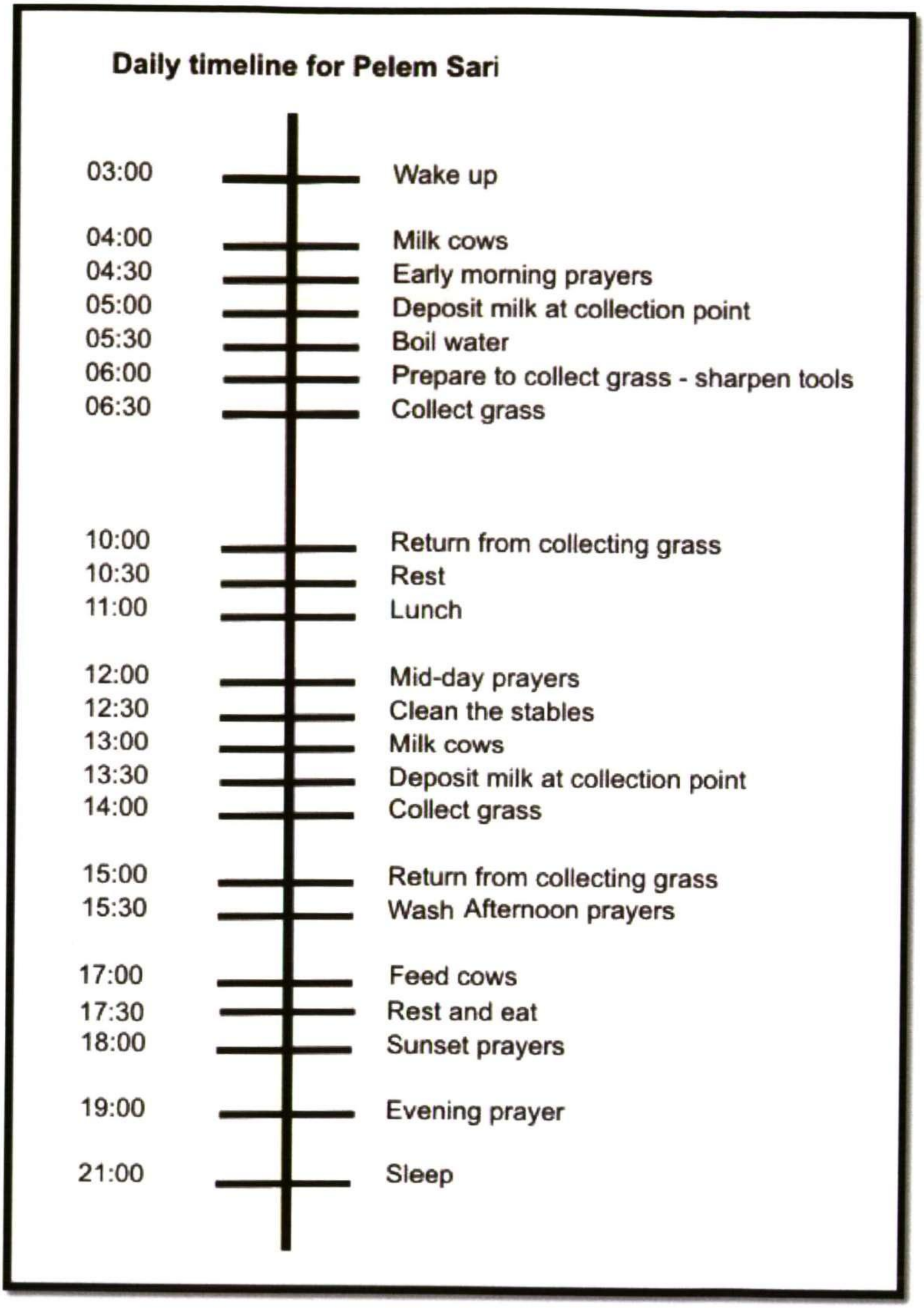


Figure 3.18: The daily timeline created by the villagers of Pelemsari in 2007.

Pelemsari is located between two of the main drainage systems from Mt Merapi. To the west is Kuning River, this river system is deep and narrow confined by ancient lavas, yet a few kilometres downstream of Pelemsari it opens out and deepens resembling the larger Gendol River to the east of the village. The Kuning River has evidence of previous lahar events and large boulders have been deposited along the river bed (see Plate 3.6). To the east of Pelemsari, less than 300 m away from Mbah Marijan's house, is Bebeng that was destroyed during the 2006 eruption. Those residents living furthest northeast in Pelemsari remarked that they could feel the heat and see the red glow of the pyroclastic flows as these thundered through Bebeng.

Plate 3.6: One of many large boulders which have been deposited by lahar activity in the Kuning River.

These two settlements are both located in dangerous locations and represent typical rural settlements around Mt Merapi. The residents of these communities have lived with both geological and political unrest that are intricately intertwined and although it is possible to gain an understanding of the physical characteristics of Mt Merapi from secondary resources, a researcher must immerse themselves within a community to understand their cultural beliefs, motivations and actions during a volcanic crisis. It is therefore vital to design an efficient, unobtrusive and ethical data collection methodology. Chapter 4 discusses the various methods chosen for this research in order to; gain access to each community, acquire the necessary information and participate within their daily lives.

Footnotes:

[1]. The diagrams within this chapter have all been drawn by the workshop participants from the corresponding village. They have then been subsequently translated into English and re-drawn into a computer programme. The designs of diagrams have not been altered from their original form and the translation has been as direct as possible. The workshop sessions as described in more detail in Chapter 4 and generally were attended by ten participants who were dominantly male. The participants were guided through a series of activities based on those that were created through Participatory Rural Appraisal techniques, also discussed in Chapter 4.

Chapter 4: Research Strategy.

4.1. Exploring and doing participatory research design and methodology.

This chapter explores the theoretical and practical aspects of the data collection for this project. Qualitative social data collection methods were chosen due to the reflexive, flexible and exploratory nature of this research. The over-arching methodology adopted is that of ethnographic observation, and includes interviews, observations, focus groups and participatory workshops (Figure 4.1).

Firstly, this chapter notes my personal and professional background and motivations for conducting this thesis. Secondly, the process of selecting appropriate qualitative research methods is outlined, before explaining the individual methods applied during the field season. Thirdly, this chapter comments on how the data collection was conducted in the field and the relating ethical considerations. Finally, the chapter concludes by outlining the methods of analysis employed in order to examine the role of culture during a volcanic crisis at Mt Merapi.

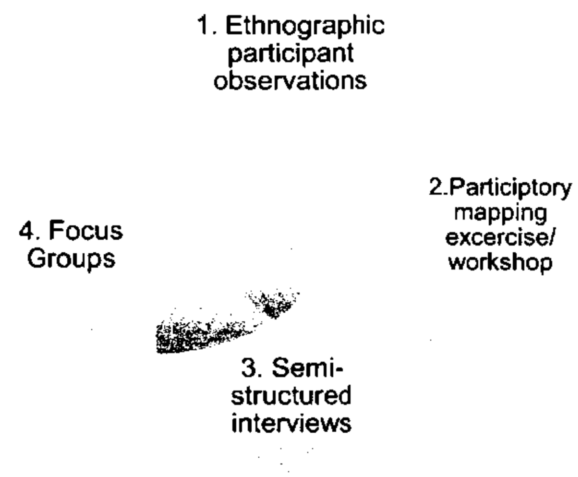


Figure 4.1: Venn diagram of methods, where the methods meet represents a bridging approach or triangulation of methods.

4.1.2. The researcher's biography: The importance of reflexivity in interdisciplinary research.

An important aspect of understanding and interpreting results within anthropological and geographical studies of society, throughout a research project, is reflexivity. Reflexive accounts explore the researchers positionality within their field site be it their personal characteristics or professional training:

> Within interpretative research there is an appreciation that the research participant, the research field and the researcher are involved in an dynamic process whereby each effects the others...researchers appreciate that there are a variety of factors in their own intellectual and social development which can affect the manner in which they relate to the social world, and interpret both their own responses and those of research participants. (Oliver 2004:158).

In this quote above, Oliver (2004) argues that the researcher influences both the data interpretation but also the manner of data collection through the relationship with the participants. Simply by being a researcher in the field you influence the social world under study (Mauthner and Doucet 2003). Therefore, my background, interests, motivations, convictions, preconceptions and geological understanding of volcanic hazards will subconsciously and consciously affect my results (Cloke *et al.* 2004). It is therefore important to be reflexive throughout the research, and by being aware of my influence during the data collection and analyses in order to find ways to recognise my bias.

My personal biography, given in Box 4.1, briefly comments my personal history and the key influences that have shaped my motivations and world view.

Any preconceived notions originate from two sources:

- Personal history – my up-bringing, race, class and gender.
- Professional training – my education, university qualifications and academic discipline.

Box.4.1 A reflexive account.

On writing this thesis I am 26 years old, I am an interdisciplinary PhD student, in geography and geosciences, at the University of Plymouth. Previously I have completed a BSc. in Geological Hazards at the University of Portsmouth, and then a MSc. reading Geophysical Hazards at University College London. I have a particular interest in volcanic hazards because of a photograph of Mt Pinatubo, erupting, pinned to a wall in my secondary school geography classroom; I remember thinking how exhilarating it would have been to have taken that photo. Fortunately, my studies at Portsmouth allowed me to undertake a research project at Mt Rainier volcano in Washington State, USA. My immersion within the scientific community at Mt Rainier was exciting; my fieldwork was interesting and gave me a sense of achievement. I felt that I was a scientist and that I was fulfilling the role expected of me by my family.

I was born in Herefordshire and was brought up in a wealthy, part Christian part atheist, middle class family with a history of academic success. All the members of my family have attended university and on completing my doctorate all but one member of my immediate family will be doctors - either medical, like my parents and my paternal grandfather, or academic, like my brother and I. It was expected of me to go to university and excel, yet within my family social science is considered, to quote my late grandfather, "a load of rubbish carried out by do-gooders". It was expected that I enter a "proper" scientific field and I was happy to do so.

Being a woman had no influence on my family's expectations as gender issues play no part in my family's outlook, in fact my family has a tradition of strong, independent, and accomplished women and I am determined to be amongst them. Yet, although I do not consider myself to be extremely intelligent, I am lucky and sensible.

Travel has always been part of my life. My parents travelled extensively during the 1970's and this tradition has been carried on by me and my siblings. Yet, I have predominantly travelled within countries that I consider "safe" and relatively straightforward, for example Australia, New Zealand and America. Before embarking on this research I had never travelled to Asia and more importantly I had never been an ethic minority.

Personally, I have always believed that the reason for studying natural hazards is to in some way reduce the impact they have on society. During my university studies, hazard events were classified according to the number of fatalities, for example the Nevado del Ruiz eruption in 1985 is classified as one of the worst volcanic disasters in recent times due to the deaths of over 23000 people, yet the eruption of Mt St Helens was deemed as a generally successfully controlled volcanic eruption as only 65 people were killed. Although our studies were influenced by these social statistics, exploring the social interactions with hazards was not considered necessary. Yet the death of anyone due to volcanic activity is unnecessary and preventable, and this motivates me to consider why people are still dying from preventable circumstances. My personal motivation for undertaking this research is therefore to explore why at-risk societies are failing to evacuate, take pro-active preventative measures and ultimately reduce the risks they face.

My professional training, as a natural scientist, has a large influence on this research and because this interdisciplinary project could be read by a variety of people it is important that the reader understands my background and the reasons why I have conducted the research in a particular manner. Secondly, my professional training as a geoscientist (having gained an undergraduate degree reading geological hazards and a masters degree in geophysical hazards) enables me to bridge the interdisciplinary boundary between social and natural sciences, whilst retaining, in the view of natural scientists, a perceived scientific approach. Lele and Norgaard (2005) suggest that there is a "belief of superiority" associated with natural scientists because their work has traditionally been believed to be quantitative and therefore more rigorous. This was certainly the general belief during my training that natural scientists are proper scientists and that social studies were less rigorous and perhaps did not merit a scientific status.

This professional blindness is often the downfall of cross-disciplinary projects as natural scientists are often not willing to accept the beliefs of another discipline. Yet, my professional training will allow me to present my work to natural scientists and my personal interests will enable me to accept and efficiently use social research methods.

This research benefits coming from a natural science viewpoint because it can be more easily accepted within the natural science community. This is important because it is often natural scientists that have been relied upon to provide solutions to hazard events, despite a social implication. For example, Lele and Norgaard (2005) suggest that despite the origins and impacts of climate change being predominantly social, it is natural scientists who are frequently asked to produce solutions. The onus is therefore on natural scientists to appreciate the social impacts of hazards and of their mitigation techniques. My background as a geoscientist is therefore key to this project; not only to strengthen an acceptance of social sciences within natural sciences but also to bridge the gap between sciences. After all, is it not disasters that 'we', as geo-hazard scientists, are trying to prevent? And disasters are socially constructed.

As previously explained, although my professional position is vital to the project my personal biography directly affects the fieldwork. My personal and social characteristics affect the way I perform in the field and how I am accepted within the community being studied. As England (1994) discusses, fieldwork is personal and it is critical to be reflexive as it can lead to new insights and hypotheses. Sidaway (1992:406) explores the "western" researcher's positionality, in particular within developing countries, concluding that 'there are no simple answers', but stressing the need to be aware of your impact within the community.

My personal characteristics are in contrast to a typical Indonesian researcher as I am a young, female, white, and in relative terms extremely wealthy. My impact within the communities I wish to study and how they view me will be explored in further detail in the following sections. Firstly however, I reflect on how these characteristics affect my interpretations.

My personal and natural sciences view means that I want to be able to find a solution and the pressure to "find a solution" may propel me to interpret my results in a bias manner. As England (1994:242) explains in reflection of her work, 'in our rush to be more inclusive and conceptualise difference and diversity, might we be guilty of appropriating the voices of "others"?' England suggests that as researchers we wish to explore what is different but our personal opinions and preconceptions influence our findings. In light of this, I realised early on in this research that I wanted to find that culture does influence people's reactions, rather than exploring how and to what extent culture influences people's reactions to hazards. This basic realisation indicates that within this research I must constantly be reflexive. I must take into account my position within the research, as an interdisciplinary project; and the community as a white, British, female research.

4.2 Choosing qualitative research methods.

Crang and Cook (2007) suggest that qualitative methods such as ethnography are designed to understand different parts of the world as they are experienced by those people who live them out, reflecting the nature of social inquiry. Studying a society or aspect of society therefore involves using more than just statistical methods. Thus, in-depth semi-structured interviews (or conversations with purpose) can delve further into the cultural setting than structured questionnaires as there is room for comment, explanation or spontaneity. McNeil and Chapman (2005) take this further by explaining that in order to really understand a community, the researcher must do more than survey; they must immerse themselves into that community and analyse the individuals through conversation, interview, workshops, focus groups and other methodological strategies. As an applied geoscientist I had to explore and learn about the numerous social science methodologies in order to decide upon the strategy which would achieve the research aims.

Qualitative research methods deal with the collection of conversations conducted through an intense or prolonged contact with the subject (Bryman 2004, Miles and Huberman 2004). By dealing with words and not numbers, qualitative data collection methods can be used in 'order to explicate the ways people in particular settings come to understand, account for, take action and other wise manage their day-to-day situations', Miles and Huberman (2004:7). This quote epitomises the aims of this research; to discover how and to what extent culture affects people's reactions to volcanic hazards. To understand the role of culture in the local community's "day-to-day situations" qualitative research methods are integral to this thesis.

According to Harris and Johnson (2000:12) qualitative research, in particular ethnographic research, provides 'a portrait of people... a written description of a particular culture, the customs, the beliefs and behaviour'. This extract indicates that certain qualitative research methods, such as ethnography, are potentially suitable techniques to fulfil the research objectives. Therefore, after spending a month immersing myself in Indonesian culture and visiting communities in and around Yogyakarta and Mt Merapi, I decided that in order to understand the beliefs of the at-risk communities I needed to live within that community gain their trust and learn from their understandings of the volcano. The intention was to interview a sample of the villagers and also those who play a role in volcanic disaster management but who are not villagers, for example Non-Government Organisations (NGOs), academics, and government officials. This would provide the wider picture of what happened during the last eruption and how the local communities responded to the 2006 eruption of Mt Merapi and subsequent hazards, in addition to gaining an understanding of their culture and belief systems relating to the volcano. Consequently, during the summer of 2007, I lived within the two communities of Batur and Pelemsari for over a month each. Bryman (2004) describes this methodology type as micro-ethnography due to the restricted time period spent with each community.

During this time I also lived within a community on the slopes of Mt Agung volcano, Bali, this case study was initially intended to provide a comparison case study to Mt Merapi, but once I had returned from the field it became obvious that two case studies produced too large a collection of data to analyse efficiently and the Bali case study was cut from the project. Although this was a difficult discussion to make, the data collected from Bali will make an excellent spring-board for a post doctorate study.

4.2.1. The pros and cons of qualitative research methods.

As Miles and Huberman (2004) explain there are imperfections and limitations in qualitative research methods; these include the labour intensive nature of the collection, the possibility for research bias, the long length of time involved in analysing the data, a possible lack of generalization and the potential for poor credibility and quality of the work produced. It is important to understand the standards that control the quality of research in the social sciences. The quality of social research can be scrutinized by its validity and reliability, criteria that attempt to ensure qualitative research is robust and scientific. Validity is concerned with how the findings accurately reflect the real situation and whether the methods used are really the best techniques to determine such results. Reliability is concerned with whether the findings of the thesis are 'repeatable'; in other words, can another similar study find the same conclusions as this one (Bryman 2004). Within social science literature there is a variety of opinion on the use of these criteria, especially in relation to qualitative methods such as anthropological research. Here I will delve briefly into this debate in regard to validity and reliability.

Although there is debate over the validity of qualitative methods, Kirk and Miller (1986) argue that 'qualitative research is socially concerned, cosmopolitan, and, above all, objective' (1986:10). They go on to suggest that the objectivity, the accuracy, truthfulness, and inclusiveness (Silverman 2006) of a piece of research has its foundations within reliability and validity. Objectivity, therefore has been suggested as a better way of controlling the validity of social research and that validity, reliability, or objectivity rests on the bias of the researcher (Silverman 2006):

> In the case of qualitative observations, the issue of validity is not a matter of hair-splitting about the fifth decimal point, but a question of whether the researcher sees what he or she thinks he or she sees. (Kirk and Miller 1986:21).

Researcher bias can be partially overcome through objectiveness on behalf of the researcher, yet bias also shapes the research and should be acknowledged. As discussed previously this highlights the need to be reflexive. A reflection on the methods used in this research is given in Chapter 8.

Bryman (2004) suggests that qualitative research should be evaluated according to its trustworthiness and authenticity. Trustworthiness and authenticity come from validity and reliability, yet entertain the idea that in the social world there are not absolute truths and that in the real world nothing is valid or reliable (Bryman 2004). It seems that qualitative research needs to be of quality and credibility but the criterion for this is as undefined and as varied as the social world under investigation.

> Any attempt to establish a consensus on quality criteria for qualitative research is unlikely to succeed for the simple reason that there is no unified body of theory, methodology or method that can be described as qualitative research; indeed, that the very idea of qualitative research is open to question. (Rolfe 2006:1).

Rolfe (2006), in the extract above implies that the very nature of qualitative research is so diverse that a criterion is not simply unnecessary, but unattainable.

Table 4.1, based on Bryman (2004) contrasts qualitative and quantitative research. The pioneering and participatory nature of this research requires the methods to be unstructured, flexible and adapt to unforeseen events in the field. To reflect this, the methods chosen for this thesis are qualitative and emphasise the need to explore beyond the basic statistics, towards the descriptive, examining oral histories, perceptions, motivations and beliefs of the at-risk community.

Quantitative	Qualitative
Numbers	**Word** - Oral histories, perceptions, "in their own words".
Point of view of researcher	**Points of view of Participants** - what they see as important.
Researcher distant	**Researcher close** – in order to understand their world through their own eyes, must build a relationship with communities, be accepted, abide by their customs and hospitality.
Theory testing	**Theory emergent** – be open to changes in theory and conclusion.
Static	**Process** – need to be adaptive to the changing political and environmental setting.
Structured	**Unstructured** – enables participants to influence research especially during the interviews.
Generalization	**Contextual understanding** – exploring the behaviour, values and beliefs of community, exploring a few additional field sites enables improved generalisation.
Hard, reliable data	**Rich, deep data** – enables the extraction of the participant's true knowledge and beliefs.
Macro	**Micro** – time restraints mean that two villagers are studied, yet other communities are also as a comparison, for example Sebudi, Bali, and Selo, Northern Merapi.
Behaviour	**Meaning** – to discover the meaning behind the participant's actions during the 2006 crisis.
Artificial settings	**Natural Setting** – investigating the participants in their natural environments gives an insight into the advantages and disadvantages provided by the environment.

Table 4.1: Common contrasts between qualitative and quantitative research methods with additional comments on how these contrasts have enabled me to choose a qualitative research design. Source: Modified from Bryman (2004).

4.2.2. Using a multi-method approach.

Qualitative research methods are creative and varied, ranging from interviews through to observer studies and in this thesis they will come from a range of participant observation methods (Figure 4.1) using an approach that is sometimes referred to as a 'triangulation' of strategies. Triangulation aims to ensure a greater confidence in findings by using one method to back up or check the findings of another method (Bryman 2004). Some social scientists, however, suggest that triangulation does not automatically produce valid results or more accurate findings. For example, Miller and Fox (2004) suggest that assuming multiple methods replace the weakness of one method with the strengths of another, or that the use of a second method will 'prove' the 'truth' of the first method, is fundamentally incorrect, because each research method produces its own different findings due to the nature of that inquiry. In other words, triangulation requires multiple methods to find the same results, yet in social research each method has the potential to derive different results, according to interpretation and the application of the methods. Although triangulation has weaknesses, these weaknesses primarily lie in the assumptions made by the researcher. Therefore Miller and Fox (2004) prefer to use the terminology of a 'bridging approach', that sees different methodological strategies linking different social perceptions. By using the bridging approach each method provides its own distinctive contributions and integrity (Miller and Fox 2004), yet by using triangulation, where the methods are fused in order to find a single valid result, these contributions might be lost.

In this study the bridging approach uses both observation techniques and interviews. The interviews were intended to extract personal oral histories, beliefs, and perceptions which should complement the participant observations. Participant observations were intended to provide insights into the community's perception of hazards and into their potential actions during a crisis. The different methods produced different findings and stand separate from each other, but both are all used to attempt to understand the role of culture in volcanic regions. I endeavoured to retain validity and reliability during the design and application of the research whilst at the same time encouraging the creative essence of qualitative research. Although Chapter 8 provides a review of the methods used, it is important to note that the bridging approach allowed certain methods to to 'take the lead' and others to have less of an impact as the research developed. During this research the information gathered through the semi-structured interviews contributed approximately 70% of the final analysis whilst the participatory activities contributed 25% and the focus groups just 5%. Ethnographic participant observations framed the final interpretations and so it is more difficult to estimate the input of this method as it influenced every aspect of data collection and analysis.

4.3. Ethnographic methodology.

As mentioned above, ethnographic methods are used in order to 'understand parts of the world more or less as they are experienced and understood in the everyday lives of people who "live them out"', Crang and Cook (2007:1). Ethnographic research involves the researcher making contact with the community under study, finding a way to immerse themselves in that society and then writing up this interaction in a structured manner (Crang and Cook 2007). These two different aspects can be at odds with one another as the researcher must be observant, yet participate, become emotive and accepted within the community, yet learn from and extract 'data'. There are no illusions in this work, ethnographic methods have flaws. Yet for this project, ethnographic methods are deemed essential as it is vital that I live within the chosen communities in order to more fully understand beliefs and perception about volcanic hazards.

4.3.1. Participant Observation.

Participant observation, (section 1 on Figure 4.1), envelops a wide range of social science data-collection methods including community activities, focus groups, discussions, and semi-structured interviews. Participant observation occurs when the researcher observes and participates in the life of a group or community (McNeil and Chapman 2005). Nonparticipant observation is where the researcher does not actively involve him/herself in the community activities, but rather takes a step back allowing the social group to take charge and evolve. These ethnographic techniques can include the combination of various data collection methods such as surveys, interviews and more quantitative methods. Chambers (1994c) claims that ethnographic methods can be reliable, valid and representative, the three essentials of good social science methods.

Semi-structured interviews complement participatory activities in that they explore aspects that cannot be investigated with a group, such as, personal experience and the freedom to talk openly about personal beliefs. I concentrated my efforts on collecting semi-structured interviews or as I preferred to call them 'conversations with purpose' and running workshops influenced by the ideals of Participatory Rural Appraisal (PRA). In this respect the approach adopted followed the work of Cronin *et al.* (2004a); Cronin *et al.* (2004b) which is in turn rooted in the methods of Chambers (1983, 1994a, 1994b, 1994c, 2001). This collection of ethnographic orientated research uses PRA to assess local perspectives originally on agricultural processes but more recently on hazards.

PRA was born from a series of participant methods [1] that incorporated conversations, informal interviews, focus groups and detailed recording (Chambers 1994a). Chambers (1983, 1994a, b, c) developed Participant Rural Appraisal (PRA) as an approach consisting of a series of methods for learning about rural life. He developed a series of activities which could be used within a workshop environment by specialist facilitators. These activities 'move' data collection from verbal to visual, producing diagrammatical information that is created by the entire group, an approach that is particularly effective in communities where literacy is not universal (Cronin *et al.* 2004b). A distinctive aspect of PRA is the use of visual representations and analysis. Maps, models and diagrams, on the ground or on paper, are produced during activities that permit contributions from all members of the community, the young, old, illiterate, and those who speak a variation on the local language. This means the data collected from these activity sessions, in the form of recordings, photographs, paper maps and diagrams form a more representative holistic vision of the whole community.

There are criticisms of PRA methodology and some concern about the philosophical and theoretical predilections of PRA. Kapoor (2002:102) suggests that a reliance on knowledge derived from experience produces 'insufficient attention to such critical issues as legitimacy and justice in participatory development'. Kapoor (2002) also argues that Chambers' view of power is inadequate and does not cover the broader issues such as gender. Moreover he criticises the lack of structure and rules within PRA and highlights this as a contradiction to its ethos. In other words, PRA must be flexible, transparent, open and yet all-encompassing, encouraging equal participation from all elements of society, male, female, young and old. Kapoor's (2002:106) concern is that there must be rules in order to allow equality with the activities:

> What ensures the PRA discussions and interaction are cohesion free? What prevents women and disadvantaged people, whom Chambers; takes pains to bring into the PRA meeting, from feeling intimidated by authority figures also present?..In short what provisions exist for free and equal deliberations? (Kapoor 2002:106).

According to Kapoor (2002), some communities may be suspicious of such relaxed procedures, and informality may enforce a lack of trust, the very thing that PRA is attempting to gain. His concern is that PRA leaves itself open to abuse and misuse and that further work is required in better theorising and systemising its methods and testing its limits.

Mosse (2001) notes, that PRA and its techniques contradict its own original ethos of providing a 'bottom-up' method of utilising and empowering local people and their knowledge. Instead; 'participatory research methods have proved compatible with top-down systems, and have not necessary heralded changes in prevailing institutional practices of development' Mosse (2001:16). He therefore argues that using local knowledge can abuse local power; a criticism echoed by Kapoor (2002) is that PRA does not adequately explore the power relations within a community. These power relations shape local knowledge within a community. Take for example, gender; local women may be restricted in participating due to gendered hierarchies within that community. PRA tries to incorporate all members of society, yet by providing no constraints and having open, flexible techniques, opens its methods to abuse from dominant members of the participatory group. Additionally, influence can also come from the outside, from the researcher, because 'Project actors are not passive facilitators of local knowledge production and planning' (Mosse 2001:19). The facilitators, be it wittingly or unwittingly, influence the participatory research, either by their mere presence or by more intrusive means. Chambers (2001) warns facilitators against interfering within the group, yet it may be impossible to find the balance between taking a step back and ensuring openness and integration. To ensure that the researcher 'takes a step back' it is important that trained local facilitators lead the workshops.

There are also long-term implications of participatory research. Chambers (1994a, 1994b) and Cronin *et al.* (2004a) believe that PRA methods have long term beneficial impacts within a community. Long after the researchers and facilitators have left, the community can continue to use the methods in order to create their own solutions to problems; in the case of Cronin *et al.*'s (2004a) research in Vanuatu, this was demonstrated by the formation of 'a disaster management committee'. Cleaver (2001:36) however contends that there is 'little evidence of the long-term effectiveness of participation in materially improving the conditions of the most vulnerable people or as a strategy for social change'.

Acknowledging that there are criticisms of participatory methods, the activities adapted from the PRA philosophy do appear to create a dialogue between the researcher and the community, this enables both the extraction of local knowledge by the researcher and enables the community to discuss and find solutions to the problems they face. In light of both the criticisms and benefits of PRA, this thesis used the PRA activities as a blueprint, adapting methodologies and using its ethos as only a guide.

4.3.2. Using PRA in a volcanic hazard assessment.

Participatory research approaches has become increasingly popular with academics examining environmental hazards and facilitating change in collaboration with local communities (Mercer *et al.* 2008). There is a growing literature suggesting an increase in the incorporation of participatory methods in disaster studies and the combining of indigenous and western hazard knowledge (Haynes *et al.* 2007, Mercer *et al.* 2007, Cronin *et al.* 2004a, Cronin *et al.* 2004b). As Mercer *et al.* (2008:9) suggest, 'participatory techniques are one way of ensuring those directly impacted upon by hazards are involved in planning strategies to mitigate against them'. Although the literature implies that participatory techniques empower, and enable the local communities to mitigate their circumstances in a 'bottom-up' method, Cronin *et al.* (2004a) provides one of the few studies who clearly explain a framework as to how participatory techniques can be used in practice exist in direct relation to volcanic hazards (Mercer *et al.* 2007). This research is described by Mercer *et al.* (2008:3) as 'spanning the divide between facilitating social interaction and discussion... with the aim of solving an existing problem or research question previously established'. Consequently, it is Cronin *et al.*'s (2004a) work which I have chosen to use as a guide to my participatory techniques

Cronin *et al.* (2004a) utilised Participatory Rural Appraisal during their research to understand the traditional knowledge and perception of the local people living on Ambea

Island, Vanuatu's most active volcano. They conducted a series of workshops that involved local populations diagrammatically presenting their knowledge of the volcanic hazards that threaten them and depicting the oral histories related to the volcano. Figures 4.2 and 4.3 give examples of the diagrams collected during their research and which have been used as a guide for my research. They digitised the diagrams originally drawn by the participants, although this is scientifically visually preferable, it is possible that certain perceptions and meanings are lost by 'translating' these maps in to a more acceptable format. These two diagrams are of the same location but created by separate female and male groups of informants. The maps show the most influential elements to the groups and therefore also demonstrate the different roles taken by different genders in the region. These maps therefore demonstrate the possible variety of information that could be gathered by using these hands on activities.

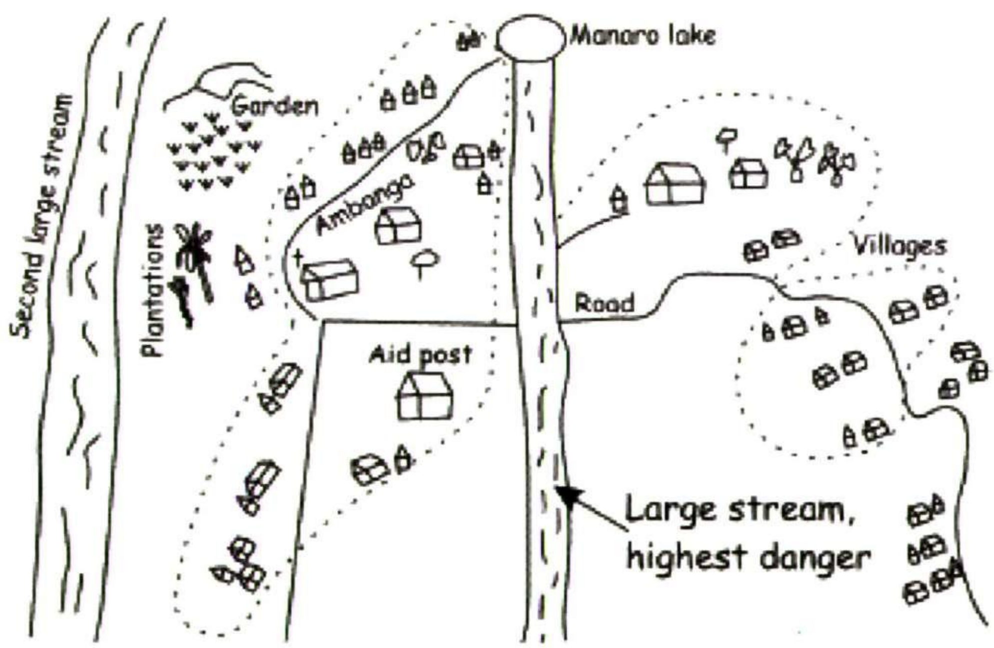


Figure 4.2: A community hazard map produced by an all women's workshop on Vanuatu. Source: Cronin *et al.* (2004a).

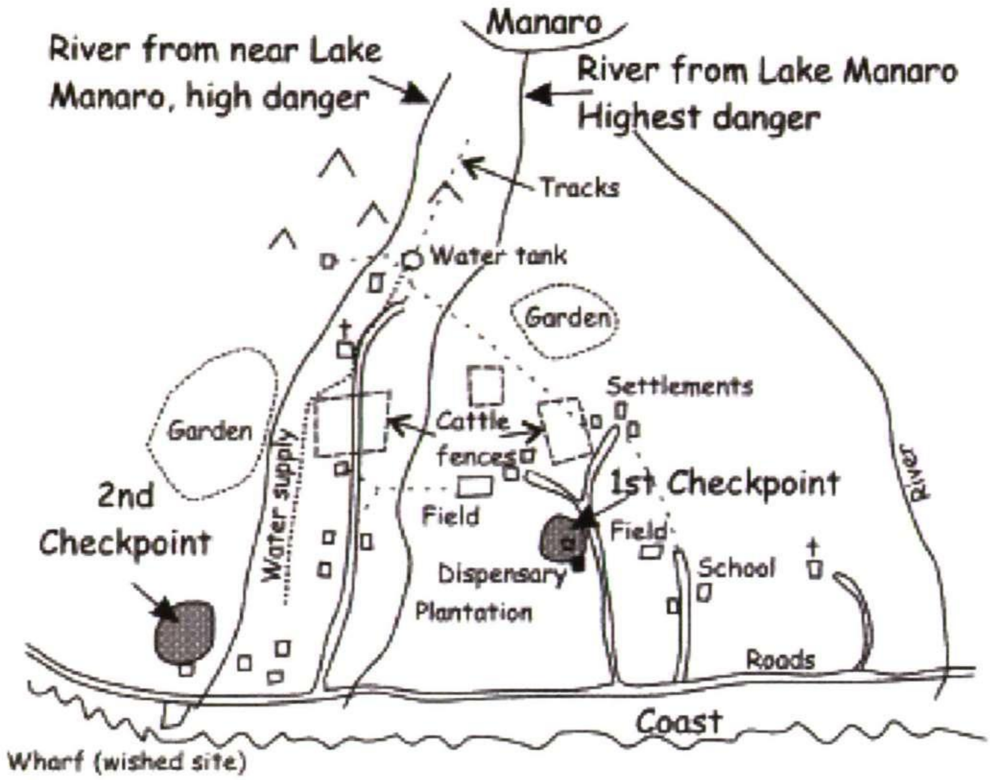


Figure 4.3: A community hazard map produced by an all male workshop on Vanuatu. Source: Cronin *et al.* (2004a).

The workshops emphasised the need to empower the people by allowing them to construct their own hazard maps and emergency plans. They also encouraged the local people to organise teams to discuss and put into effect the volcanic hazard and evacuation plans (Figure 4.4). These teams were able to carry on the work of Cronin *et al.* (2004a) beyond the research time period, allowing the community to evaluate their own risk and provide valid, valuable and acceptable indigenous solutions. Although Mercer *et al.* (2007:247) applaud Cronin *et al.*'s (2004a) work and publication of the methods used, they suggest that the research does not 'address the underlying vulnerabilities which contribute to the hazard becoming a disaster in the first place'. Cronin *et al.* (2004a) focus on the hazard perception rather than delving into the many other social issues such as vulnerability and how people perceive their own vulnerability and therefore risk, and in turn react to the hazard.

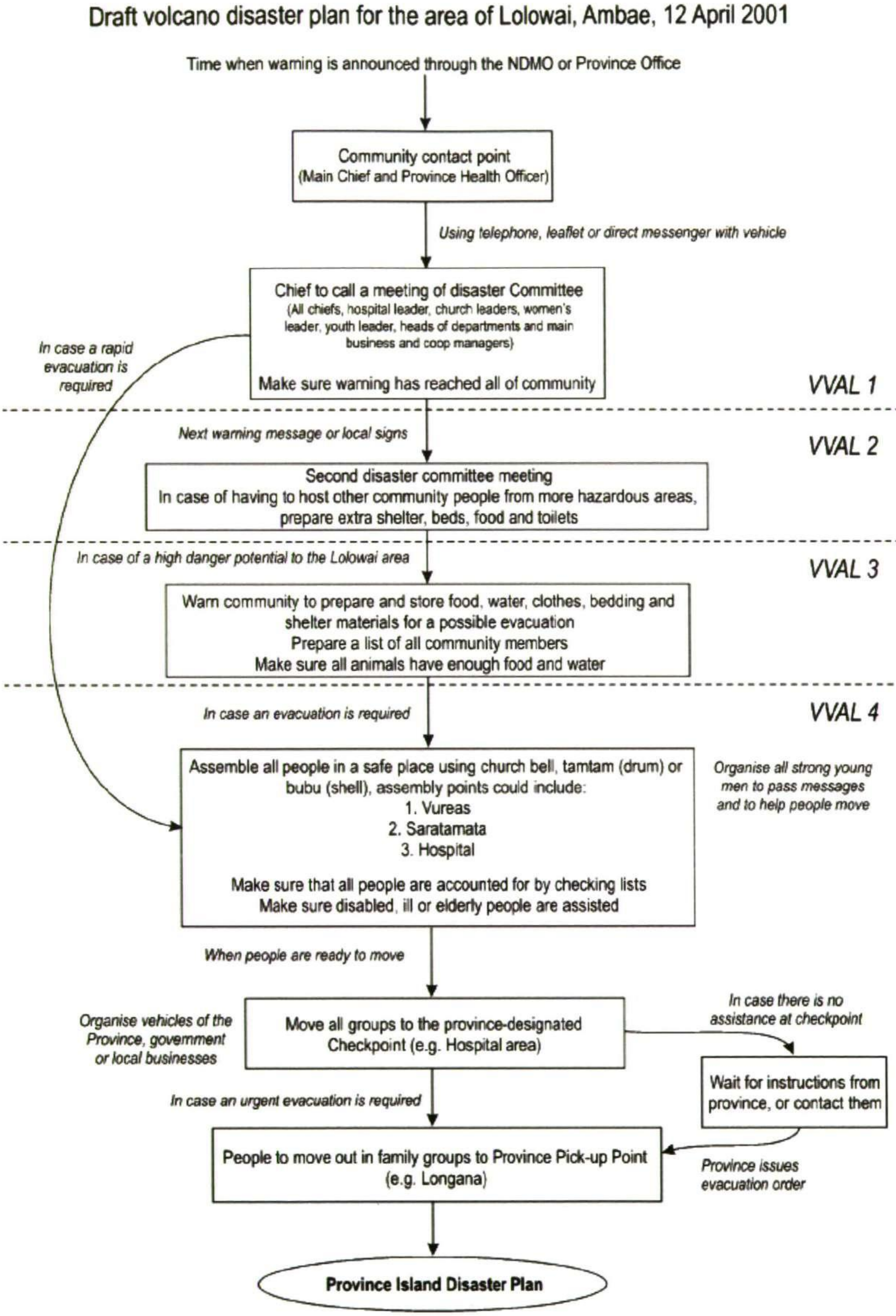


Figure 4.4: Community volcanic emergency plan created during a PRA based workshop conducted in Vanuatu. Source: Cronin *et al.* (2004a).

Cronin *et al.'s* (2004a) analysis of the diagrams is limited, focussing again on the hazard rather than the social implications of the hazard perceptions. The paper is focussed on the methods used rather than any analysis and findings, (though this may follow in a future article). Also although they have utilised social science methods to fuse western and indigenous knowledge there is no mention of key issues such as ethical considerations or objectivity within this study. The paper reflects the investigators' natural science background and so indicates the struggle to produce an interdisciplinary study. The approach adopted at Vanuatu, has also been applied to other regions such as Savo in the Solomon Islands by Cronin *et al.* (2004b) and as described by van Aalst *et al.* (2008) in Cambodia and Costa Rica. Despite the drawbacks of Cronin *et al.'s* (2004a) paper it does provide a guide to conducting participatory research in volcanic regions and consequently it seemed appropriate to field test PRA influenced workshops based activities at Mt Merapi.

4.4. Gaining access.

Bryman (2004) describes entering the field or gaining access to the particular community as the most difficult steps in ethnography. Gaining access to open/public settings, such as the villages on the slopes of Mt Merapi, not only requires gaining official permission but also a positive 'welcome' from the villagers. As Calveley (2002:4) found during her research into failing UK schools, accessing the research environment through the 'front door as an invited guest' is vastly more preferable than entering the community through a more covert 'back entrance'. My research is overt; I wanted to enter the community with an open and honest attitude and due to the micro-ethnographic nature of my study I had to employ certain institutes and people to help me access the communities legally, sensitively and above all quickly (Bryman 2004). Crang and Cook (2007) warn researchers about the sometimes frustrating length of time involved in the initial stages of accessing the field.

Gaining access efficiently was therefore a priority during my initial immersion in Indonesia.

Before entering the field it is important to gain the correct official permission to carry out research. Deveruex and Hoddinott (1992) warn potential researchers of the pitfalls of obtaining a research visa, relating to time length, politics and a fear of critical research on the host nation. I required a social/cultural visa in order to carry out my research in Indonesia and the Inter-cultural Institute based in Yogyakarta assisted me with my application and my visa was granted with remarkable speed. The Inter-Cultural Institute also organised my other official documents as I had to gain permission from the Governor of Yogyakarta all the way down the intricate government hierarchy to the head of the hamlets. This also required some prior visits to the villages chosen for the study in order to meet, sit and drink Jasmine tea with either the head of the village, head of hamlet or influential local elites, referred to as 'wise men'. In Bali, I needed additional permission from the temple priests, from both the village temples and regional temples. This was not only for legal reasons but it served as a way to introduce myself to important members within the communities. These meetings would often provide a way of organising the workshops and an impromptu guided tour of the village area. The heads of hamlets and certain spiritually important villagers organise each community, without their help my research would either be impossible or extremely challenging.

4.4.1. The ideal research assistant.

So how do you enter into a community and become accepted within their everyday lives? After all, as I experienced during an initial one month immersion course (undertaken in November 2006) a white English girl [2] in Indonesia attracts a lot of attention. The task of integrating and gaining the trust within a potentially isolated community on the slopes of Mt Merapi was not only going to be a logistical challenge, but also a long and sensitive process. In order to speed up this process, I needed a research assistant who could introduce me into the communities, act as a translator and bridge the gap between 'them' and 'me'.

A research assistant is an invaluable asset during ethnographic research [3] facilitating access to research participants and ensuring the researchers acceptance within the community under-study, in addition to helping with the conduction of surveys and interviews (Scheyvens and Story 2003). According to Devereux and Hoddinott (1992:27) a good research assistant has, 'good communication skills, good knowledge of English as well as the local language (s), a perceptive intelligence, inexhaustible patience, unfailing dependability, and ability with all elements of the local population'. The challenge was met by the Inter-Cultural Institute in Yogyakarta, who put me in contact with a 25 year old Javanese research assistant, Aris Suriyanto. Aris not only speaks Indonesian, Javanese, and English, but as a young Javanese male he is knowledgeable in Javanese village hospitality and customs and due to his love of mountaineering has regular contact with villagers in the region. He also gained access and allowed me to gain access to some of the male-only ceremonies and meetings; equally he provided me with greater security although thankfully this was never required. Aris had recently graduated from Gadja Mada University, Yogyakarta, having read Philosophy. He is therefore well-educated and a perfect candidate fulfilling Devereux and Hoddinott's (1992) job description for a research assistant. He became my research assistant for the entire time I was in Java providing a dependable, trustworthy and patient assistant who went to great lengths in order to enable my research goals. He would often give up his rare free days in order to transport me around Yogyakarta for supplies and would spend hours tirelessly translating interviews. Plate 4.1 shows Aris in the centre with Riyanto primary contact (or gatekeeper) in Batur and his older sister, Sinto.

Plate 4.1: Riyanto, our contact in Batur, with his older sister Sinto, either side of my research assistant Aris. This photo was taken on our day out when Riyanto drove us around the east side of Merapi to visit his uncle and explore the Klaton region of Mt Merapi.

Devereux and Hoddinott (1992) conclude their article on research assistants by explaining that the most important characteristic of a research assistant is that they and the researcher get on well together, sometimes under physically uncomfortable conditions and for long periods of time. I believe this is especially true and fortunately Aris and I got on well and became professional friends [4] during the field season, my acceptance within the community and the quality of my experience on Mt Merapi reflects this.

4.4.2. First impressions count.

As Swanson (2008b) discovered whilst trying to access a closed and remote indigenous community in Ecuador, first impressions count. She gained the trust of the community leaders initially before being invited to live within the village for a period of one month. She explains that in attempt to produce a good first impression she spoke to them in their native language. Due to the time constraints in my research it would have been unfeasible for me to learn Javanese, Balinese, and Bahasa Indonesia. I endeavoured to learn Bahasa Indonesia and hoped I would have to create a good impression via other means. As for Swanson (2008b) in Ecuador, it was important for me to abide by the cultural and social etiquette in order to speed up my acceptance within the village. For example, it was initially important that I used the correct form of transport to enter the village.

I had assumed some sort of transportation would be required, yet a car would have been highly inappropriate. From my experience during my immersion course in November 2006 I realised, and Aris reiterated, that a car in the village is an unusual sight and would immediately alienate me from the local population. I would automatically be stereotyped as a tourist, as a car owner or passenger are seen as wealthy and are automatically set apart from the villagers. To drive a car into the village would immediately label me as an outsider, and seeing that we wished to be accepted as members of this community we decided to ride the hour and half up the volcano from Yogyakarta on Aris's old moped (which broke down several occasions leaving me to arrive in the village on foot, to the pleasure of on-lookers).

I was also acutely aware of my race and gender and how these characteristics may affect my entrance into the community. As I have mentioned above, being a white girl doing PhD research in Indonesia is unusual. I was considered extremely young to be carrying out doctoral research and I was concerned as to how I would be perceived in a male dominated society. Yet, like Morrison (a co-author in Twyman *et al.* 1999) found during her research in a male dominated community of Botswana, being female caused fewer problems than I had anticipated because, like Morrision, I was considered nonthreatening and un-influential (Twyman *et al.* 1999). Because I was so different from them I was almost considered un-gendered or as an honorary male and often invited to attend male only events. Yet, my race would also often influence interviewee's stories, some tending to tell me about what life was like during colonial times, they felt the need to connect with me as a white person by telling stories about white people, the Dutch.

Aris had grown up in the Klaten region and was therefore sensitive to the needs of the villagers and acutely aware of when an interview was inappropriate or when it was suitable to ask the head of hamlet whether he would mind organising another workshop. This knowledge was especially necessary during the first few weeks of the main field season when I was new to the village culture and customs. I was initially obsessed by timetables because I was still thinking in western terms, for example, I believed once a date, location and time are set for meeting participants will turn up. But this is sometimes not the case in Indonesia. At this point it was important for me to recall Chamber's (1994a) advice to researchers conducting participatory rural appraisal, that personal demeanour counts, that you need to remain patient and flexible. Equally Chamber's (1994a:1255) suggests 'failing forwards', meaning that as a researcher you need to learn from your mistakes and accept that you will make errors and that you should learn from them.

4.4.3. Jasmine tea and coconut kue.

Gaining access and being accepted into these communities was always going to be challenging. As mentioned in the previous section, I had not only to gain official permission but also social acceptance. I used Aris as my primary gatekeeper [5], for as Twyman *et al.* (1999) suggest researchers are often perceived as 'outsiders' whilst assistants or translators are 'insiders'. Although this was certainly true during my research, Aris was in some ways also an outsider (coming from a different district) albeit on a different level. He introduced me to the important members of the community and as we walked through the village he would stop and chat to the villagers and introduce me. As suggested by Dunlap and Johnson (1999) during their work on the social world of drug sellers, the 'right contact' is essential. I needed contacts that are genuinely interested in helping me rather than those who see a relatively wealthy westerner who will pay for information. Luckily as the majority of villagers were pleased to help. This honesty and willingness to assist me during my time in the village reflects the Javanese hospitality and generosity.

Once I had officially arrived in the villages I had to meet the important members of the community first; these included the government staff, i.e. the head of hamlet and village, the head of *adat* (the religious and cultural authority in the hamlet) and any people who were considered wise by the villagers. In Pelemsari, this included Mbah Marijan, the "care taker" of Mt Merapi and his assistant Bapak Pujo. In Batur I was required to meet the government representative, the head of hamlet and also the *adat* representative. These initial meetings were formal involving the local customs and traditional hospitality; this involved drinking a large quantity of jasmine tea or black coffee with large quantities of sugar. Additionally traditional Javanese cakes, or *kue,* would be produced. (Milk in coffee is an extravagance. As dairy farming this is their main economy milk is a precious commodity, especially when these people rely on only two or three cows).

In order to integrate within the society I needed to become an honorary member of a family within the village. In order to abide with custom and placate the Inter-Cultural Institute's concerns I agreed to pay my hosts enough to cover food and general costs of hosting two people [6]. My host families were chosen in two ways. The first family in Pelemsari chose me (Plate 4.2), as the head of the hamlet Ramijo decided that in his position it was his responsibility to invite me to live at his house. The second family in Batur allowed me to stay in their home as Aris had previously meet the eldest son, Riyanto, and explained my research to him. Riyanto was intrigued by my research and welcomed me into his family and became an important gatekeeper (Plate 4.3). As a member of a family I immediately gained a mother and father, sisters and brothers, who were all keen to show off their new *anak* or *peranpuan* (child or sister). I was initially still an outsider but after being introduced by my *Bapak* or *Ibu* (father or mother), I was quickly accepted. I spent a lot of time introducing myself to the community, visiting houses and being invited in for the customary tea or meal. I was honest and open about my research throughout my entire time in the field and the villager's interest would entice them into talking openly about many issues relating to the volcano and everyday life. Being invited into their homes for a chat and something to eat was the best way to initiate an interview, the interviewee was comfortable in their own home and generally there were no distractions.

As suggested by Giacomi *et al.* (1993:131), 'the only way of gaining access to the activities of the community is to assume an active role; simply being an observer to events is not acceptable'. Although this produces logistical problems of taking notes whilst carrying out activities, I would often shadow a member of my family for the day in order to experience their lives.

Plate 4.2: My host family in Pelemsari, Aris is on the far right, and I am on the far left. The head of hamlet, Ramijo, is central (4th from the left) with his wife and then sister to his right and his mother and father to his left and his two young boys in front.

Plate 4.3: My host family in Batur, with me on the far left then the oldest daughter Sinto, the father, mother, Riyanto, and then his wife and baby, and lastly Aris my research assistant.

I would collect grass for the cow, carrying it home on my back using a sarong, climb with the men to clear the path for ceremonies, make offerings with the women, cut wood, pick cloves, and as I became more accepted within the community I was invited to take part in more and more activities (Plate 4.4).

I was also invited by the women of Batur to help prepare for a wedding this included one week's preparation of cooking and making offerings (Plate 4.5). This is quite an honour for a western woman to be included in such a special and large community event. Initially my presence was exciting for the women, although at this point I had been with in their community for over three weeks and had become a regular sight. Like Wray (Calveley and Wray 2002) found whilst researching within a factory in the United Kingdom, my position went from "the foreign girl doing research" to just "one of the girls" helping to prepare the traditional wedding food of diced potatoes, *sambol* (chilli, onion, and garlic paste), and stock. I would sit on my little stool in amongst the chatting women peeling potatoes with a spoon and observing their interaction with one another, in the evenings we would all sit down on mats and prepare *lompor* sticky rice and shredded coconut wrapped in banana leaves and held together with splinters of wood. The community worked together everyone giving parcels of food to add to the mountain of noodles, dried fish and rice that was accumulated in a corner of the house. Every member of the village came and gave up their time to help prepare endless meals for the men who prepared the infrastructure for the ceremony. Even though they knew I could speak only limited Indonesian they involved me within every aspect of the preparation and would often say "*Di mana Ibu anda*?" "Where is your mother?" or "*Anda perempuan di sini!",* "Your sister is here!" At this stage Aris could respect tradition and help the men leaving me unescorted. Not requiring a gatekeeper meant that I had been accepted within their community and could freely ask questions whenever appropriate. I began to point and stare at strange long noised westerners in their big expensive cars, they became the outsiders and my family were the villagers. It was shocking to look in the mirror. Despite this I had to remain objective and would rely on a strict timetables in order to retain a sense of objectivity, I would write up notes systematically arrange workshops and interviews with key villagers efficiently. Essential trips to Yogyakarta for supplies would also provide perspective and respite.

Entering the field and carrying out research is described by Leslie and Storey (2003:119) as a challenge, something that could potentially cause a researcher to 'go mad, panic in the field' and be in a high state of 'anxiety', in short to be 'paralysed by fear'. In order to overcome these emotions the researcher should be prepared logistically and mentally. Logistically it is possible to ensure that you have gained the correct official permission to carry out the research, that you enter the community during the day not at night and that you have arranged accommodation, appropriate transport, and importantly access to clean water and food. Mentally, the effect of culture shock, brought on by the sudden immersion within a community can cause a researcher to become overwhelmed by the task ahead, homesickness, cultural isolation, and in some cases physical sickness. I overcame my homesickness and cultural isolation, by accepting that what I was experiencing during the first few weeks of my field season was completely normal. Once I had accepted that, I became more calm and focussed, dealing with each task or event one at a time.

Plate 4.4: Helping the women of Sebudi, Bali, to prepare offerings for one of the many family ceremonies. During the one month survey at Mt Agung volcano.

Plate 4.5: Behind the scenes at the wedding in Batur. I spent many hours helping the women prepare food and offerings.

4.5. The participatory workshops.

A range of PRA based activities can be used to enable local people to share, enhance and analyse their knowledge. It enables the collection of data as well as nurturing knowledge growth within the social group taking part. The main aim of PRA is for the researcher to 'take a step back' allowing the community to shape the workshops, influence input, develop activities and become integral in the research process. This research adapted the activities developed by Chambers (1994a) and then applied by Cronin *et al.* (2004a), namely daily and seasonal timelines, community mapping, listing and ranking, emergency plans, storytelling, community timelines and discussion (focus) groups. Starting with the timeline activities was an important initial step, because the timing, or sequencing, of activities is important (Chambers 1994a). The sequence of the activities during the workshops can influence the overall quality of the output. It is important to allow the workshops to flow, building the confidence of the local community with easier, straightforward activities such as daily timelines before making them do complicated diagrams such as hazards maps or emergency plan diagrams. The daily and seasonal timelines, therefore were, the initial activities undertaken during the workshops. These are relatively easy to create as they reflect the everyday lives of the participants. The community timeline is a good bridging activity as it is used to diagrammatically illustrate events which have influenced community memory or folklore. Figure 4.5 shows an example of one of the timelines produced during a workshop held in Vanuatu.

It is worth bearing in mind that,

> the information from these tools must be interpreted with caution: recent events are likely to mask earlier ones, severe impacts may overshadow by lesser but still significant disasters. Memory of hazard events is often incomplete or distorted, and may vary between different groups of people (e.g., men and women). (van Aalst *et al.* 2008:169).

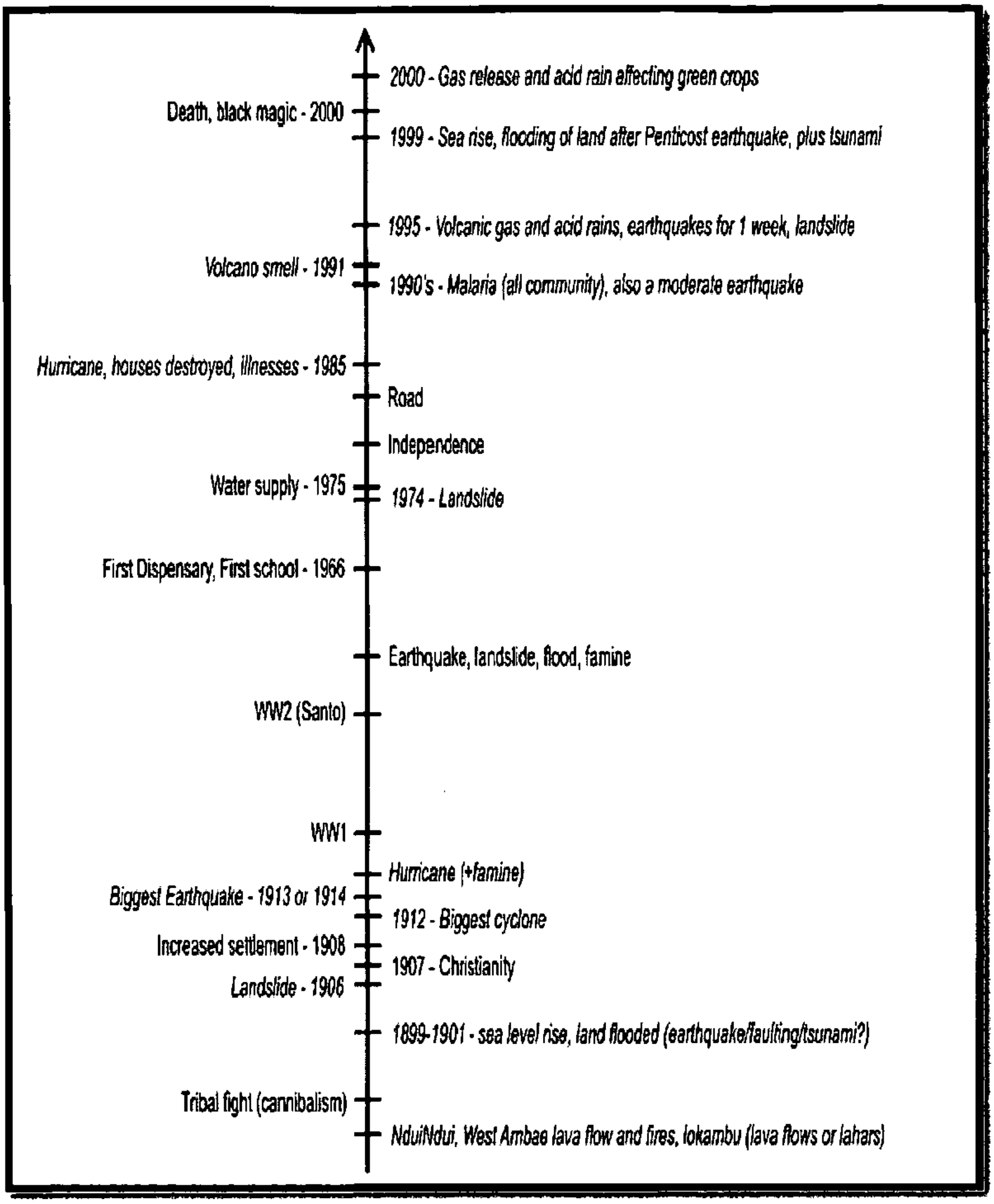


Figure 4.5: An example community timeline. Source: Cronin *et al.* (2004).

Van Aalst *et al.* (2008) highlight the need for caution when using PRA based activities, namely timelines. Bearing this in mind, the aim of the workshops at Mt Merapi were for the participants to complete a hazard map and emergency plan, in addition to a daily, seasonal, and community timeline. The hazard mapping exercise allowed the participants to highlight the regions that they believe are either dangerous or safe. From that they can illustrate their maps further with evacuation routes, important buildings, important land, meeting points, main roads, unofficial paths, and many other objects. The emergency plan consists of a flow diagram starting with an eruption of Mt Merapi flowing the participants' mental and physical actions. Table 4.2 provides an overview of the activities utilised during the workshops. The resulting maps and diagrams are examined in the next chapter.

4.5.1. Taking a step back: The ethos of PRA methodology.

As previously explained, part of the nature of PRA activities require the researcher to "take a step back" and allow trained facilitators to guide the participants. I trained Aris to carry out the workshops and we went through all the activities together beforehand and prioritised the activities just in case an unexpected time restraint occurred or people left early. Table 4.2 details of the activities carried out and the order of preference. These activities relate directly to the hazard perceptions of the villagers, identified by Cronin *et al.* (2004), and also complement each other sequentially. Other activities were added to the itinerary if there was time; such as ranking the most important issues, discussing traditional stories about the volcano, and discussing the existing official hazard map. Reflecting the ethos of PRA methods the workshop activities were kept as flexible and open as possible. The participants could freely add to diagrams, use their own materials, create their own methods of drawing timelines or maps and the older participants were able to instruct the younger more literate participants during the activities ensuring those members who wanted to take part did so. During the workshops I tried not to interfere, only doing so when Aris had a direct question or query and usually my answer would be positive and allow the participants to have be spontaneous and develop their own styles.

Activity	Explanation
Hazard map,	The participants drew a sketch plan of the village and then identified which areas were safe and unsafe, evacuation routes, and any other information they wished to add to the map.
Emergency plan	The participants drew a flow diagram to illustrate the actions they would take if Mt Merapi showed signs of erupting or if the government issues an alert.
Community timeline	The participants recounted key events in the communities past, for example, eruptions, floods, new school.
Seasonal and Daily timeline	The participants made lists to describe their daily timetable and seasonal calendar. Usually this was used as a warming up exercise because it is simple.

Table 4.2: Participatory activities in order of importance.

4.5.2. Men and cigarettes: The dominance of the male head of household.

The participatory workshops were an ambitious part of this project. Due to my geographical location within the settlements they were organised through either the head of hamlet in Pelemsari or my host family in Batur with the consent of the head of hamlet. This produced two different workshop sessions. In Pelemsari, hosted by the head of hamlet, the meeting was very formal with opening and closing prayers and speeches. The participants were all male, except for the occasional female who was serving food and drinks. The male participants were either heads of households, members of the hamlet committee or head of particular groups, such as the young mens society. In Batur the participants were men and women, our host's friends and work colleagues, in addition to the women of the family and their friends. This meeting was less formal, with no opening or closing prayers and unlike Pelemsari once the refreshments were provided the women stayed and participated. When I requested a separate meeting for women in Pelemsari I was meet by confusion and the wife of the head of Pelemsari hamlet exclaimed [7]:

*"Why do you want to talk to the women? We know nothing", **Ramijo's wife,** 27.06.07, 12:30.*

Despite the male dominance during meetings and official discussion making, Kurujarti and Tickamyer (2000:416) found that in rural Java 'women and men often share tasks, resulting in a relatively equal status and power'. They explain that traditionally, before the Green Revolution of the 1970's, women in rural Javanese villages enjoyed a 'significant role and status' and although I was unsuccessful in organising a meeting solely with the women of Pelemsari, in Batur, women voluntarily attended the workshops. In Batur appear to women play a more active role in community affairs, reflecting Kurujarti and Tickamyer's (2000) suggestion of gender equality. This could be because Batur has had the opportunity for alternative employment through the modern Merapi Golf course. This golf course is of international standard and is just 3 km from Batur. According to villagers it attracts extremely wealthy business men from around Indonesia. Merapi Golf has a policy of employing only local women and girls to be caddies. They must be from the local villages (Pelemsari is too far away), they must be under 35 years old. This has empowered the young women of the local villages; as they are earn their own wage. They see a different life and demand more from their own. The villagers are very happy with Merapi Golf as it employs so many, not just caddies but also maintenance workers. Golf, it seems, has empowered the local women.

4.5.3. Customs, timings and refreshments.

The workshops had to be held in the evenings because of the participant's busy daily schedule. Their early 3am or 4:30am start to the day, in order to milk their cows and deliver this fresh milk before the morning collection and complete 5am prayers, meant the participants would become tired and some even fell asleep by the evening. Traditionally, there are many meetings that take place throughout the week ranging from ceremonies to agricultural education. The participants' long working days and the continuous rounds of meetings meant that although initially these workshops were relatively formal once the activities started, the participants relaxed spreading themselves out on the floor, smoking, chatting and telling stories. This meant that I held two shortened workshops rather than one all-day or half-day workshops. As long as the 'sequencing' of the activities was balanced, their attention was held and the evening workshops were reasonably successful. Table 4.3 lists the participants of each workshop, the date, time and location.

Complying with traditional custom in Java, after the end of the workshop series I gave the participants a gift of thanks. These gifts, like the ones Cronin *et al.* (2004a) gave to the people of Ambea Island, Vanuatu, were not only to abide by the local *adat* (Indonesian tradition) but also in order to stimulate a reminder of the work that had taken place in these workshops. In Pelemsari I provided the participants with hand held scythes, these are tools that they use everyday collecting grass for their cows. Therefore these were useful and symbolic of the "tools" that I had given to them, through creating their own hazard maps and emergency plans, and the "tools" or information they had provide me. In Batur it was more difficult to find a suitable gift, as the livelihoods are more varied. Not all the participants had cows and therefore collected and relied on the scythes in the same way that the Pelemsari participants did. I decided that as the custom is to drink tea when visiting neighbours and when hosting a guest that I should provide ceramic mugs with Mt Merapi printed on the side in addition to my name, my university affiliation and some words of thanks in Javanese. These would hopefully provide a trigger of remembrance of my time in the village, the research that I carried out and to keep them thinking about the potential threat from Mt Merapi.

Name	**Age**	**Gender (M, Male and F , Female)**	**Location**	**The participant attended 1 or 2 workshops.**
Sihono	63	M	Batur	2
Riyanto	34	M	Batur	1 and 2

Puji	25	F	Batur	1
Tolo	33	M	Batur	1
Wanto	29	M	Batur	1 and 2
Supri	20	M	Batur	1 and 2
Bingat	55	M	Batur	1 and 2
Untung	27	M	Batur	1 and 2
Surahmi (Ibu Sihono)	55	F	Batur	1 and 2 (came in and out of workshop)
Sinto	35	F	Batur	1
Rubiman	50	M	Batur	2
Nyariyem	26	F	Batur	2
Ngatimin	22	M	PS	1 and 2
Ponijo	24	M	PS	1 and 2
Purwanto	65	M	PS	1 and 2
Wardi Wiyono	65	M	PS	1 and 2
Slamet	20	M	PS	1 and 2
Asih	40	M	PS	1 and 2
Ramijo	35	M	PS	1 and 2
Pudi	70	M	PS	1 and 2
Sunar	22	M	PS	1

Table 4.3: The common characteristics of the workshop participants from Batur and Pelemsari (PS). M or F relates to Male or Female. This table illustrates the male dominance during the workshops.

4.6: Semi-structured Interviews: Conversations with purpose.

Interviews were the back-bone of my data collection methodologies (Plate 4.6). They are commonly used in hazard perception studies and often form the main methodology utilised by the few natural hazard scientists investigating social reactions to geological hazards (Solana *et al.* 2008, Haynes *et al.* 2008, Dibben and Chester 1999).

Interviews can either be structured and semi-structured. A structured interview follows a set of predefined questions and responses that are contained within a defined context. As Solana *et al.* (2008:4) found whilst carrying out questionnaires around Vesuvius, it was necessary to conduct interviews that enabled the respondent to 'express a spontaneous personal opinion'. This was exactly what I required as I needed elaboration, spontaneity, stories, and insights, basically a conversation that reflected how these people felt? Therefore I followed a set of pre-designed guideline questions, such as, what happened during the last volcanic crisis and how did that made them feel? What do they require during future volcanic events? And what a volcanic eruption means to them? These guides were used to keep the conversation going and were there for my research assistant if it was unacceptable for him to break the conversation flow by asking me which questions needed asking next or relaying the answer back to me. I needed the guide lines in order to retain a degree of replication, transparency, and generalization; so that other researchers would understand which particular questions I asked and the flow of the conversation.

Like the research carried out by Twyman *et al.* (1999) in Botswana, the interviews were all tape recorded with the permission of the participant. As Twyman *et al.* (1999:318) found during their research 'it was not considered unusual to repeat and stress explanations' this was seen as part of the interview structure. It was extremely important to remain overt and honest about our intentions and this way the respondent felt secure and able to talk freely.

The interviews were transcribed into note form in the field immediately after each interview, if possible, or at least during the evenings, regardless of whether the interview was in English, Javanese or Indonesian. Occasionally it was acceptable to translate on the spot, although as suggested by Schevyens and Storey (2003) it is preferable to translate the tape recordings after the interviews had taken place in order to reduce misinterpretation, interruptions, and bias. Schevyens and Storey (2003) discuss how despite the advantages of developing language fluency there was rarely time for developing such skills within a doctoral programme; this unfortunately was the case for me. Although I undertook language lessons both in Indonesia and in England I have never reached the level of fluency needed to carry out interviews. My lack of Bahasa Indonesia and Javanese meant that I preferred that at least some of answers were translated on the spot so I could ask related questions. Unfortunately this was not always appropriate as occasionally the interviewee would be initially interested in this by-lingual approach, but would soon get bored and their answers would get shorter.

It should be noted that the inescapable act of translation in itself is a complex issue. Translation 'is the replacement of text in a source language by text in a target language equivalent in meaning'; in this quote Müller (2007:207) implies that the meanings embedded within text can be lost through translation. He explains that as geographers continue to carry out research in different languages it is vital to acknowledge and safe-guard against a loss of meaning. As foreign researchers we must be 'good translators' and we rely on our translators to convey meaning as well as fact.

Aris's needed to be fully briefed before each interview took place and we held regular discussions in order for us both to know what was required from each interview. These meetings were also intended to reduce his bias whilst holding the conversations. As a Javanese villager himself he was very concerned with the welfare of the local population, and so it was important for him to be objective and yet sensitive. As suggested by Scheyvans and Storey (2003), before entering the field time was spent discussing the nature of the project and the research assistant's role within the research. This enabled us to build up a professional relationship and enabled him to understand what was expected of him. His background as a university level researcher enabled him to understand the need for him to be objective and this helped reduce facilitator bias. Having an educated assistant was preferable and because Aris was employed solely by the Inter-Cultural institute he had no external time constraints or responsibilities.

Plate 4.6: This photograph was taken during one of our interviews. The participant was collecting wood and vegetables whilst we talk with her.

4.7 The unfocussed nature of focus groups.

> Focus groups are especially useful in the study of human responses to natural hazards. (Ziegler, Brunn and Johnson 1996:124).

The final methodology to be utilised during the first field season were focus groups. These were intended as a way of "interviewing the hazard map" and like Ziegler *et al.* (1996) exploring the victims reasons for ignoring evacuation warnings before and during a natural hazard. In groups of three or four the participants discussed the merits and problems of the existing maps, posters or booklets that had been provided for the hazard education. Additionally these small groups provided an opportunity to discuss some of the oral histories related to Mt Merapi.

Historically focus groups were initially used for the evaluation of US Army training and propaganda films during World War II (Goss 1996), then developed for market research and help groups, such as Alcoholics Anonymous (Crang and Cook 2007). Focus groups are now widely accepted as a valid research method employed by social sciences to explore various aspects of people's everyday interactions with their social and spatial worlds (Hopkins 2007, Goss 1996).

Holding discussions with small groups of participants enables the researcher to observe group thinking and interactions and it has been successfully used to explore sensitive issues, such as Hopkins (2007) work examining young Muslim men living in Scotland, Ziegler *et al's.* (1996) research into the reactions to Hurricane Andrew in 1992, or Vissendjee *et al's.* (2002) research using female only focus groups in a culturally sensitive rural community in India. The latter's work in rural India exposed some issues with using focus groups in culturally sensitive regions, and concluded that focus groups are preferable to quantitative surveys. This preference is due to oral traditions and the informal and open nature of societies. This was, in part, what I found during my initial field reconnaissance. The tradition of telling stories and chatting late into the night seemed to fit with the focus group method and I believed that I could engage small groups of villagers in discussions on the eruptions, the mystical stories surrounding the volcano and the needs of the local community in relation to disaster management. I was therefore intending to organise these as I had done the workshops, but it soon became apparent that I had asked enough of the heads of hamlets and my host family already. These focus groups therefore took place opportunistically, sometimes with my host family, sometimes while visiting other villagers or when I was helping to collect bamboo or grass, or clearing the ceremonial path. During one day I was able to hold mini focus groups as we drove around the volcano through other regions because we continuously would get lost and required assistance. The local people would be intrigued by the strange foreign girl and would come over to help, they would stand and talk in groups and assess the only detailed map we had, the official hazard map. Because these discussion groups took place opportunistically it was unfortunate that I could not prepare them as efficiently and culturally sensitively as Vissendjee *et al.* (2002) (Table 4.4). Yet even during these impromptu meetings I would still attempt to follow some of the guide lines for focus groups. It should be noted that there is a certain amount of debate to whether focus group facilitators should follow guidelines which were essentially laid down by market researchers (Goss 1996). Despite these arguments there are some essentials whilst carrying out focus group work in rural developing regions. Table 4.4 highlights these guidelines but because of the impromptu nature of my focus groups there was inevitably a degree of flexibility. Most importantly, all members of the group should have the opportunity to comment as groups can be dominated by a strong personality (Bryman 2004). Domination can be overcome by using smaller groups (Hopkins 2007). Another reason of exclusion was illiteracy, because the focus groups in the villages revolved around a map or diagram those who were illiterate could have been marginalised; in attempt to reduce this occurring I would introduce the product describing it in detail (which was translated to them by Aris) before the discussion began. In addition, often the younger members of the group would make efforts to include older less literate members in the discussion.

Basic steps towards culturally competent focus groups
Be Flexible: Expect the unexpected in terms and cultural difference.

Share information about yourself with the participants. This increases trust in the research team and is a logical precursor to asking them to share their lives with you.
Take the time to understand local customs and respect them during data collection. Do not disregard local customs as you could be alienating yourself and your research from the very people from whom you intend to learn.
Consult others in the areas who have conducted similar studies: Their success and failures will guide your approach and highlight areas of caution.
Engage local community members in the elaboration of research design, choice of methodology, planning and implementation of your focus groups.
Be prepared to adapt literature or previous experience with focus groups in developed countries and look for more techniques that are culturally appropriate.

Table 4.4: Basic steps towards culturally competent focus groups. Source: Vissendjee *et al.* (2002).

The focus groups would often become unfocussed, as the conversation led away from the topic to be discussed. It was up to Aris and, to a certain degree me, to re-focus attention back to the matter in hand. Alternatively, it was often more useful to let the group discuss their own topics as these often led to aspects of hazard perception I would not have preconceived.

Although focus groups have the potential to explore topics efficiently and creatively within culturally sensitive communities, during my research I had exhausted my host's patience in organising separate meetings. This was disappointing, but not a disaster. Taking opportunities where I could enabled me to 'drop in' on discussions without the requirement of an 'organised meeting'.

4.8. Ethical considerations.

> Ethical tensions are part of the everyday practice of doing research. (Guillemin and Gillam 2004:261).

Since the 1960s, social science research authorities have developed codes of conduct or ethical guidelines for researchers carrying out studies involving human participation (Guillemin and Gillam 2004). It is now compulsory for all researchers to complete ethical clearance to ensure that the participants are protected and the researcher is made aware of the ethical considerations before undertaking fieldwork. To guide researchers a vast literature exists exploring the ethical implications of qualitative research and virtually every textbook relating to qualitative research contains sections on ethical considerations (Bulmer 1982, Hammersley and Atkinson 1995, Bryman 2004, Burgess 1984, Scheyvens and Storey 2003). Procedural ethical clearance is compulsory, yet another aspect of ethics exists, ethics in practice. Ethics in practice is acknowledged by the American Anthropological Association (AAA) who declared that 'no code or set of guidelines can anticipate unique circumstances or direct actions in specific situations (1998: II). The AAA suggests that during fieldwork there are times when no guidelines can assist the researchers and it is up to them to make ethically correct decisions. These 'ethically important moments', as Guillemin and Gillam (2004) test the researchers ethical competence. Although this competence can be enhanced by the ethics committee process ultimately it is the researcher's responsibility and obligation.

Before undertaking this research I sought ethical clearance from the Human Ethics Committee of the University of Plymouth, see Appendix 3. Whilst completing the application for ethical clearance I had to make some initial decisions about who I would be interviewing and how I would go about it. I decided that interviewing children was unnecessary and so no one under 18 years old was interviewed during my time in the field. All the participants were adults and they could withdraw from the interview at any stage.

In order to get ethical clearance from the University it was essential that I gain consent from the participants. I decided not to use the official consent forms because I was unsure of how literate the participants were, and was unclear, how would I feasibly carry consent forms with me for five months? In addition, these forms would have had to been translated into Indonesian. In light of this, I confirmed that I would gain the participants consent verbally. Before each interview or workshop I would explain who I was, what my research was about and that they could pull out at any point. I would explain how this research would enable to understanding of Javanese culture and that I would learn more about the volcano. All of these explanations were carried out through Aris who translated for me. In reality this type of consent was difficult to initiate. As Scheyvens *et al.* (2003) explains verbal consent is not always as straightforward as indicated in ethical clearance forms. In reality the presence of the Dictaphone often scared the participants and they would give short or blunt replies and sometimes refused to talk at all, yet when the Dictaphone was placed out of sight the participants relaxed, even though they knew they were being recorded. This often meant that I had to introduce myself and the project and gain their permission before the Dictaphone was introduced to them and turned on, meaning that their consent was never recorded. I had to make an ethical decision, did I record the interviews covertly or did I record the interviews openly without the official initial consent being recorded? I had to lean away from the official guidelines and accept that in the field ethical responsibility rested with me. Yet I tried to remember the AAA's advice that the individual bears ethical as well as scientific responsibility and the responsibility is a human judgement (American Anthropological Association 2000). I could only do what I thought was best at the time. Once this ethical dilemma was overcome the interviewees were happy to take on the teacher role, proud that they could contribute to my research and explain their culture. They were happy that I, an educated westerner, was interested in their lives and that I wanted to live within their community.

Another important ethical issue surrounding the field work was the sensitive nature of some of my questions. I was asking the participants to think and talk about events that could have been very traumatic. The volcanic eruption in 2006 had turned their lives upside down and had killed two local volunteers. So it was made clear to them that they could describe as much or as little as they desired and the participants were not pushed to describe events that have had an intense psychological impact. This information was always given freely and at a pace that the participant was happy with and I tried to retain a conversational feel to the interviews in order to overcome Kellehear's description of interviews as 'polite interrogation' (1996:98). In order to retain my ethical competence I attempted to remain reflexive during my fieldwork, constantly reassessing my position and influence on the participants. Guillemin and Gillem (2004) suggest that reflexivity during research not only improves validity and quality, as described previously in this chapter, but can also be an important tool in gaining ethical credibility.

Fieldwork in developing countries opens up a plethora of ethical dilemmas (Scheyvens *et al.* 2003). There are issues of power, exploitation and expectation. There is sometimes a degree of expectation from the participants that because a western scientist is studying them, their lives might be changed by it or some kind of compensation may be given. As western scientists, are we exploiting developing countries and disregarding that the 'respect and well-being of persons takes precedence over expected benefits to knowledge'? (Commonwealth of Australia 1999:1.4:11). Inevitably when researching in developing countries, the researcher will be in a position of power due to real differences such as wealth and education, in addition to perceived differences such as the superiority of the western world. Sidaway (1992:403) explains that when undertaking research in developing countries 'we move towards the top of a social hierarchy in a society that we often do not well understand', whilst Madge (1993:297) goes on to explain that the researcher's own positionality plays an important role in research in developing countries and that it is important to 'work passionately and sensitively within (those) power relations'. In order to combat this power gradient, to a certain degree, Aris would lead the conversations and in the ethos of PRA I would 'take a step back'. In this way, a Javanese person was interviewing another Javanese person, restoring the power imbalance. I would occasionally intervene but we explained to the participant that we were a team and that Aris was not working for only me, but for the project.

Although it is to some extent possible to overcome minor ethical issues during interviews, what about the ethical implications of the entire research process? Is it possible to carry out ethical research in an unethical world (Patai 1991)? The unequal power relations between individual and countries produces a complex ethical issue. After all, as Madge (1997:115) suggests, 'only through the existence of privilege through the existing status quo of global power relations, that I went to a (Gambian) village to do my research rather than someone from that village coming to England to investigate my life-world'. Madge (1997) questions should first world researchers carry out fieldwork in third world countries at all? She concludes that these larger ethical issues are inherently political issues and therefore require a political solution and that ultimately it is up to the researcher to decide whether the research is 'worth doing'. Does my work have an ethical responsibility 'to do good'? (Madge 1997). I believe that ethically the outcomes of my research should in some positive way affect the participants of this research, yet as Sidaway (1992:405) notes 'politics, logistics and resources often dictate otherwise'. He suggests that collaborative research is the ideal, and so hopefully through my collaboration with the Inter-Cultural Institute and the Geography Department at Gadja Mada University, Yogyakarta, this research may become more ethically and locally relevant.

4.9. Data analysis.

As discussed previously, qualitative research methods such as participatory observation have no well formulated methodology of analysis (Miles and Huberman 1994). Crang and Cook (2007) describe the analysis of qualitative data as an 'informal process of piecing things together' and 'figuring things out'. For,

> most analysis is done by words. The words can be assembled, subclustered, broken into semiotic segments. They can be organized to permit the researcher to contrast, compare, analysis and bestow patterns upon them. (Miles and Huberman 1994:7).

The unorganised nature of qualitative data analysis attracts a variety of experimental, spontaneous and creative analysis methods personal to each research project and each researcher. Crang and Cook (2007) suggest that this is the reason for why some call qualitative research 'woolly' and subjective.

Classically the examination of qualitative data can be split into three analytical approaches; interpretive, social anthropology and collaborative social research (Miles and Huberman 1994). In this research the data collected during the field seasons, in the form of interviews, workshops, and participant observation, will be analysed reflecting the principles of social anthropology. This means that the analysis will lean towards the descriptive rather than the quantifiable. Although this may seem at odds with a traditional geological analysis, it is in fact extremely similar to the analysis carried out by geologists in the field. As Libarkin and Kurdziel (2002:199) note, geological 'stratigraphers spend a significant amount of time making observations and taking field notes', and then analysing these notes for patterns and, like qualitative researchers, provide a synthesis of that data. Description and interpretation is at the heart of both geological and social data collection and analysis (Frodeman 1995), and therefore the following section and chapters blur the boundary between these sciences by producing a holistic interdisciplinary account.

In order to create a valid and reliable results the analysis will follow a classic procedure suggested by Miles and Huberman (1994), whilst also acknowledging and incorporating the more creative side of qualitative research thus creating a balance between the creative and structured (Crang and Cook 2007). Table 4.5 gives on overview of the procedures for analysing word based data. The field notes and interviews will be classified using a coding system. Coding will reflect the common recurring themes and concepts that have become apparent during the initial pre-analysis stage of the procedure, during the typing up of field notes.

Classic set of analytical procedures
Affixing codes to a set of field notes drawn from observations and interviews. Noting reflections or other remarks in the margins.
Sorting and sifting through these materials to identify similar phases, relationships between variables, patterns, themes, distinct differences between sub-groups and common sequences.
Isolating patters and processes, commonalities and differences and taking them out into the field in the next wave of data collection.
Gradually elaborating a small set of generalizations that cover the consistencies discerned in the database.
Confronting those generalizations with a formalized body of knowledge in the form of construct or theories.

Table 4.5: A classic procedure for qualitative analysis of field notes and interviews. Source: Miles and Huberman (1994).

The counting of themes and concept relates to 'content analysis' (Berg 2007) which is traditionally a quantitative method of analysis, although it can be used to identify key recurring themes that are influential within the community. Yet, at this stage in the research a more in-depth descriptive analysis is required in order to gain an understanding into the daily lives of the informants, what is important to them and their beliefs related to the volcano. In light of this, the analysis focuses on a set of procedures known as grounded theory (Glaser and Strauss 1967). Grounded theory is not so much a method but a style of analysis that involves using a coding paradigm to form theories from the data (Strauss 1987). In this study grounded theory is used to initially identifying key repetitive ideas or topics from the interviews and these are coded accordingly. Codes are labels that correspond to what that segment of data is all about (Charmez 2006). After thorough reading and reviewing the codes patterns or overarching codes appear that can lead the research into new directions.

Because of the large number of interviews conducted during the field season (over 100) the analysis was carried with the aid of social data software called NVivo 7. This software provides an efficient way to store and search large amounts of data, and additionally it also allows the user to code the interviews or other data formats (Bazeley 2007). In conjunction with using NVivo 7 I also prepared and collated the interview transcripts into books categorised according to the field sites in which they were conducted. These books allowed me to read and make annotations on the transcripts without the restraints of a software system. Using grounded theory gave me a freedom to interpret not only the interview text but incorporate my own observations and impressions gained during the field season. Key themes were further developed by incorporating information from interviews with non-government academics or NGOs, in addition to the products and observations from the workshops and my overall observations. There is therefore considerable creativity involved when using grounded theory that enables the researcher to not only pin point elements that are vital to the research but it also takes the research in directions previously unanticipated.

Discovering unanticipated strands or topics during this analysis is key to the effectiveness of grounded theory; in essence this style of analysis can help reduce researcher bias because of the inclusive nature of the procedure. As the procedure of reading, coding and note taking continues the researcher should note down any reoccurring, unusual or research related data, and in doing this the researcher does not only search for the items that interest to them but is also open to new ideas and topics that reveal themselves. As Charmez (2006) notes the codes are the skeleton of the research, they are more than the beginning of analysis but rather are the structure and guiding ideas of the research. Ideas and hypothesises are formed from these codes rather than the codes confirming an idea, and as the final chapters of this thesis reveal the ideas that come from these codes can take research into an unanticipated and novel direction. Chapter 5 details and examines these themes, detailing the influences and consequences of these key findings.

4.10. Summary.

This chapter outlined the methods used during my social science data collection in two communities on the slopes of Mt Merapi, Indonesia. Initially I discuss the reasons for selecting qualitative research methods, such as semi-structured interviews and PRA inspired workshops. Qualitative research methods enable me to explore the local culture and reactions to the volcanic hazards which threaten the villages. Qualitative methods produce a 'portrait of people' (Harris and Johnson 2000), that cannot be gained through the use of quantitative techniques. It was important to the project that I live within these communities and gained an understanding of what they thought of the volcano and what they experienced during the eruption last year. In order to 'test' some methods used by Cronin *et al.*(2004a), I carried out a series of participatory workshops that involved the local participants designing maps and diagrams relating to their village and the volcano. Chamber's (1994a) ethos of 'taking a step back' enabled my research assistant to facilitate the workshops whilst I observed.

An important issue discussed in this chapter was that of gaining access to a community as this is one of the most potentially difficult stages of field work. First impressions may allow immediate access to all the community members or exclude you further from the participants. It was vital that I had a research assistant and Aris effectively filled this role, exceeding initial expectations. He introduced me to the village and eased my access into the community.

I also discussed the ethical considerations required when conducting research with human participants and have argued that ultimately, it the researcher's responsibility to be ethically competent and fundamentally 'do no harm'. Finally, I discussed the style of grounded theory analysis used to process my data and key themes that are discussed in chapter 5.

Overall, this chapter demonstrated that social research methods require not only careful design but personal reflection, appropriate ethics and cultural sensitivity. In other words, as England (1994:84) notes 'we do not parachute into the field with empty heads and a few pencils or a tape-recorder in our pockets ready to record the facts'.

Foot Notes:

[1] PRA was born from other approaches such as Activist Participatory Research (APR), Rapid Rural Appraisal (RRA), Field research on farming systems, and Applied Anthropology such as Rapid Assessment Procedures.

[2] I describe myself as a girl because this is how they see me; I was often told that I am incredibly young to be undertaking PhD research and to be undertaking such a long journey from my home by myself (I was 24). This reaction is not surprising as only 22% of the Indonesian population has a level of education of senior high school or higher (as of 2006 Baden Pusat Statistik (n.d)) and those Indonesians who carry out PhD research are generally male and over the age of 35 years.

[3] A research assistant is an invaluable tool whilst doing research in a foreign country, 'working entirely without help is not feasible unless the fieldworker fully comprehends the local language, and has a good understanding of the local culture (Devereux and Hoddinott 1992: 26)'. For me the fieldwork would not have been possible to without my research assistant.

[4] I describe Aris and my relationship as a professional friendship because I was aware that I needed to remain slightly distant from him in order to retain a good working basis. We were good friends but there was always a certain formality about it, this may have also

reflected the lack of friendships between men and women in Indonesian cultures. Most men were best friends with men and the same for women.

[5] According to Bryman (2004) a gatekeeper is an individual who can 'smooth' an ethnographer's entry into a particular field. A gatekeeper can be a member of the community, someone who is sympathetic to your project (Crang and Cook 2007). During my research, to a certain extent, this role was performed by Riyanto in Batur village and Pujo in Pelemsari, although realistically it was my research assistant who fulfilled a more active introductory role.

[6] Paying the host family conjures up ethical issues of bribery in order to gain information, yet it was the polite custom to offer money for our accommodation and food. In Pelemsari the host family accepted our expenses and where able to install windows into their newly built home. In Batur the family refused to accept the money we offered because we had become very close to them and we were guests to them rather than researchers. This refusal to accept our money shows how we were accepted into the community in Batur more than Pelemsari, but it also shows that the people of Pelemsari are not as wealthy as those in Batur.

[7] Direct quotes from informants are formatted in a distinctive way, using italics and font style Calibri. They are formatted differently from the main body of the thesis in order to emphasise that this is 'their voice' and their personal information. Other academic quotes are formatted according to publications from the Royal Geographic Society (with The Institute of British Geographers).

Chapter 5: Data Analysis

5.1. Introduction.

This chapter explores key themes that emerged from the interviews, workshops and observations collected during the main field season at Mt Merapi. The interviews were assessed with the intent of answering the main research question discussed in chapter 1, namely, **how and to what extent does culture shape the villager's reactions to the hazards they face?** This broad research question was subsequently spilt into manageable sub-questions that guided the development of key categories. Quotes and notes that related to the key categories and new unforeseen ideas were coded and sorted.

The participant's demographic characteristics, and the date and time of their interviews are noted in Tables A4.1-A4.4 in Appendix 4. Tables A4.1, A4.2 and A4.3 within Appendix 4 also contain some basic results and these are discussed in the main body of this chapter. This chapter also examines some of the diagrams and maps produced during the participatory workshops. As specified in chapter 4, there were approximately ten workshop participants from both Batur and Pelemsari, activities were carried out over two to four hour evening sessions in each community. Overall 94 semi-structured interviews were carried out in the main field sites, whilst, a further 10 supplementary interviews were conducted whilst travelling around the east and west flanks of the volcano. In addition, 26 interviews were held with non-villagers who were instrumental in emergency management in the region and included relevant informants from government led departments, non-government organisations, and academics from Yogyakarta.

The data collected from Pelemsari and Batur provided an insight into the events and experiences during the 2006 eruption and the everyday lives of those living on Mt Merapi volcano. It is clear that their lives, religions and traditional beliefs are complex, contradictory, and entwined.

5.2. Main themes.

5.2.1. A responsibility to stay behind: "live or die we stay in the village".

Responsibility was a reoccurring concept within the interviews and observations. This section will examine three important codes linked to a common theme of responsibility:

- Village and hamlet staffs have dual responsibility to both government and villagers.
- Responsibility to protect hamlet and fellow villagers.
- Responsibility to care for and protect their livestock and livelihoods.

In addition this section will introduce some significant events that occurred during the 2006 volcanic crisis.

During the 2006 volcanic crisis the informants felt they had a responsibility to protect their livestock, homes and fellow villagers, whilst remaining loyal to the government and more significantly, to Mt Merapi itself. The villagers gave the impression that it was therefore difficult for them to decide what to do; should they stay and provide for their cattle having faith that Mt Merapi will not endanger their village; or should they leave, thereby placing themselves at the mercy of the government and non-government organisations (NGO's) and possibly antagonizing the volcano and its spirits further?

The village-based government staff, such as head of hamlet or RW (Rukun Warga, the administrative unit below the head of hamlet) felt they had a responsibility during the 2006 eruption to follow the official evacuation orders and to enforce this order throughout the village. These informants who were official government staff and residents found themselves with a personal and professional contradiction, being certain that their village was safe but also having an official responsibility to evacuate fellow residents. Adi Sarju, who is head of the neighborhood association in Batur found he "was in a difficult position...because (he) had to order the villagers to go the evacuation site" even though he thought "it was okay to stay at home". There seems to be a conflict of interests, on one hand to fulfill the duties of an official whilst on the other hand retaining the village beliefs. In Pelemsari, villagers who had volunteered to help at the evacuation site or those who are official staff explained that although they would often go to the evacuation site they would also return home to carry on with "normal "everyday chores.

> *"When the recent lahar occurred I was building a new porch for my house, but then I and my friends ran. After two nights in the evacuation site I went home to finish my porch", **Margo,** logistical representative for Pelemsari during the evacuation in 2006.*

It could therefore be argued that the attitudes of the key village-based government staff instigated a false sense of security within their fellow villagers. This might have led to confusion as a result of their instructions conflicting with their actions.

In addition to conflicting and confusing messages and actions from the government staff, the officials prematurely allowed residents to return home during the crisis.

> *"I evacuated because I was afraid, the government ordered us to evacuate several months before [the big eruption], the government then announced that it was safe to go home and then the big eruption occurred. Now I trust my own judgment", **Purwanto,** Pelemsari.*

Purwanto, explains that just before the largest pyroclastic event the official alert level was dropped and the villagers were told that they could return to their homes from the evacuation site. Unfortunately, just a few hours after many of the villagers had returned, the eruption became more violent killing two people and producing hot lahars down the

Gendol River. Giono, a young man from Pelemsari argues that this event "made the villagers lose faith in the government". False alarms in emergency situations can greatly undermine trust and decrease a community's compliance (Barberi *et al.* 1984, Perry and Godchaux 2005, Cola 1996). After this event the villagers trust and sense of loyalty towards the government disintegrated.

The lethal pyroclastic flows caused panic and confusion amongst the population. For example, some of the older villagers thought that because they had been told to return home, that they were not allowed to go back to the evacuation site. As a consequence many of the villagers were at home during the worst of the eruption, fuelling the insinuation that the villagers had refused to evacuate. As Figure 5.1 shows, over 80% of Pelemsari interviewees were at home during the largest pyroclastic flow event as they had returned to the village under the government orders.

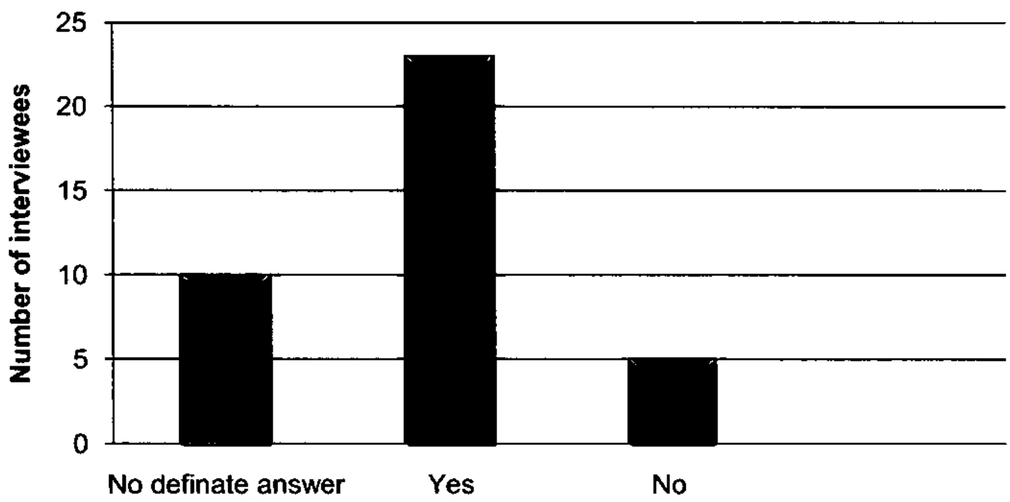


Figure 5.1: The number of informants from Pelemsari who were at home during the largest pyroclastic flow event during the 2006 eruption.

The government officials allowed the villagers to return home because at that time their resources were overstretched; three weeks prior to the lethal pyroclastic flow activity a magnitude 6.3 earthquake struck the nearby region of Bantul, 25km southwest of Yogyakarta, killing 5749 people and injuring 38,568 (USGS Earthquake Hazard Program 2007). Disaster aid was re-directed from Mt Merapi to Bantul, a fact that may in part explain why the government was so eager to allow the residents to return home. They could then concentrate their relief efforts on a fatal disaster that had already occurred, rather than one that might potentially happen. The unpredictable nature of volcanoes and the constant resource pressures resulting from an evacuation can lead to difficult and chancy decision from officials (Tobin and Whiteford 2002). For example, Smith (2001) describes the evacuation of 72,000 people from the Soufriere volcano in Guadeloupe in 1976 base on an 'erroneous prediction'. Over several months of decreasing volcanic activity the Guadeloupe evacuees lost confidence in the officials and scientists and returned to their homes (Smith 2001, Fiske 1984). This example and the Mt Merapi event demonstrates that due to the erratic nature of volcanic eruptions it is very difficult for any emergency planner to judge when it is safe for villagers to return to their homes. Despite this, false alarms and mistakes do influence the local population's reactions to the next eruption and consequent evacuation. As one informant told us:

*"If I was offered again to evacuate I would not evacuate", **Suparjo**, Pelemsari.*

Many of the Batur informants were frustrated with the government. Aris, a young educated man from Batur, alleged that "the government staff were too afraid to come to the village to do their job" and because of this, many of the villagers took on roles of responsibility that should have been fulfilled by official government staff. Riyanto, our main contact and a gravel collector from Batur, decided to help evacuate the villagers using his family's truck. He was not paid for this work but he felt it was his responsibility to help his fellow villagers. Sriyanto Tiwul, who later organized a village-run emergency team, reiterated that "the official drivers" of the evacuation transport "were not brave enough to go up to the village, so local people became drivers". This was also confirmed during an interviewee with the Head of Transportation for Slemen district, Sapto Winarno, (who was in control of the transportation during the evacuation). He explained that the transportation was supposed to wait for the local people in the villages during the day and then take them back to the evacuation site in the evening but "unfortunately the drivers would get increasingly worried and panic, leaving the villagers behind". Winarno concluded by saying that in the future they want to be "more professional in handling the evacuation".

Winarno also implied that the officials had to 'force' some villagers to leave the danger area. They were hoping the villagers would stay in the evacuation site voluntarily but because they did not he had to have, as he put it, "relaxed control" over them. Fortunately, despite the evacuation being controlled by the regional government departments and the military, none of the interviewees described any extreme force used to retain them in the evacuation sites. Paradoxically, this relaxed attitude perhaps led the villagers into a false sense of safety, as a very relaxed attitude implies that there is nothing to worry about. Studies of disaster warning psychology have found the common individual response to a warning is disbelief rather than panic and action (Bolin 1989). Perhaps in this case, disbelief united with the relaxed appearance of government officials, and previous 'disaster' experience generated a complacent community.

The villagers' strong sense of responsibility often put them in danger. Many of the interviewees refused to evacuate fully during the 2006 eruption period because they felt they had to return home in order to care for their livestock, Ibu Mukirah explains how she "used to collect grass in three sessions, carrying small bundles and running because she was so afraid". The villagers rely on their homes, gardens and livestock for a living, the necessity to tend to their belongings seemed to unbalance their perception of risk.

*"They told me not to return home, but they gave me no work, but I felt I had a duty for my cow", **Karyo**, Pelemsari*

As Karyo explains although some were afraid they still felt they had to return to their homes, at least during the day to tend to their livestock. Therefore many of the villagers evacuated on a part-time or diurnal basis, returning home during the day light hours (Figure 5.2). As discussed in the literature review, these actions were also recorded by Lavigne *et al.* (2008) and similar events have also occurred during other volcanic crises, such as at Mt Tungurahua in Ecuador, that also erupted in 2006 (Whiteford and Tobin 2009).

In order to control this part-time evacuation the official transportation would deliver the villagers to their homes in the mornings and pick them up in the evenings. This system ensured that villagers were at least in the evacuation site during the night, but during the day they were free to tend to their homes and livestock.

Apart from their responsibility to their livestock and the necessity to retain their income, some refused to evacuate because of the bad conditions of the evacuation site. Many of the interviewees explained how they were unhappy at the evacuation site and would rather stay in their own homes and face the dangers. Those that did evacuate "did not feel at home" or were bored. This seems to be common problem in evacuation sites during volcanic eruptions and other long-term hazards (Mowforth 2001). Mitrorejo, from Batur, explained that "in the evacuation site (she) just sat, and even though (her) house is bad it would have been better to stay at home". The attitude of the villagers implies that despite being forced to evacuate, their homes were not destroyed and with hindsight they could have happily stayed at home. Despite a lack of studies into evacuation site psychology, Perry and Hilrose (1991) have explored shelter problems during volcanic emergencies in the United States of America and Japan. Issues such as lack of sleep and too much noise, were raised in these studies and correspond to the experiences of the Mt Merapi evacuees, suggesting that such shelter problems could be universal rather than intrinsic to local cultures.

Arguably, in the worst case scenario, if a pyroclastic flow had hit Pelemsari, the village would have been partially destroyed and a majority of the population would have been killed. Figure 5.2 illustrates that 88% of those interviewed only stayed in the evacuation site for one week or less. Consequently, in that worst case scenario, 215 residents out of a total population of 245 could have been killed.

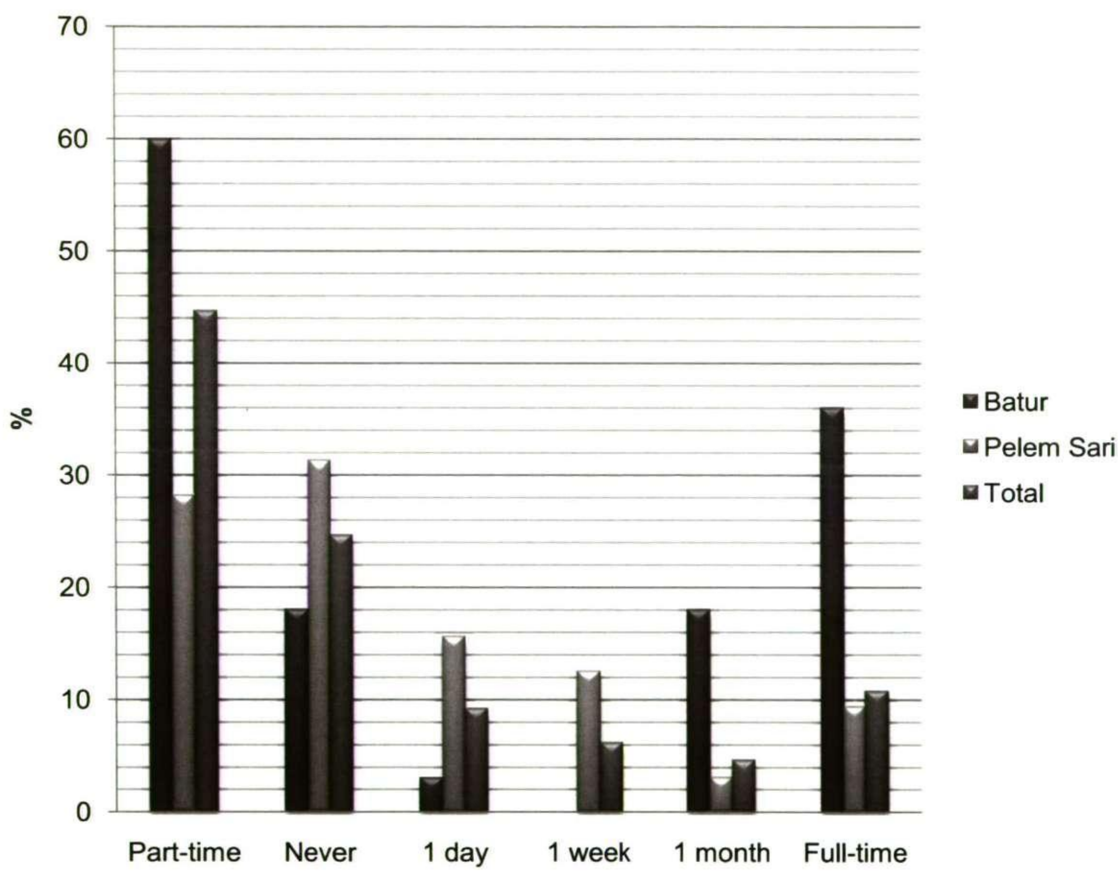


Figure 5.2: This chart illustrates the length of time the interviewees spent in the evacuation site during the 2006 eruption. The majority of those interviewed either evacuated part-time or remained in their homes for entire crisis.

Darso, from Batur, explains that "those people who stayed in their homes during the last eruption said, *"live or die we will stay in the village"*. Ironically, they were correct because even those who did evacuate from Batur did not actually leave the village region, as the evacuation site was less than a kilometre from Batur's lower houses, in the local secondary school. Some of the interviewees picked up on this remarking that *"the evacuation place was in my back yard... not far from the volcano, so I was worried"* (Ibu Sarto, Batur). The close proximity of the evacuation place to the Batur homes influenced the villagers' movements, because they could easily walk back to their homes from the evacuation site, and they therefore believed that during an eruption it would be very easy to get back to the evacuation site. This is reiterated in the statistics; double the amount of Batur villagers interviewed evacuated part-time in comparison with Pelemsari villagers, whose hamlet is over 3 km from their evacuation site. (Figure 5.3 shows the evacuation site locations for both Pelemsari and Batur).

In response to the apparently "late" and "unorganized" government actions some of the more proactive members of the community in and around Batur decided that the government was not doing enough to help them manage the risks they faced from Mt Merapi and formed the SKSB. Aris, explains that SKSB was developed after the eruption and formed from the volunteers from the Kepuhajo region (Batur's sub-district) and that the group gave out the posters and maps to those who wanted them and put them in public places. Yet despite the apparent widespread distribution of information, many informants thought that the hazard map was a gift and displayed it with pride without understanding it's purpose. This could be because those distributing the map did not offer any accompanying explanation [1]. In addition, many of the villagers could not or did not read and understand the hazard map and therefore the map was widely redundant. Despite the failure of the map as an educational tool the villagers were proactive and took responsibility for evacuating their fellow residents, volunteered in the evacuation sites, monitored the volcano, and the men remained in the village to provide security. The crisis produced what Bolin (1989) terms a ‘therapeutic phase’, where a supportive environment and social solidarity emerged to overcome the negative effects of the volcanic event.

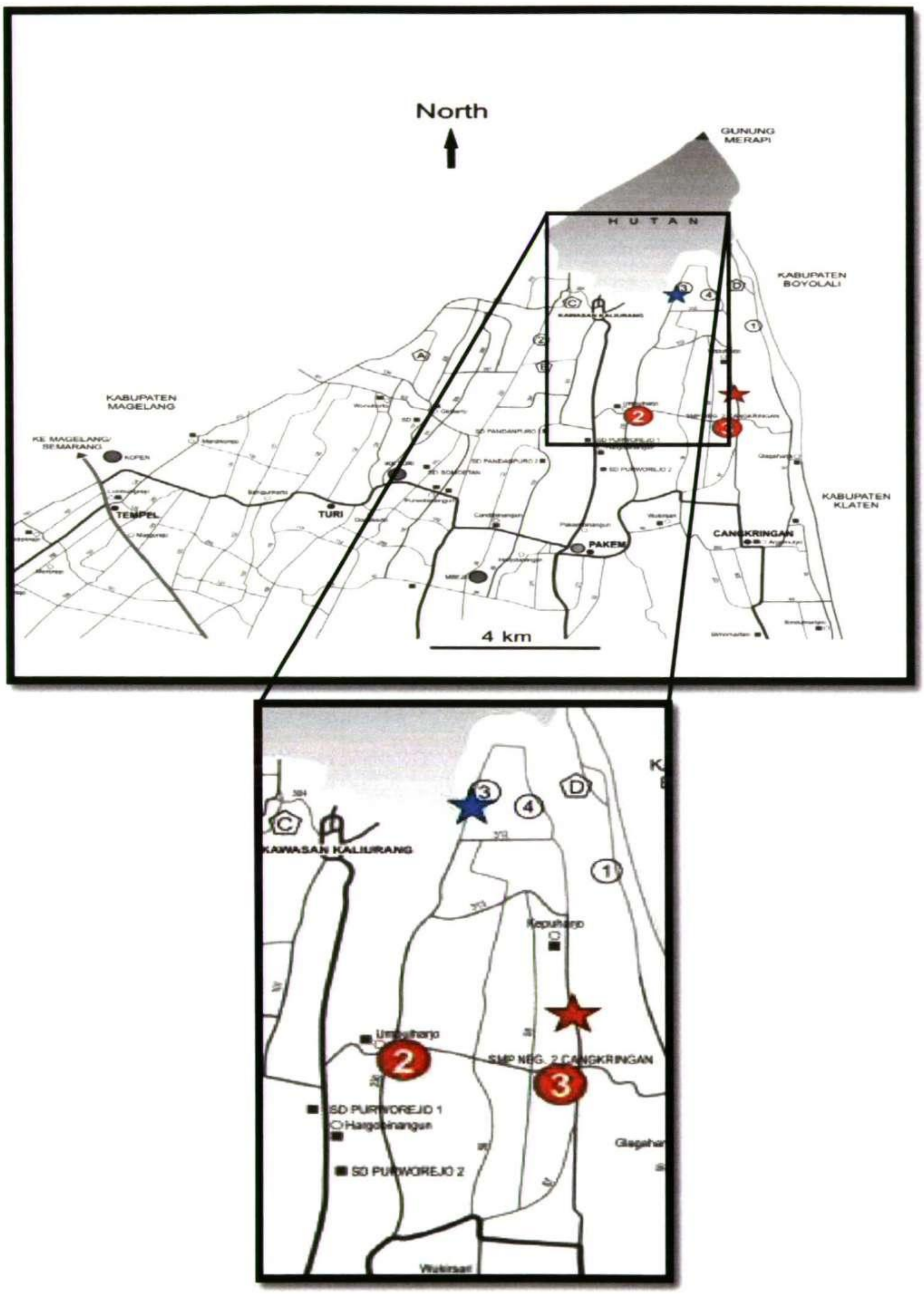


Figure 5.3: Locations and details of the evacuation sites for Pelemsari (blue star and number 2) and Batur (red star and number 3). Source: this original map was provided courtesy of Sabto Winarno Head of Transportation division for Slemen district.

5.2.2. Livelihood, vulnerability and perception of risk.

The slopes of Mt Merapi generate the highest production of maize, peanuts, cassava, long beans, soybeans, sweet potatoes and many other crops in Central Java. Like many volcanic regions regular ash fall produce rich soils that allow for significantly increased crop production. In the southern regions the forests are government owned restricting land ownership and therefore space for growing crops. Pelemsari is surrounded by government owned forest and is consequently a dairy farming community. As discussed in chapter 3 the Pelemsari daily timeline (figure 3.17) drawn during the workshops exemplify the time and effort needed to maintain this economy. The villagers' livestock represent not only their earnings but their savings and as a result the residents have a strong attachment to their animals. Despite having a wider range of occupations in Batur, livestock still provides an important sustainable income and during the 2006 eruption it was reported by the media that the villagers were not willing to abandon their livestock and therefore refused to evacuate. Because the cattle are not free grazing if they were abandoned in the villages alone they are may starve. As Narti for Pelemsari implies in the quote below, the villagers were unwilling to accept this loss and so continued to care for their animals throughout the crisis.

*"If I stayed in the evacuation place I get food, but my cow does not", **Narti**, Pelemsari.*

ProFauna Indonesia estimated that up to 3000 cows were at risk during the recent volcanic event and prepared a livestock evacuation plan (ProFauna International 2006). Unfortunately the villagers refused to evacuate their cattle and so ProFauna compromised providing a tagging system for the animals and urging the villagers to free their livestock if the situation worsened (Pers.Com. Diana Wright 2008). It is common that during a volcanic eruption at Mt Merapi, and other volcanoes, cattle and other livestock are not evacuated. For example, in 2008, tens of thousands of animals were abandoned during the recent increase in volcanic activity at Chiaten volcano in Chile, and it was the farmers who were the last to be forcefully removed from the area (Hearn 2008). The immediate aim during a crisis is to evacuate the population, it is often logistically very difficult and time consuming to remove all livestock and provide food, water and shelter for both people and animals. This is especially true for Mt Merapi in 2006 as resources were already stretched due to the multiple hazards impacting on the region.

According to some informants however cattle had been evacuated during previous eruptions. And during an eruption in 1888 eruption it was documented that the local residents left their villages with their cattle (Voight *et al.* 2000a). Sapto Winarno, head of transportation for the affected region in 2006, explained that because the villagers did not want to abandon their livestock the evacuation transport had to accompany the local people when they returned home to feed their cattle. Despite previous animal evacuation attempts he said that this was an "unforeseen extra job". The official's primary concern was to ensure the safety of the population. Additionally, an interview with a representative for Slemen district Water, Mining and Disaster Management Department (a government department) revealed the lack of official coordination during the eruption. He explained that in an extreme situation the villagers were told to let their cattle roam free and if they died the government would reimburse them, yet the villagers seemed unaware of this compensation plan and continued to put themselves at risk unnecessarily. There seems to be no consensus relating to animal evacuations at Mt Merapi.

Cows are so central to the villagers on Mt Merapi that they believe that the volcano also owns a cow, "*sapi gumarang*". The mystical cow's grazing land used to be located a couple of kilometers southwest of Batur. Now, as noted in chapter 4, this site is occupied by Merapi Golf shown in Plate 5.1. Sukirman, the manager of Merapi Golf, explained that when they built the golf course they had to perform a special ceremony in order to move the mystical cow on to a new grazing area, although they were not allowed to remove a sacred boulder, shaped like a cows head, Plate 5.2. This would have been unacceptable to the local population. Despite performing the correct rituals some villagers believed that the 2006 eruption was due to the construction of the new golf course and the relocation of Mt Merapi's mystical cow. Yet Sukirman contends that this is resentment as the course cannot employ all those from the villages who wish to be employed.

Plate 5.1: Merapi Golf course, with the volcano in the background. The researcher was given a guided tour of the course after the interview with the manager. The golf course employs many Batur villagers as 95% of the workforce are from the local sub-district; they are employed as gardeners and caddies.

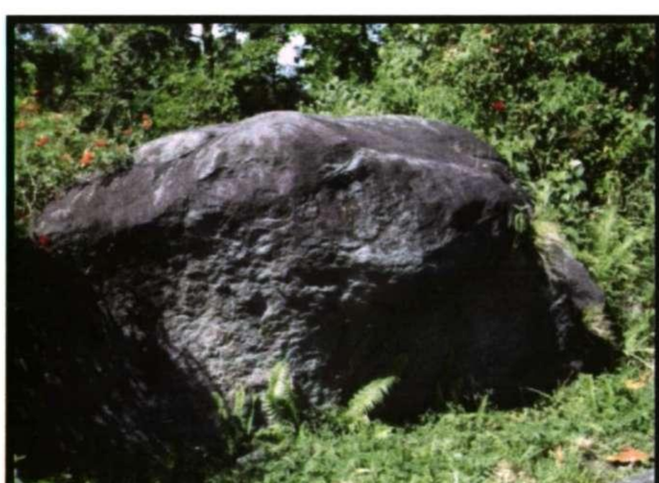


Plate 5.2: The sacred boulder located within the Merapi Golf course. The boulder resembles the head of a cow and the villagers believe that it is sacred. They call it *Batu Gumarang*.

5.2.3. Following government orders to stay in the village.

Dove (2007) explains that during the 1994 eruption the villagers of Mt Merapi viewed the government as a secondary hazard, especially in relation to forced evacuations. Yet during the 2006 eruption the male interviewees explained that they were actually asked by the government officials to remain behind during the evacuation in order to guard the village:

> *"Only the old and children and pregnant women were evacuated, the young and fit stayed in the village and carried on working as normal", **Sihono**, Batur.*
>
> *"It was my initiative and also the government ordered me to protect the house, the village men must protect their belongings in the village", **Darto**, Pelemsari.*

The large majority of men interviewed explained that they remained in the village during the eruption because they were either asked to protect the "empty" homes or monitor the volcano. Unfortunately, the need to guard the village was spurred on by a rumor that:

> *"In 1994 eruption, when the lahar went down Kali Boyong, there was a thief in Kaliurang when the villages had evacuated", **Baryanto**, Batur.*

Thus, the majority of men remained in their hamlets during the eruption and were apparently encouraged to do so by the government. The men therefore had official approval to remain in the village and feed their cattle.

So far, it seems that the government actively encouraged some of the villagers to remain at home, yet during some interviews, informants also explained how they would hide from the officials when they came into the hamlets. This may have been an automatic reaction to authority resulting from colonial and post-colonial violence. Karyo, the oldest man in Pelemsari, describes in the quote below, the trauma and oppression experienced during his life, from the Dutch through to the unpredictable New Order Regime and Suharto. Karyo and other older members of the community recall the fear during the abolition of the communist party in the 1960s. Suharto manipulated an attempted "coup", claimed the presidency, and ordered the extermination of any communists within the country, resulting in the torture, imprisonment and massacre of half a million Indonesians (Brown 2003, Anderson 2008, Roosa 2008). The actions of past governments have produced a distrustful rural population.

> *"Two of my siblings were shot by the Dutch.*
>
> *After the Dutch came the Japanese, DI/TII, then Grayak [rustler], the villagers were afraid and would hide.*
>
> *In the time of the BKI [communist party] many of the villagers did not know about communism. The Indonesian government shot many communists and threw them in the sea and Nusa Kambangan [an island off the coast of Java]",* ***Karyo,*** *Pelemsari*

There is evidence that a deep seated historically ingrained suspicion guides the villagers to ignore orders and advice from the officials. Exploring the political and historical issues relating to the villager/government relationship in Indonesia is too complex a field of study for this project. However, it is important to have a basic understanding as it seems likely that the villagers have retained a lack of co-operation with officials as demonstrated by Ibu Narti:

> *"I hated it when they came to ask questions like "why she did not want to evacuate?" and "who invited her to the house?" to check I owned the house and whether I followed some other person. So if they asked me to leave in the afternoon I would say "yes just one moment I want to collect grass first" they replied "if the transport comes you must go!" I would say "yes" but I would not go",* ***Ibu Narti,*** *Pelemsari.*

Ibu Narti, explained that she would try any method to stay in her house (nearly the highest in Pelemsari village) and that she would often hide so that she could stay in her home. Indeed only three informants from Pelemsari and two from Batur said that they trusted the government and obeyed their instructions. Other informants explained that in an emergency they required both government warnings and traditional signs of an eruption. They will listen to the government warnings about Mt Merapi, discuss these and take notice, but will not leave until they have had a traditional sign to confirm that an eruption is imminent. As Giono implies:

*"The village will ultimately decide if it is dangerous", **Giono**, Pelemsari.*

The need to have both official and traditional warning signs, is illustrated by the emergency plans for both villagers (Figures 5.4 and 5.8). These were created by the village participants during the workshops and have been translated into English and digitized. The model structure has remained essentially unchanged from its original design and reveals, to some extent, the villagers thought process during a volcanic crisis.

When examining the diagrams it can be seen that the signal or warning for an eruption comes from two sources, from the government and from traditional beliefs. This is especially obvious in the Pelemsari plan. Yet, this community appears to be more Islamic and, therefore, likely to have less of an attachment to traditional Javanese beliefs. This however exemplifies the religious complexity experienced by these Javanese-Muslims; the hybridity of being nationally Muslim and locally Javanese. The data suggests that the villagers in Pelemsari live with many contradictions, for example, Islam and local Javanese beliefs, fear of the volcano and faith that the village is protected and the decision to follow Mbah Marijan (their supposed spiritual leader) or the scientists and government.

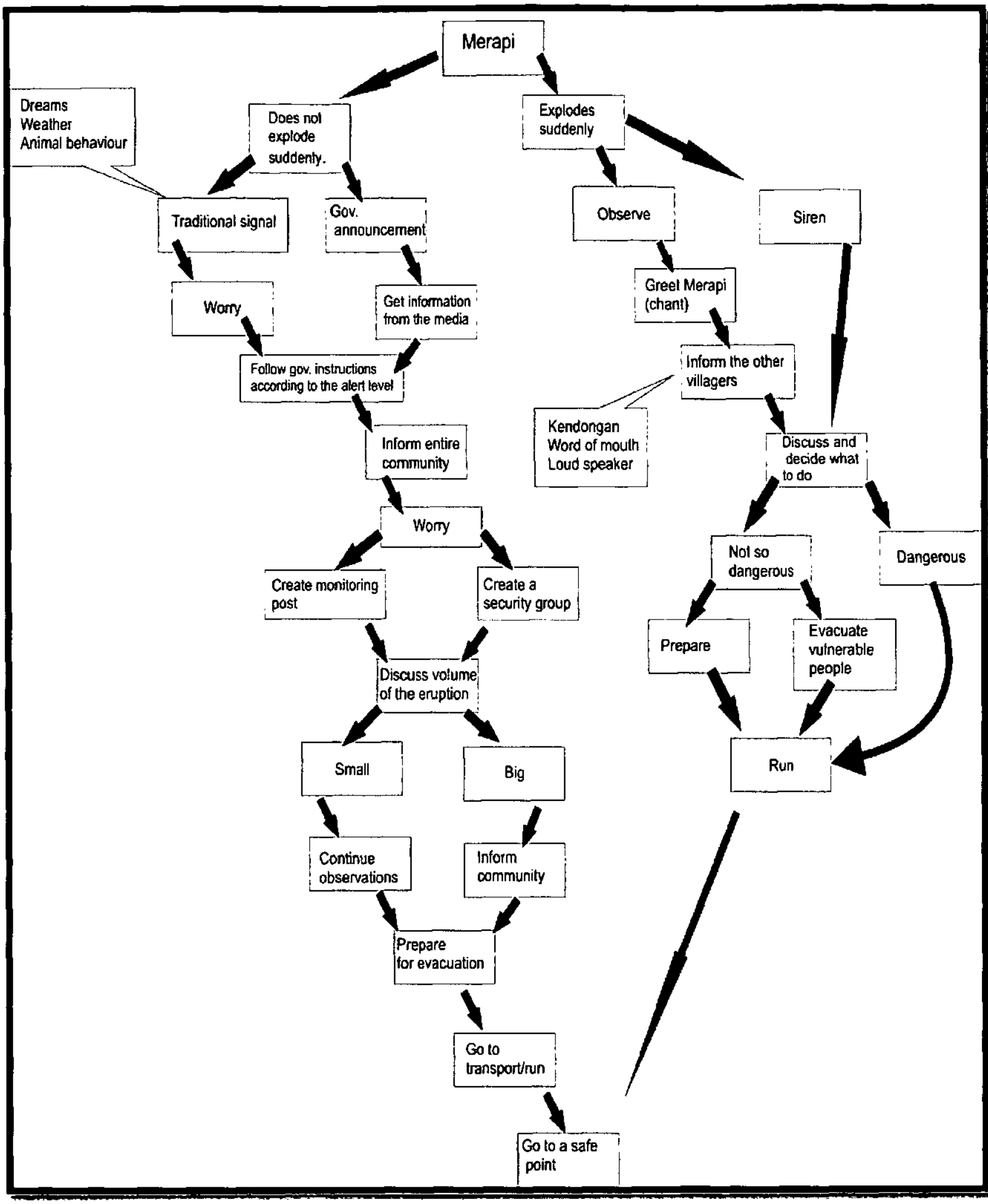


Figure 5.4: Pelemsari emergency plan designed by the participants during the workshop sessions.

5.2.4. Cultural dimensions of disaster: Victimisation.

Many people have fallen victim to the dangers produced by Mt Merapi, either directly by an eruption, or indirectly, as a result of exposure whilst climbing. When the villagers discuss these victims, they often refer to them as "foolish", having done something to deserve their fate (this expression was used every time an eruption victim was mentioned). Cashman and Cronin (2008) infer that this behaviour in hazard-prone regions could be part of becoming a resilient community as it provides explanations for traumatic events, reduces post-traumatic stress and fosters a psychosocial resilience to the volcanic crisis. In the words of an informant from Batur:

> *"The victims of the big eruption are fools because there was a man who warned them and said come down but they went into the bunker instead, the other man was saved",* ***Henri,*** *Batur.*

As Henri suggests, the victims from the 2006 eruption had apparently been told to come down from their monitoring post as it was too dangerous to be in Bebeng. Sadly, they had trusted the bunker's ability to protect them. Their bodies were found ten days later by the Search and Rescue teams from Yogyakarta. According to Sugeng (the man in charge of the Search and Rescue team) during the 2006 eruption, when they eventually found the bunker the temperature inside was still over 500°C. Plate 5.3 shows the Bebeng region, 300m east of Pelemsari, nearly a year after the eruption. The two volunteers had apparently decided to go to Bebeng because they were "*bored in the evacuation place*" and so they went *"to help with the monitoring post at the top*" (Wento, Batur). Other villagers also volunteered to monitor the volcano or simply remained at home to avoid the boredom (*kebosanan*) and physiological deterioration experienced in the evacuation site.

Some believed that the eruption was a consequence of recent political and local events, such as, moving Mt Merapi's mystical cow, the construction of Merapi Golf, or a decline in the number of ceremonies. Additionally, the daughter of Mbah Marijan (the caretaker of Merapi), described how Bebeng was an area used by young people to gather and have parties, the insinuation being that the lahar was punishment for this indecent behaviour. In a context where there are usually strict rules on social conduct, many rural areas provide a safe haven for young unmarried couples. At Mt Merapi, some informants believed that the pyroclastic flow had punished and cleansed the area.

This notion of the victims having done something to deserve their fate seems especially evident when the informants discussed the deaths of 64 people during the 1994 eruption of Mt Merapi (Thouret *et al.* 2000). All the victims were attending a wedding in the village of Turgo and were killed by a pyroclastic flow and it is widely thought that the wedding party died because they disobeyed the instructions given to them by a supernatural creature or '*makhluk alus*' (the unseen creature) [2] that lived in Turgo.

> *"In 1994 the farmers in the village of Turgo were given permission to live in Turgo by the supernatural creature, with one request: If you plan a ceremony or wedding party do not use the days, Jumat Gliwon and Selasa Gilwon [of the Javanese calendar].*
>
> *The victims of the 1994 eruption were attending a wedding on Selasa Gliwon. He wanders why the lahar went down Bebeng and then back up north and hit Turgo and the wedding party",* ***Karyo****, Pelemsari.*

This is a well known moral story amongst the Pelemsari villagers, instructing the village on 'what not to do'. This reaction to others dying on the volcano also relates to what has been referred to as 'unrealistic optimism bias' where people perceive themselves as being less vulnerable or more skilful than those around them or the average person (Paton *et al.* 2008). By believing that they are experienced and more prepared their risk perception decreases, leaving them less likely to prepare for a future eruption and ironically making them more vulnerable.

One Turgo resident, Yanto (37 years old), described how Turgo has a special relationship with Mt Merapi, because Turgo hill is the mother of Mt Merapi. The people in this village hold a special ceremony for Mt Merapi and the creature of Turgo and although he was happy to discuss their spiritual beliefs he did not mention the 1994 eruption.

Plate 5.3: The Bebeng area, directly north of Kaliadem hamlet, destroyed during the pyroclastic flow events during the 2006 eruption of Mt Merapi. The buildings shown in the photograph were 'warungs' (small shops and cafes). The bunker was completely buried increasing the difficulty of locating and removing the bodies.

The area that was destroyed is abandoned and the house that was holding the wedding ceremony is now a ruin. The remnants of the wedding were never removed and the area is avoided as if cursed. The reclusive nature of this village may reflect the stigma of losing so many of its community, and conviction that they brought it upon themselves. Pelemsari and Batur do not hold as many regular ceremonies as Turgo, implying perhaps that the residents of Turgo are making repentance for their previous mistakes and appealing to the spirits not to punish them again. They have experienced disaster recently and their attitude to the volcanic hazards they face is different to that of the other villages. Yanto explains that they all know what to do if Merapi erupts, 'they will run down slope'. This reaction to hazard has been noted by Paton *et al.* (2008) during their work surveying risk perception in New Zealand; they saw that people who had more experience were more likely to prepare for future events.

It is believed that people are apparently not always killed directly by an eruption, some are 'taken' whilst carrying out their everyday chores, some go to the volcano having been 'asked' and some are taken after they die naturally. Even those who die whilst summiting the volcano are thought to have broken a taboo or not followed the traditional rules. As Margo explains:

> *"Because of these strange things you must be careful on the mountain. Do not speak of anything important. For example if you speak about rain it will rain, and if you are unlucky the rain will kill you",* ***Margo,*** *Pelemsari.*

There are many taboos that instruct those wishing to climb Mt Merapi and they seem to be another way of explaining away why people have gone missing. For example, according to Sumadi, in Batur, a "*climber should not wear green clothes and trousers or black clothes and trousers. If they did they would be "kesaput pedut"* (taken by the mist). A certain shade of green is also very sacred and is reserved only for certain supernatural beings such as the Queen of the South Sea [3]. It is inferred that if you wear this colour in sacred regions such as Mt Merapi or the South Sea, then you will be punished.

In Batur, the supernatural creatures are recognised but not in the manner described by those who live in Pelemsari. Henri, a young male Batur villager, was so afraid of these creatures that he did not want to utter their names or tell their stories:

> *"In the volcano there are thousands of creatures, if something happens to Merapi the creatures will give news to Mbah Marijan. I believe in the supernatural creatures in Merapi because I am Javanese",* ***Henri,*** *Batur.*

The notion of the creatures 'giving news' implies that the supernatural creatures seem to be regarded as protectors. As Henri explains, in the quote above, that despite the creatures terrifying character they will warn the villagers of any danger from Mt Merapi. In contrast, in the north the creatures are the creators of the hazards. The creatures are also often described as villagers who have been taken by Mt Merapi. In Pelemsari however the creature's existence is related mainly to the Kraton and the *Labuhan* story.

> *"When they offer the offerings at Labuhan they offer it to Turgo, Gunung Kendil [a hill], Plawangan [a hill], Gunung Wutoh [a hill], Umbul Temanten [water resource]. They chant for all the creatures who live in these places and offer it [the offerings of food and clothes] for Labuhan, it has come from the Kraton and the sultan. Labuhan is the duty of the care taker",* ***Ibu Pujo****, Pelemsari.*

The story of the *Labuhan* explains how the first creatures came to live on Mt Merapi, sent to live there by a previous Sultan (discussed in detail within the following section).

Although the creatures play a different role around the volcano, they are a representation of unusual events on the volcano; they are a personification of the volcanic hazards.

> *"The people who died last year were wrong to be in the bunker because they knew it was dangerous. The supernatural creature wanted them",* ***Yadi****, Batur.*

This could be interpreted as a way of protecting themselves from the reality of the risks under which they live. If they can deflect responsibility for their fellow villagers' deaths then it means that their village is still safe and they would have to do something wrong in order to be killed. The traditional stories about Mt Merapi are more of a way of explaining why people die rather than a useful traditional mitigation technique, although they may be vital parts of psychological resilience and healing. Rather than "learn" from these events, the villagers use it as a coping mechanism. In other words, because they must stay in the village and collect grass or gravel in dangerous regions and continue living in their home village, they have no choice but to cope with this psychological and physical stress, so they invent reasons why people have died and therefore ways to protect themselves (Bangkoff 2004; Fleishman 1984).

As an aside, the residents of Pelemsari and Batur are not the only volcanic population who create myths from eruption victims. Arguably a western equivalent occurred after the 1980 eruption of Mt St Helens, North America. Before the eruption a local resident called Harry Truman refused to evacuate from his home near the volcano, exclaiming that he was part of the mountain, and the mountain was part of him (Finley 1981), an expression similar to that used by Mbah Marijan. He was killed during the eruption and was then immortalized within North American folk tale and songs. Even now, 28 years after the eruption of Mt St Helens Harry Truman is considered a hero and lives on within the oral traditions of the Oregon state residents (Cashman and Cronin 2008). Harry Truman could therefore be considered a westernized version of the supernatural beings of Mt Merapi.

5.2.5. Volcanic mythology: the unseen creatures of Mt Merapi.

As previously noted, the villagers believe that there are strange supernatural creatures that also live on the flanks of the volcano. According to Javanese mysticism there are apparently two types of *muhluk alus*, unseen creatures, ones that are born as creatures and ones that were originally human (Sangga Sarana Persada 1999). Around Mt Merapi the *muhluk alus* mostly have a human origin. The creatures exist in a parallel dimension that can interact with reality, resulting in volcanic eruptions, or people vanishing. The creatures can bridge dimensions, not being visible in this dimension but able to take the form of a human or pass on information to special "sensitive" people in the villages. The dimensions are symbiotic and just like the victims described in the previous section every action has a consequence. Because of this the villagers appease the creatures by offering food, clothes and money during various ceremonies.

In Pelemsari, the creatures are linked to the *Labuhan* ceremony and the Kraton. According to oral tradition the first creatures on Mt Merapi were those who were apparently banished by a previous Sultan after they had been poisoned by "the egg of the world" [3]. During the annual *Labuhan* ceremony the creatures are offered clothes and food, and their names are chanted, along with those of certain important geographical locations. Plate 5.4 shows Bapak Pujo, Mbah Marijan's assistant and one of the participants from Pelemsari, presenting the clothes to the creatures of the volcano. He chants their individual names, such as *Empu Rama*, or *Nyai Gadung Melati*, pre-fixed with a title such as grandmother or father, as a sign of respect.

Plate 5.4: Pujo presenting the clothes as offerings to the creatures of Mt Merapi during the *Labuhan* ceremony in August 2007. This photograph was taken by the researcher, sat amongst the crowd at the *Labuhan* site watching and taking part in the ceremony.

In Selo, on the northern flank, the supernatural creatures are extremely important to the villagers' protection against the volcano. The villagers strongly believe in the creatures and their power, in particular Mbah Petruk and Simbarjo. I spent one week in Selo and on the first evening an old trekking guide, called Auto, explained the story of Mbah Petruk. Auto is 87 years old and apparently was a "good friend" of Mbah Petruk when he was still in a human form. In short, when Mbah Petruk was a boy he ran away to Mt Merapi and telling his fellow villagers that the volcano wanted him to live on its flanks and that the villagers should provide him offering of cigarettes, coffee and *jadah baker* (a baked rice patty) if they wished to be blessed and protected [4].

The head of Jlakah village just northwest of Selo recalled that Mbah Petruk came to the northern village of Pancar in 1954, dressed as a beggar, but the Pancar villagers did not "respect" the beggar and gave him dirty water to drink. According to him:

> *"The beggar told them that at nine their village would be destroyed and it was"* ***Head of Jlakah**, Selo.*

This story demonstrates how the creatures can inflict a "punishment "on the villagers, just like the story of the wedding party killed in 1994. It also corresponds with the belief that if you die as a result of Mt Merapi you have done something to deserve your fate.

In contrast, the creatures can also provide a warning to the villagers of an impending disaster and protect the village. For example, Atmo from Jlakah village also suggests that Mbah Petruk will send a message to the villagers, but only to those that the creature loves. This is similar to the stories from the south of Mbah Marijan about receiving a premonition or warning of an eruption within a dream:

> *"The dreams come from Merapi's supernatural creature not from god",* ***Samijo,*** *Pelemsari.*

The *mukhluk alus* are a recurring theme during the interviewees regardless of geographical location, and are often held responsible for strange or disastrous events. Both in Selo and in Batur it was mentioned that the most recent eruption itself was the consequence of the supernatural creature building or creating a new structure. For example, Alef, from Selo, explains that during the 2006 eruption Mbah Petruk "was building a shrine with nine roofs". The idea that the creatures control an eruption was (for the villagers), confirmed by a mysterious photograph which depicts an old Javanese man sat in the middle of the eruption plume from the 2006 event. Alef had a copy of the photograph, along with other images of the 2006 eruption [5]. A copy of the image is displayed in Plate 5.5. The villagers believe this is the image of Simbaryojo, one of the lesser creatures. Simbaryojo is often talked about by the Selo community but in contrast to Mbah Petruk his story has been forgotten. It is possible that Simbayojo's history has been lost through the generations or perhaps the villagers did not want to explain something which they feared, just like Henri in Batur. Alef added that there were other images in the plume caught on camera during the eruption, one of many snakes, and one of a smiling Buddhist man. To the villagers who are generally technologically illiterate the photograph is proof that a parallel dimension exists and that they are protected and controlled by the *mukhluk alus*. Photographs like Plate 5.5 have the potential to increase the villagers' reliance on mystical beliefs and defy evacuation orders. In the southern regions of the volcano, such as Pelemsari and Batur they seem unaware of the photograph's existence. Geographical location influences the development of oral traditions and hazard perception. Those who have experienced the dangers first hand are more willing to evacuate than those in less recently affected regions, such as Selo (Paton *et al.* 2008). This will be discussed in the following section.

By transferring the 'blame' for their own risk from the volcano or their circumstances, the villagers find that they can remain in their homes throughout an eruption because they have justified their actions; the events that affect their region are "out of their hands". Dibben and Chester (1999) also found communities living in volcanic regions increase their vulnerability through fatalism that is framed within a 'religious' world view. The Javanese and Islamic beliefs intertwine creating a fatalistic community who believe they are controlled, either protected or punished, by creatures living in a different dimension.

Plate 5.5: This photograph purportedly showing the image of Simbayojo supernatural creature in Mt Merapi's eruptive plume. The original photograph belongs to Alef the head of the host family in Selo. Many villagers own photographs of the 2006 eruption as memorabilia. They show them to guests and some have a small stock to sell to tourists. Many of these photographs, like the one here, have been altered using computer software.

5.2.6. The geography of hazard perception.

The geographical dispersion of hazard threats around the volcano shapes the development of oral traditions and myths, and offers clues into the ways cultures react to different hazards (Cashman and Cronin 2008). At Mt Merapi the villager's perceptions of hazard and risk and consequently their reaction to an eruption are influenced by their previous experience, which is in turn is a function of geographical location (Paton *et al.* 2008). Paton *et al.* (2008) notes that their risk perception survey in New Zealand found that an overestimation of perceived preparedness due to surviving a previous eruption (*normalisation bias*) can led to residents being 'less attentive to new information, less likely to perceive a need for any additional preparation, and less likely to alter the level of perceived risk they attribute to a hazard' (Paton *et al.* 2008:182). An example of this occurs in Batur, where most interviewees were convinced that Mt Merapi had only erupted three times. In other words, they believed that their area had only been directly affected by a volcanic event three times within living memory, whereas in fact Mt Merapi has erupted over nine times in the last 50 years (Global Volcanism Program GVP n.d). It was also inferred that these eruptions had never caused serious damage; these previous events have created an inaccurate mental template for future eruptions. Informants from Batur said that:

> *"Merapi has erupted 3 times. In 1960 there was ash fall in the village with several "krakal" [stones as big as a thumb]. They did not evacuate and the village was always misty.*
>
> *When they collected the grass they had to bring a sweeping brush because the grass was covered by ash fall and the leaves were broken",* ***Adi Sarju****, Batur.*

> *"He was not afraid [in 2006] because in the past Merapi erupted and was more dangerous than the 2006 eruption. There was rain of "krakal" small stones and also "krikel" in the past. [Krakal are small stones and krikal are smaller still]",* ***Darso****, Batur.*

To complement the interview data the hazard maps created by the workshop participants illustrate how their location influences their hazard perception (Figure 5.5). They represent a 'mental map' of the villager's domain demonstrating their focused and limited geographical knowledge.

In Batur, the participants believe that their village is generally safe, marking these areas with green hashes, exemplifying the point that their previous experience has given them an overestimated sense of safety and preparedness. Only the rivers are considered to pose a threat, they are drawn in red. They also dutifully mark on simple evacuation routes, leading to the main tarmac road and then south to the evacuation site designated during the 2006 eruption and this is no doubt influenced by their recent experience.

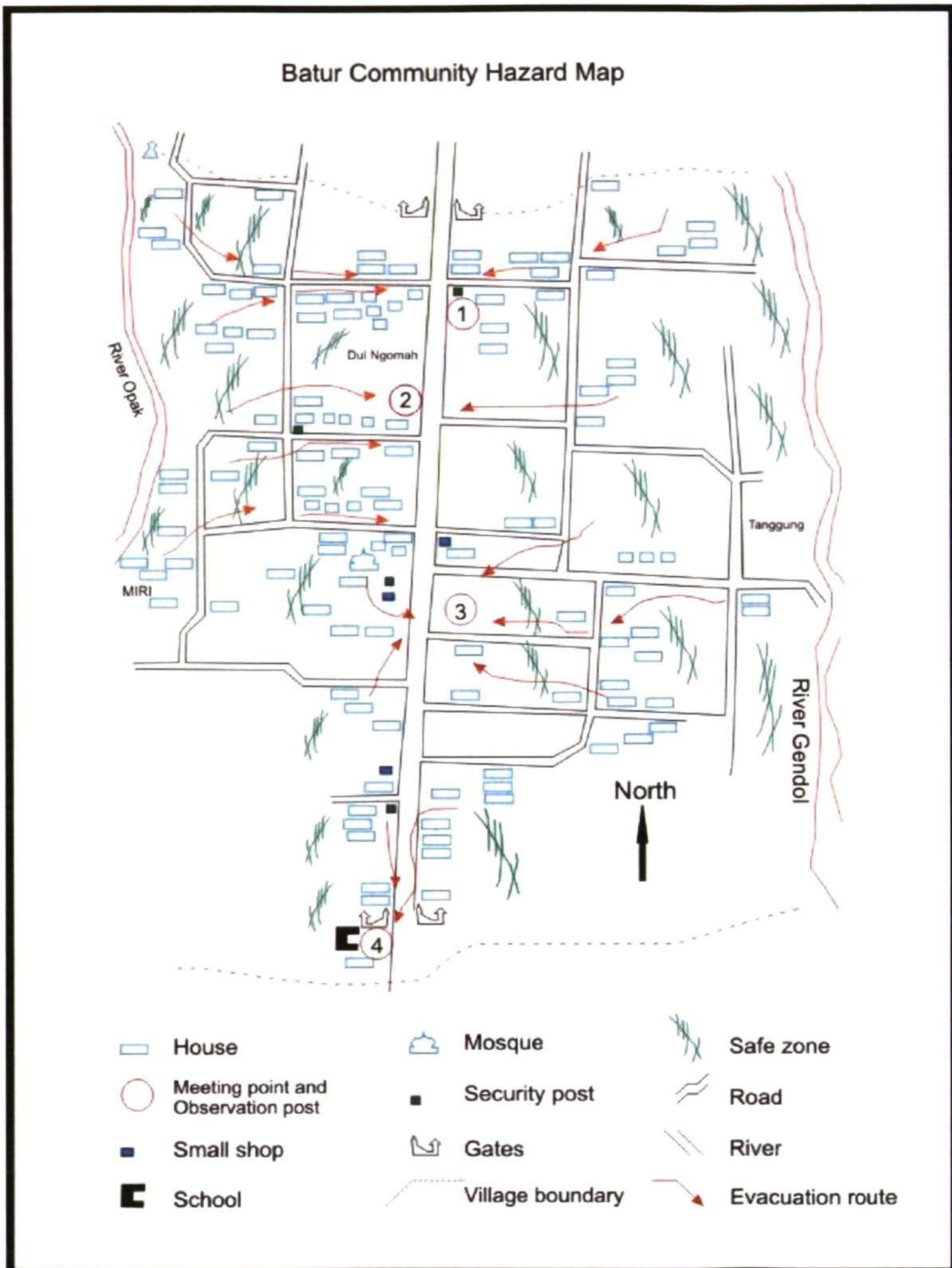


Figure 5.5: Batur hazard map based on those drawn during the workshops. The maps were redrawn and translated using Coral Draw but the details were not altered.

The predominantly green (safe) hazard map reiterates that the Batur villagers have a low perception of risk, indeed 75% of relevant interviewees believed that their village is safe. Yet it also highlights their increased lahar hazard awareness, no doubt because they work in the rivers collecting the lahar deposits that supplement their economy. This information reinforces the interview findings that for the villagers Mt Merapi does not bring disaster but '*rejeki*' which means sustenance or livelihood.

In Pelemsari 80% believe their village is safe. This is perhaps because although in 2006 they were exposed to volcanic hazards, the pyroclastic flows did not enter the village and lahars were contained within the main river systems. The villagers in this community have survived many eruptive phases; previous and recent experiences have fed their sense of safety. Bolin (1989) explains that such a tendancy to underestimate the hazards within their physical environment is a psychological coping mechanism in order reduce the disaster produced stress.

The hazard map drawn during the workshops by the Pelemsari participants seems to be completely clear of any hazard symbols (Figure 5.6). When asked about this, the participants said that the entire area should be coloured red because it is all potentially dangerous (just like the official hazard map) but since this would take them too long to draw they left it blank. So although during the interviews 80% of the participants say that their village is safe, during the participatory activities they illustrate that it is not. This contradiction probably arises from the influence of the official hazard map. It has been widely distributed around Mt Merapi and indicates that Pelemsari is entirely within the highest hazard zone. In addition, the workshop participants from Pelemsari are also all either members of the village council or volunteers for various groups, such as the young men's association and helped during the crisis in 2006 and therefore received crisis training. Consequently, most of them had seen the hazard map and when asked to draw zones of high and low hazard onto their community map they automatically used the information from the official hazard map. This indicates that the official 'modern' mitigation techniques, such as a hazard maps, are modifying traditional knowledge. It also suggests that the hazard map had influenced the perception of risk around Mt Merapi, especially it seems in Selo.

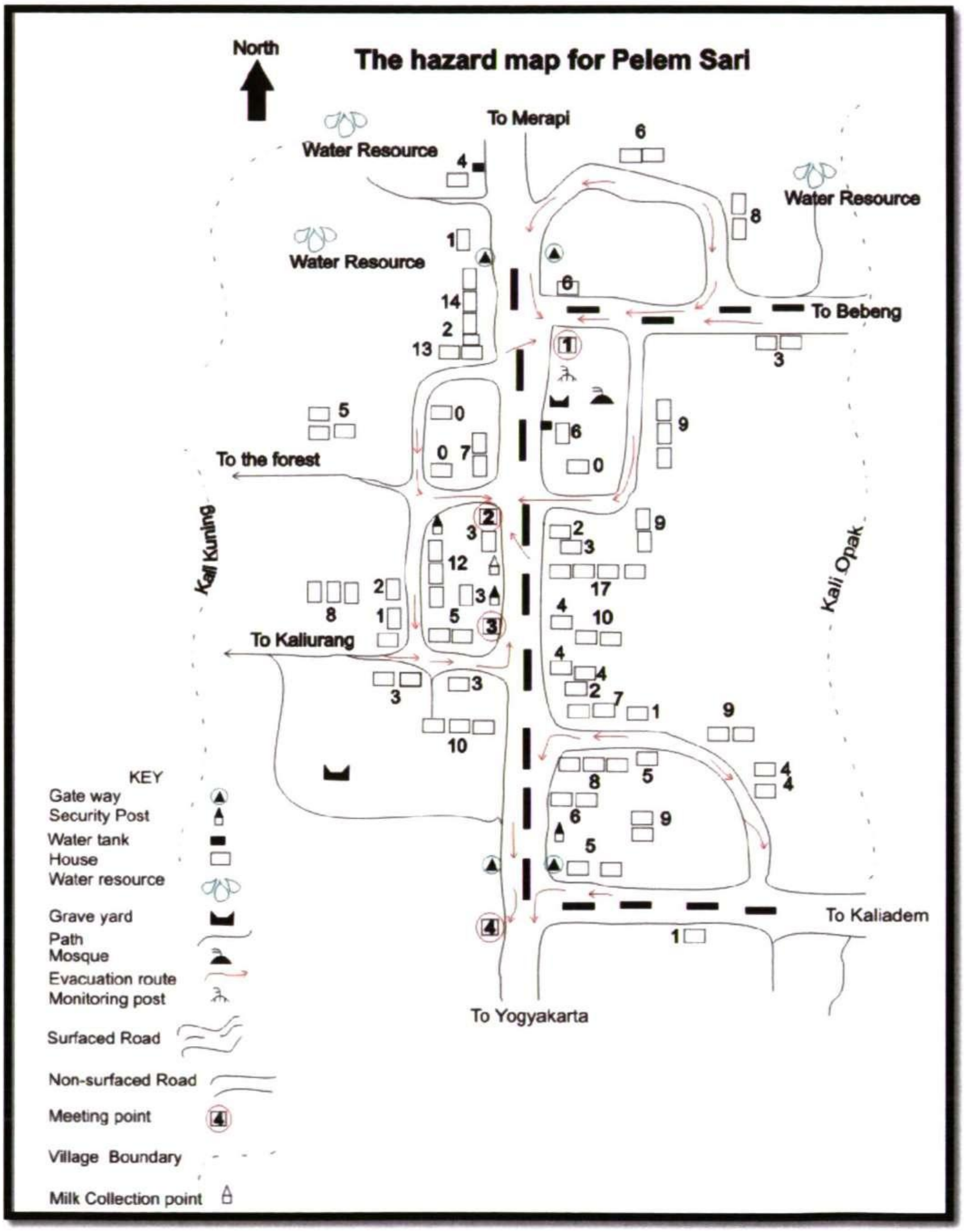


Figure 5.6: The hazard map for Pelemsari drawn by the workshop participants. The main tarmac roads are marked with black rectangles lining the centre of that road. The map has been redrawn and translated using Coral Draw for clarity but the details have not been altered. The numbers relate to how many people are in each family/ building complex.

The revised official hazard zones do not extend as far as Selo down the north flank of Mt Merapi, indicating that Selo is safe (Figure 5.7). The reason for this was explained by Mr Subandrio, the head of the Merapi Volcano Observatory. The new map is based only on the last 50-100 years of eruptions, and apparently during this time no officially recorded event has significantly affected the northern flank. In Selo, all of those interviewed believed that their village was entirely safe from volcanic hazards. The geographical location of Selo, the hazard map and the strong traditional beliefs in the community has produced a village that is almost unaware of the potential volcanic threat, despite the summit dome being less than 3 kilometres away. In contrast to the official hazard zones some of the residents to the northwest of Selo recalled that an eruption actually had affected the northern region in 1953:

> *"Pancar village was broken because the head man hit the kendongan in order to inform the villagers of the eruption, yet when he hit the kendongan it was not only informing the villagers but also inviting the creature",* ***Citro Kamli,*** *Bakalan hamlet.*

In the quote above, Citro, the RW (administrative unit below the head of hamlet) in Bakalan, explains how the small village of Pancar was destroyed during an eruption that occurred in 1953. After the eruption those that survived deserted the village and were relocated to the north of Selo on the slopes of Mt Merbabu. Only one original resident from Pancar still lives in the region, an elderly woman who is still extremely traumatized by the 'forgotten' eruption:

> *"I was working in the garden and when I looked back I saw black and green fire. It was normal for me to stay in the house and work in the garden because I did not have the tools to work with my father and brother; because of this they were killed in the fields but I was saved"* ***Somo,*** *former resident of Pancar village.*

She explains that after 'it' occurred she never went back to the village. In fact, no one ever returned [6]. She is too afraid to return to Pancar since it is regarded, somewhat like Turgo in the south as, 'cursed' and punished by Mt Merapi. No one in Selo seemed to know exactly where Pancar used to be or if the remnants still exist today.

The current hazard map does not take into consideration a large explosive eruption (Lavigne *et al.* 2008, Thouret *et al.* 2000). It consequently does not show the potential 'worst case volcanic scenario' and is therefore misleading not only for the villagers but also for local emergency managers. The hazard map and its limitations are discussed further in chapter 6.

To further investigate the influence of geographical location on village hazard perception some members of the small isolated north-western villagers were interviewed. Located just a few kilometres from Selo, these communities have frequently experienced the dangers from Mt Merapi and their hazard perception is in complete contrast to Selo. Here the residents explained how they were evacuated to Selo in 2006 and how they have repeatedly asked the government for new access roads and equipment such as torches. They want to be able to self evacuate during the next eruption, as they are aware that government assistance will probably not reach them in time. This area was covered in ash during 2006 and the residents seemed acutely aware of the dangers they face. In contrast to Selo, they are very afraid of Mt Merapi.

The head of Sumber hamlet, the furthest reached by foot to the northwest of Selo, explained that the residents here hold ceremonies every two weeks or less in order to receive a blessing from Mt Merapi and to ask the creature to keep them safe [7]. As mentioned above, Atmo (head of Jlakah village in the northwest), described how they must also respect Mbah Petruk if they are to be protected. He has also asked the government to repair their tributary road as evacuation vehicles cannot drive to the village at present; he is still waiting for a reply. These small communities are not far from Selo (a busy market town on the main road to Magelang from the city of Solo), but are trapped, so poor they cannot leave, apparently ignored by the government officials and so relying on their own resources and actions to save them from the volcano that looms above their settlements.

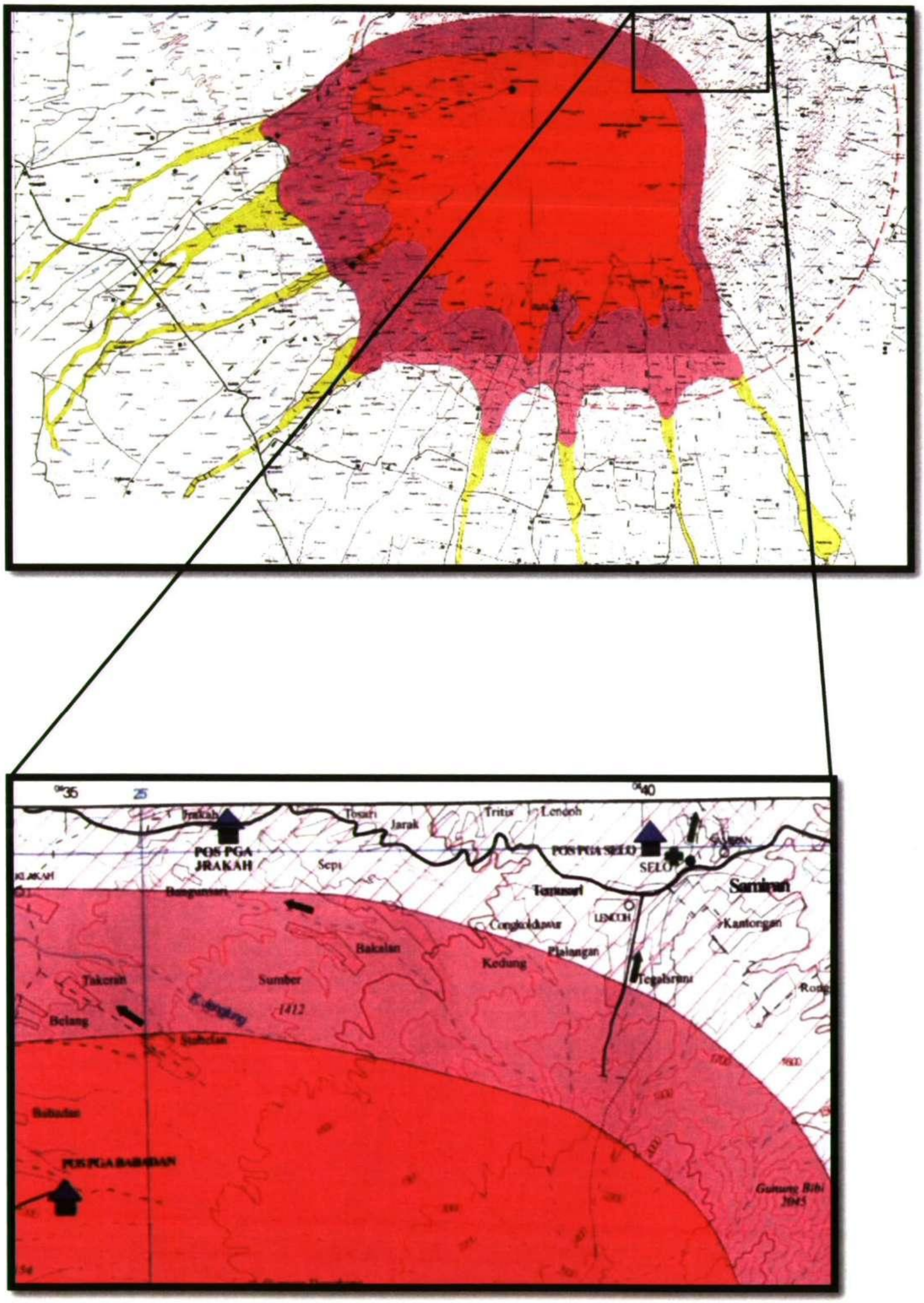


Figure 5.7: Section taken from the 2002 official hazard map for Mt Merapi. Selo is shown out of the hazard zone is a safe region. A full version of the hazards map is available within Appendix 1.

5.2.7. Indigenous hazard awareness: Oral history.

In contrast to other communities living on the flanks of active volcanoes (e.g. McAdoo *et al.* 2006, Cashman and Cronin 2008, Swanson 2008), there seems to be very little record of volcanic events within the Mt Merapi resident's oral history. The oldest eruption recorded orally occurred when some of the oldest villagers were children, approximately 60 years ago. The oral records therefore seem to be generational, dying out with the oldest villagers. This means that although they believe they 'know' Mt Merapi and have experience of its eruptions, their knowledge is based only on the last 60 years of eruptions, similar to the official hazard map.

> *"In the past they did not know much about the eruption, they did not know it could come to this area. So when it happened they realised that it could reach this village", **Baryanto,** Batur.*

A loss of oral mitigation or traditional knowledge caused confusion during the eruption in 2006, with villagers not knowing what to do. The emergency plan draw by the Pelemsari workshop participants shown in Figure 5.4 gives an insight into their potential actions during an eruption. It includes moments where they 'stand around discussing the event' or 'worry'. These stages in the flow diagram demonstrate their loss of direction and knowledge. This is also echoed in the emergency plan drawn during the Batur workshop, (Figure 5.8), where they have added captions such as 'try not to panic' or 'thinking'. In addition, the participants wrote that they would 'gather', and 'wait and see' what happens before taking any action. As Perry and Godchaux (2005) note, that indecision and confusion during a crisis can cause fatalities and from the workshops it was obvious that those who had been given a little training and education about the volcano knew that during an eruption it was important to act fast. Yet their training also appeared to have given them the confidence to make risky decisions, just like the victims during the 2006 eruption.

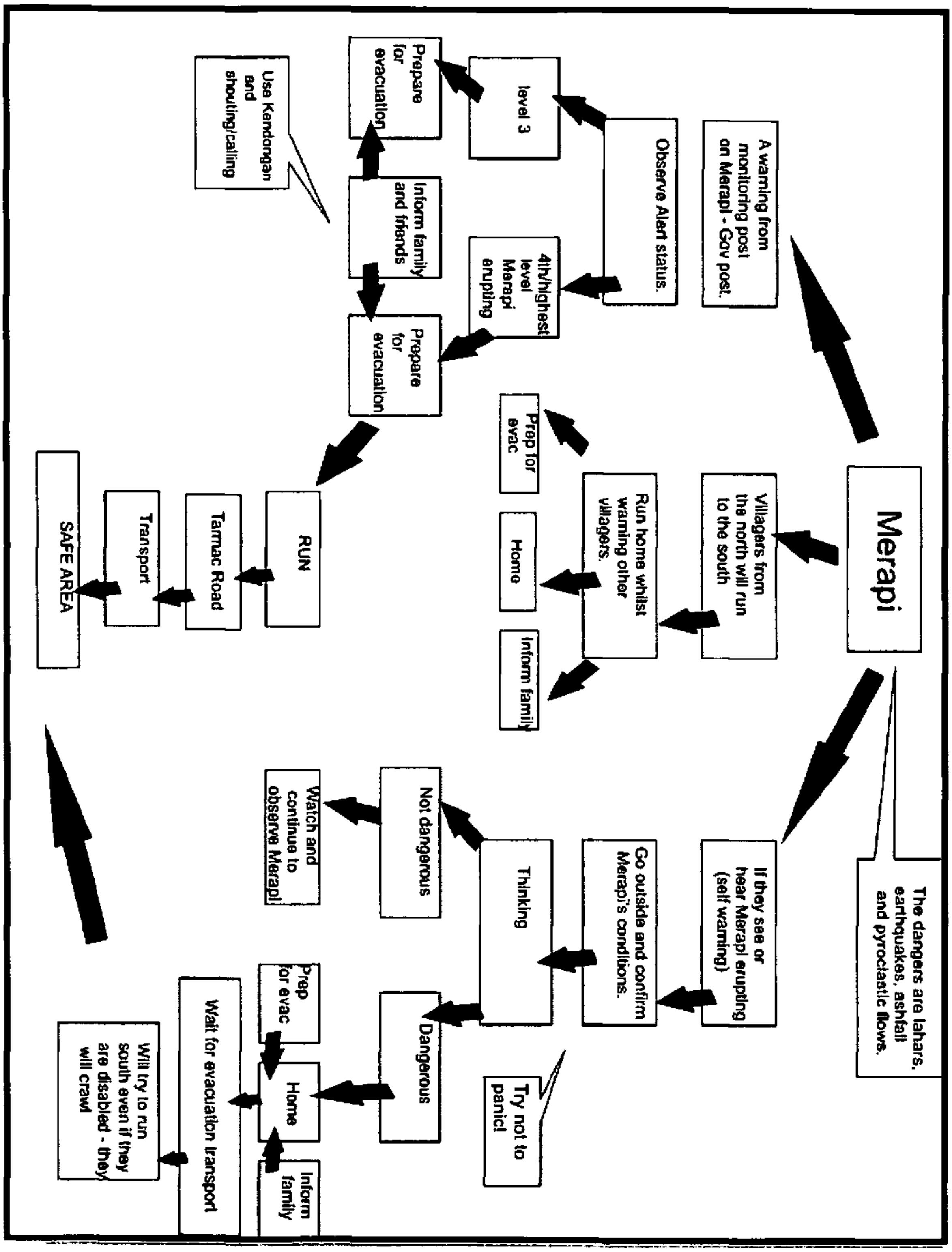


Figure 5.8: Emergency plan designed during participatory workshops in Batur. The original plan was redrawn and translated immediately after the workshop and then redrawn using Coral Draw. Every attempt was made to retain the original design and meaning.

During the workshop sessions, the participants were asked to produce community timelines; these illustrate the village's oral history while providing additional information on the risk perceptions and their specific knowledge about the volcanic events that usually affect the area.

Figure 5.9 identifies that in Batur the main volcanic related issue is the lahar hazard. This is not surprising as lahars have recently been channeled down the Gendol River system which provides a useful resource. The Batur timeline also shows three volcanic events, the 2006 eruption, the 1994 eruption and in 1972 when a cold lahar inundated the Gendol River. These events may have been applied to the timeline purely because of the workshop atmosphere, the participants knew that the aims of the research focused on the volcano and therefore this was foremost in their minds. In contrast, despite the volcano being a prominent topic during the workshops, it was not the predominant issue on the timelines. Historical events that seem to linger in the community memory are either political, economic or social because these events have changed and improved their everyday lifestyle, such as a new tarmac road providing better access to markets and to the city or the introduction of electricity. In contrast the volcano is a permanent feature in their lives and often rumbles away in the background, Wright writes that (personnel communication 2008) they are so used to the hazard threat from Mt Merapi that it is no longer worried about or influences their everyday lives. Lavigne *et al.* (2008) also commented on this during their brief study at Mt Merapi, they describe the volcano's permanent activity as being integrated within the villagers' daily lives. This also corresponds with the findings of Perry and Godchaux (2005), which suggest that those who have spent a lifetime living on a volcano often see it as a nurturing environment, rather than a threatening one. Familiarity with the volcano and its dangers influenced their actions during the crisis, refusing to evacuate choosing instead to concentrate on their everyday struggles.

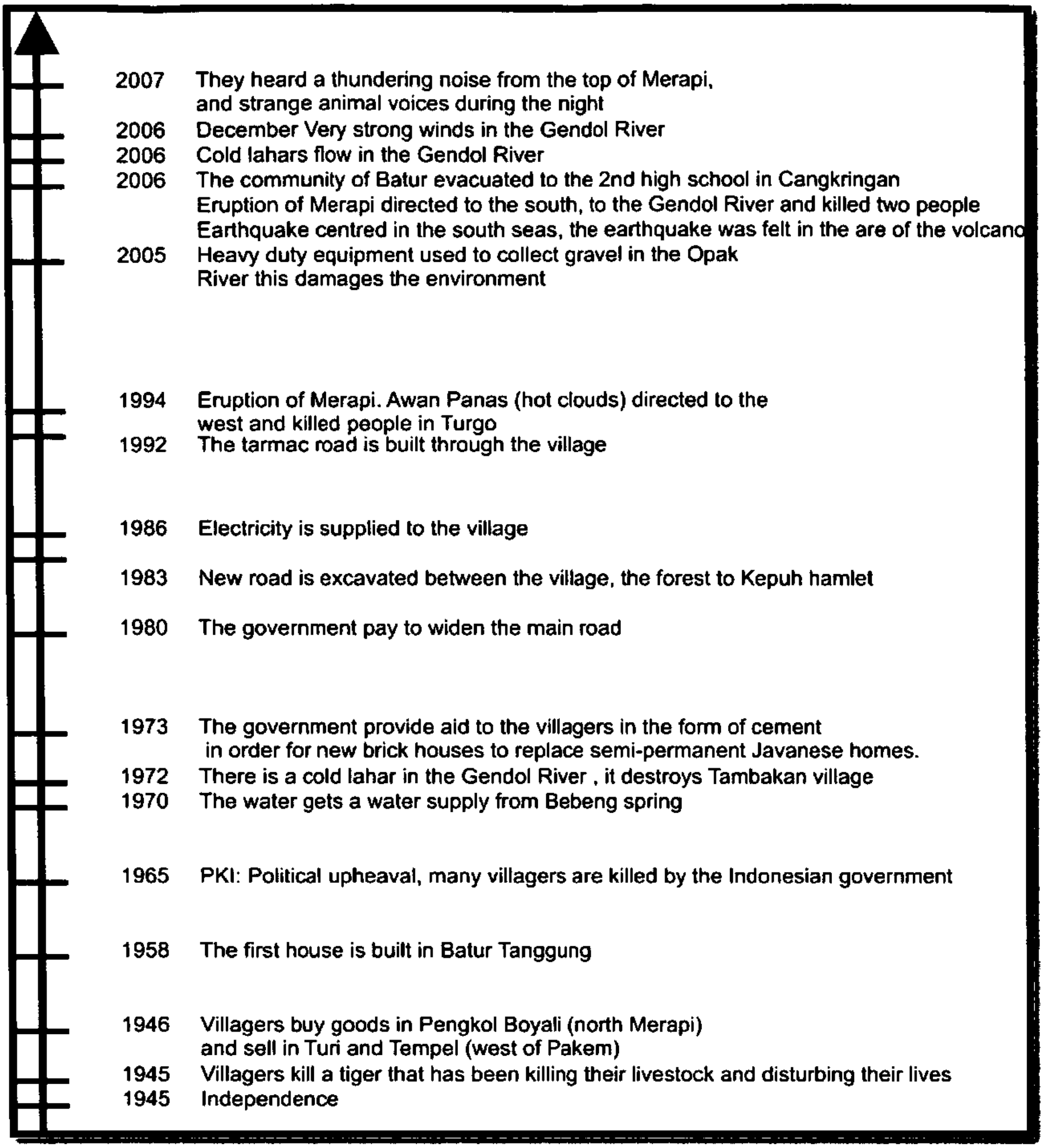


Figure 5.9: The community timeline for Batur, the volcano seems to feature recently indicating only a recent oral history. The original was translated immediately after the workshop and then redrawn using Coral Draw. The original design remains the same.

The Pelemsari community timeline focuses on major national events, illustrating as previously noted, the extreme political upheaval that Indonesia has experienced during the last 100 years (Figure 5.10). It shows that major political events have not only affected the urban population but also the 'isolated' rural settlements. The timeline also highlights key volcanic events from Mt Merapi, going as far back as 1872. This emphasis on the volcanic events stems from the workshop environment as mentioned earlier.

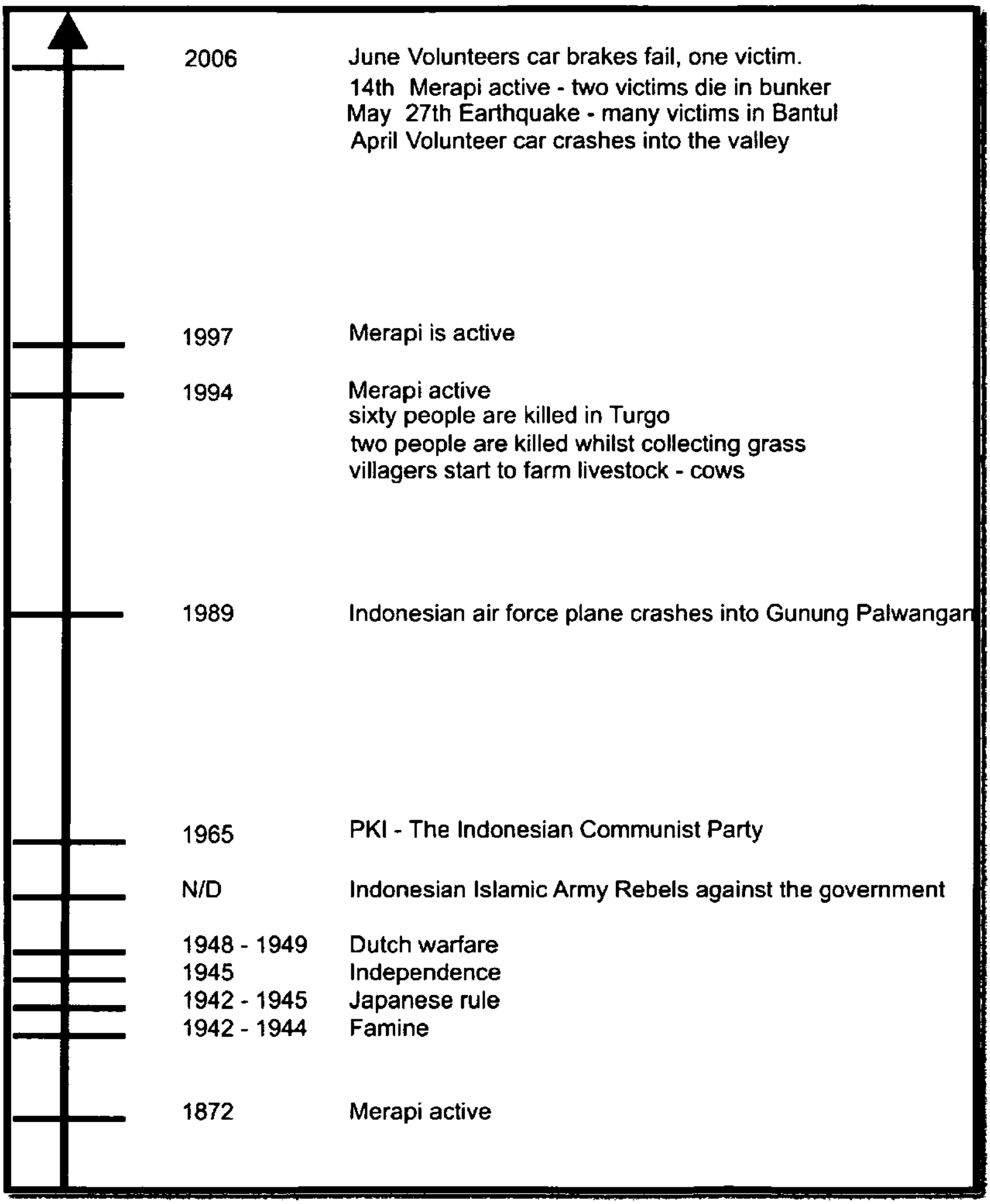


Figure 5.10: The community timeline for Pelemsari village, created during the participatory workshops. The original was translated immediately after the workshop and then redrawn using Coral Draw. The original design remains the same.

5.2.8. Mt Merapi, the fire mountain: Oral Tradition.

The villagers were asked about their experiences during the most recent eruption and their knowledge of the volcano and its hazards. Despite the lack of apparent oral history relating to the volcano, there does seem to be a collection of traditional warning signs for an impending volcanic event. These signs are conceivably linked with the observations that the villagers have made during their lifetimes, in contrast to the stories about supernatural creatures that are passed down from older generations and nationally through Javanese puppet performances (*wayang kulit*). This could imply that these signs are a more reliable as a mitigation technique than the guidance and moral stories. The traditional warnings vary from feeling hot, to thunder and lightning (a scientifically accepted consequence of volcanic activity), to messages in dreams and strange animal behaviour.

In Batur the majority of interviewees believed that if Mt Merapi was about to erupt the only signal they would receive was noise coming from the volcano. They describe a loud rock fall sound and rumbling just before a large eruption. Other signs used include strange animal behaviours, when monkeys or tigers would descend into the village; but now they do not rely on these signs as the tigers on Mt Merapi have been hunted to extinction and the monkeys have relocated to the lower slopes.

In Pelemsari the residents believe that before an eruption someone will receive what they call a '*wisik*' or premonition and these come usually in the form of a dream. In 2006, according to the villagers, Mbah Marijan, and several members of the community received strange dreams which foretold the eruption. In conjunction with these premonitions the villagers also believe that the area will experience small earthquakes. Their traditional warning signs seem to combine both material precursors (earthquakes, increased fumerole activity and rock falls) with more mystical signs (premonitions and strange animal behaviour). The villagers continue to combine both scientific and mystical beliefs to form a hybrid dualistic belief.

In concurrence with this, some of interviewees describe the hazards at Mt Merapi as having a direction:

> *"[Merapi has a] special direction where it will direct its explosion. So if the plume "mentelung" to the south it will not always affect the south. Merapi has a "driver" (who chooses which area affect). Mentelung, when the plume goes at 90° from the vertical, the driver is 'ono sing nglakoke', the driver is like a ghost",* ***Adi Sarju,*** *Batur.*

They had their own way of describing certain features of an eruption. Adi Sarju, above, describes how different areas will be affected according to the wind direction, he is describing a volcanic process using his own reasoning. The "driver" is the wind; by taking on a human personification it links to the ghost-like unseen creatures which often feature in Javanese mythology. In a similar way, Endang, describes how the lahars, which are the most common hazard experienced in Batur, are topographically controlled in the Gendol or Krasak River systems:

> *"I believe this area is safe because the eruption of Merapi has a route like Krasak and Gendol",* ***Endang,*** *Batur.*

Although they do not describe the events in scientific terms, the interviewee's observations are reasonable in the context of volcanological understanding. This implies that they have an understanding of how certain hazards are controlled either by topography or meteorological features and have applied their own explanation. Additionally, some of the residents traditional signs correspond to certain precusros observed through scientific monitoring (section 3.1.3).This is the foundation of traditional mitigation techniques which have been successfully used in other volcanic regions and hazard prone societies (Cronin *et al.* 2004, McAdoo *et al.* 2006, Cashman and Cronin 2008, Shaw *et al.* 2008).

Often an interviewee will describe a precursor to an eruption using onomatopoeia. These words sound like the event being described are a creative use of the Javanese language:

> *"before Merapi erupts, Merapi makes a noise 'njebluj' explosion, 'krembul-krembul' plume......I heard Merapi making a noise like 'ngrosok n kemresek' so I went directly home and when I returned to my village, I found the villagers running south.....",* ***Mukirah****, Batur.*

> *"I know when a flood occurs because I heard 'gemlugu' and then 'murup'. Gemlugur is the noise of rock fall and murup is the flames, embers",* ***Sarto****, Batur.*

Subtle differences in the onomatopoeia reflect different hazards, rock fall, eruption, lahars or pyroclastic flows. Although they are more widely used amongst the older generation these descriptions are still used as traditional warning signs of danger. The traditional warnings at Mt Merapi are also very similar to others found around the world. As noted in chapter 2 the indigenous residents of Mt Mayon volcano, Philippines, also have their own traditional precursors that include strange animal behaviours, premonitions and low rumbling noises. These residents also rely on their traditional precursors more than the government warnings saying that they don't really take any notice of official orders unless they see their own signals (Cardena 2008). This is very similar to comments made by the interviewees at Mt Merapi.

According to Schlehe (2006) it is taboo to talk directly about the eruption directly; these descriptive words have therefore developed in order to explain and discuss the volcanoes "voice" without upsetting the mountain. Personification of volcanoes is common in indigenous belief systems. For example, the Cascade volcanoes on the west coast of the North America are often personified in Native American oral traditions, they refer to the volcano as being very 'angry' or 'throwing things' (Cashman and Cronin 2008). Similarly, Mt Merapi means more to the villagers than a mountain; they talk about the volcano as if it were alive. Just as the onomatopoeias are considered to be Mt Merapi's voice, in Selo, on the northern slopes, the volcano is seen as a giant sitting with its back to the village. During an eruption the volcano is 'vomiting' and because humans only vomit from the mouth, Mt Merapi also only erupts material to the south the direction it is facing (Figure 5.11):

"If you climb Merapi from the south the sultan says that it is dangerous and impolite because you are climbing up the face of Merapi", ***Ismail****, Selo.*

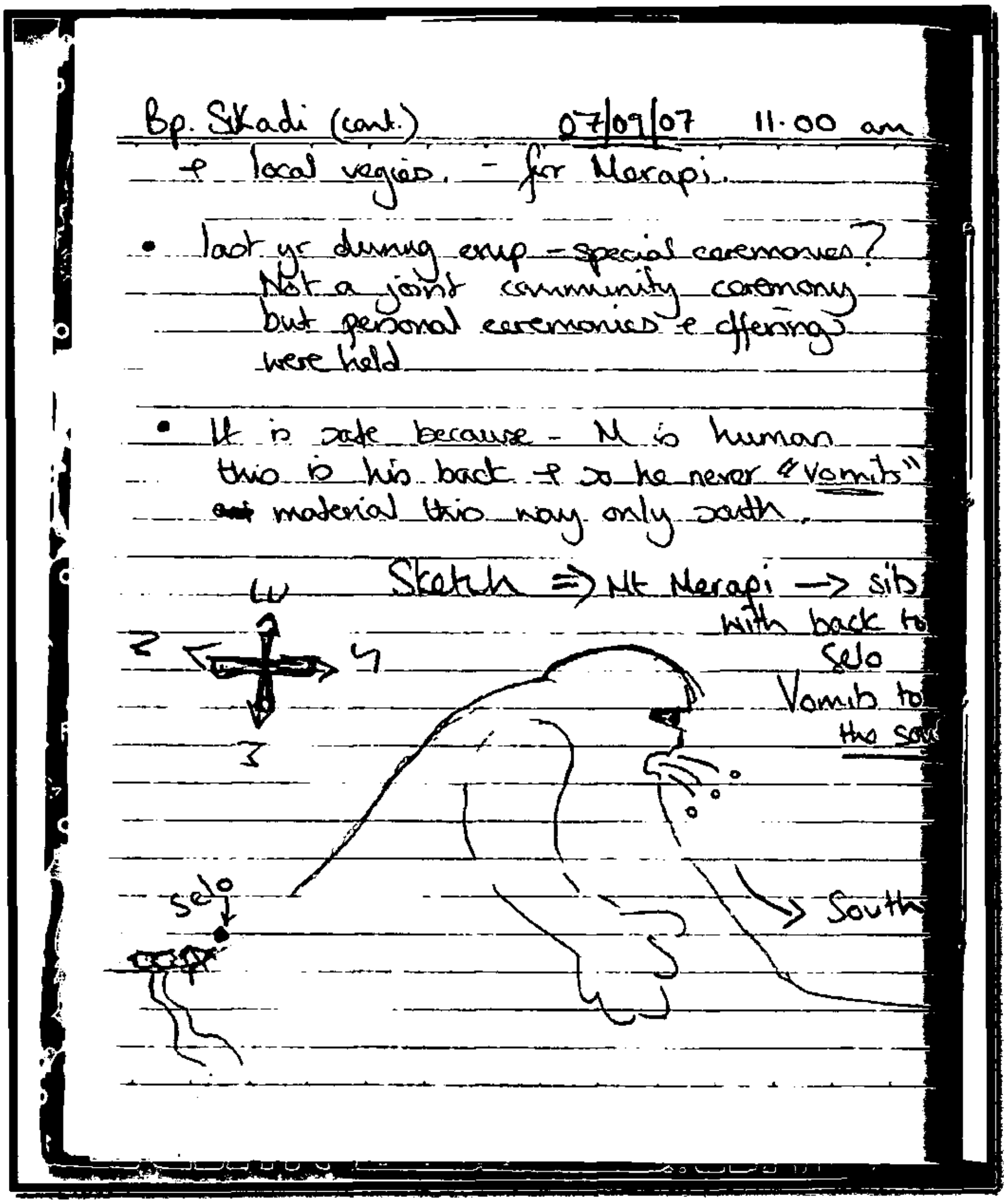


Figure 5.11: Scanned page from Selo notebook 2007, the page contains notes taken from an interview with Sukadi, 07/09/07 at 11:00am and also depicts a sketch of Mt Merapi as a person vomiting southwards.

In addition, the villagers in Selo explain that Mt Merapi would never erupt to the north out of respect for Mt Merbabu who is older:

"even Merapi's father did not affect this older volcano", ***Harjo Pangrad,*** *Selo.*

The traditional knowledge and oral history for Mt Merapi is gradually being lost as younger generations discontinue the ritual and storytelling. Yet a revival of these beliefs, signs and stories occurs after a significant eruption. After the 2006 eruption there was an increase in traditional ceremonies and a renewed interest in the mystical beliefs of the local people. The traditional mitigation techniques are extremely valuable to the local communities and should be encouraged.

5.2.9. Mbah Marijan.

Mbah Marijan is the person described by the media as the spiritual leader for the villagers on Mt Merapi. He is the '*Juru Kunci*' or 'care taker' of Mt Merapi as was his father before him. Traditionally the *Juru Kunci* is appointed by the Sultan to oversee any ceremonies related to Mt Merapi. The role of Mbah Marijan during the 2006 eruption has been highlighted in many news articles.

Merapi more than just a mountain

...But the local people do not listen to government officials. They listen to Marijan, the old "gate-keeper" to the volcano who enjoys an intimate spiritual relationship with Merapi. He insists there is nothing to worry about, and he has refused official pleading that he set an example to everyone else and come down from the danger zone. (Head (2006), **BBC News,** 18th May 2006.

The extract from the BBC article portrays Mbah Marijan as more authoritative than the government, implying that his spiritual relationship with the volcano is more important to the villagers than official orders. Reports also described how he had refused to leave his village, despite being asked personally from the present Sultan of Yogyakarta Province and even the prime minister of Indonesia. He apparently replied to Sultan Hamengkubuwono X that he would only take orders from the Sultan Hamengkubuwono IX (the present sultan's father) who appointed him; Sultan Hamengkubuwono IX died in 1988.

> *"the creatures will protect this area",* ***Mbah Marijan****, Pelemsari.*

Although, in reality, Mbah Marijan did not actively dissuade his fellow villagers to evacuate, the extract above infers that his actions spoke louder than words. The villagers confirm that Mbah Marijan encouraged them to leave but by remaining behind, he, perhaps unintentionally, reinforced the sense of safety.

> *"Mbah Marijan suggested that the villagers should evacuate, but he did not",* ***Simba****, Pelemsari.*

Lavigne *et al.* (2008) describes the Sultan and the *Juru Kunci* as the two leaders in Javanese culture, yet in reality the Sultan has far more cultural power and reverence. Although the villagers in Pelemsari have a great deal of respect for Mbah Marijan, and his relationship with both Mt Merapi and the supernatural creatures, he is regarded only as the "care taker" of the *Labuhan* ceremony employed solely by the Kraton and certainly not held in the same high regard as the Sultan.

Plate 5.6 shows Mbah Marijan trying to conduct the *Labuhan* ceremony in 2007, whilst surrounded by journalists. As the photograph suggests, his fame created a frenzy of media attention, he would receive hundreds of visitors every day, and he made time to speak to every person. Often he would receive bus loads of people who would come and visit him as part of a village outing or religious ceremony. The people wished to receive a blessing from Mbah Marijan and would often ask him to heal a sick member of their family or to ensure them wealth and prosperity. Yet, he declares that he does not understand these requests, that he does not hold a special power to bless people.

Plate 5.6: Mbah Marijan (centre in the white checked material) with Pujo his assistant to his right during the *Labuhan* ceremony, 14th August 2007. For the entire procession up to the *Labuhan* site Mbah Marijan was hounded by the media, local national and foreign journalists fought for the best photograph disregarding any cultural sensitivity. This photograph was taken by the researcher who then continued to observe the entire ceremony. The *Labuhan* ceremony took place at the end of the time spent in Pelemsari and by photographing the event I became a tourist rather than a member of the community.

He regards his position as staff member of the Kraton (the Sultan's palace) and his role is to perform the *Labuhan* on behalf of the Sultan.

> *"Labuhan is the duty of the care taker. If the kraton has a need to do with Merapi it is the job of the caretaker "juru kunci",* ***Ibu Pujo****, Pelemsari.*

He is in charge of leading the *Labuhan* and organising the entire three day event. He explained that it is his duty to "*pasrah*", to present the offerings to the creatures of Mt Merapi. Weeks before the event Mbah Marijan can be found every day preparing the *Labuhan* path cutting back the new growth on the path leading through the forest up to the *Labuhan* site (to the annoyance of some villagers who watch him cutting away at their precious grass supplies). On Sundays the other members of the Kraton staff who live in the village clear the path and they are also responsible for preparing and running the *Labuhan* ceremony. Plate 5.7 shows the *Labuhan* procession weaving its way up through the 'fields' of grass, to the right of the procession villagers continue to collect grass not even stopping to admire the spectacle. To the villagers who know and see him every day, Mbah Marijan is just another member of their community who has been given an important traditional role by the Kraton.

Some do regard him as one of the "wise men" in the village, believing that the supernatural creatures of Mt Merapi will give Mbah Marijan information and possibly warnings about a forthcoming eruption.

> *"Mbah Marijan got a "wisik" (a premonition) in 1994: Mbah Marijan was preparing the path when he met an old man "Pinisepuh" he told Mbah Marijan that it would be better if you went down because something will pass. The he saw that Turgo was broken",* ***Darto,*** *Pelemsari.*

Plate 5.7: The *Labuhan* procession making its way up through the fertile grass fields just above Pelemsari village, a villager to the right continues his daily grass collecting as if oblivious to the ceremony. This photograph was taken by the researcher, on 14th August 2007, who followed the procession to the *Labuhan* ceremony site.

Despite some of the Pelemsari villagers believing that Mbah Marijan has a special relationship with Mt Merapi, most would not rely entirely on his advice or actions during a crisis. In contrast to the BBC news article and other media reports most villagers did not, and will not follow Mbah Marijan during an eruption, and those that did during 2006 were mainly his close family.

Paradoxically, outside of Pelemsari Mbah Marijan is regarded as a mystical figure fuelled by rumours, speculation and media hype. In Batur, for example the villagers regard Mbah Marijan as a spiritual being who knows what is happening with Mt Merapi.

*"Mbah Marijan has the power of Merapi", **Mulyorejo**, Batur.*

Sihono and Bingat, two brothers in Batur, explain that if Mbah Marijan says to remain in the village they will do what he says, even if the government declares that it is not safe. Sumilah from Batur explains that because Mbah Marijan did not evacuate the area must be safe. The further away from Pelemsari the more extravagant the stories about and trust in Mbah Marijan seems to become. In Selo, one interviewee states that Mbah Marijan is actually one of the creatures of Mt Merapi living in a different dimension. Even scientists and government officials interviewed in Yogyakarta attribute power to Mbah Marijan. Even the most important politicians such as President Yudhoyono and Arief Koesno, leader of the Indonesian Unity and Fusion Party, have made pilgrimages to Mt Merapi to receive blessings from both the volcano and Mbah Marijan (Marshall 2008).

Mbah Marijan himself seems a little perplexed that so many people want to come and see him and that he has become revered. But the villagers are not complaining at the intrusion into their hamlet of hundreds of spiritual tourists. He has made a lot of money for the region, as he took part in a large advertising campaign in 2006 for a power drink company and more recently a coffee company. Additionally, the head of hamlet or *Kelurahan*, Ramijo, would often leave in the evening to attend organizational meetings about the forthcoming *Labuhan* ceremony. Ramijo would discuss with the Tourist Department how they can encourage more tourists and make the *Labuhan* profitable. The Pelemsari villagers are poor, and Mbah Marijan is a financial opportunity, yet his fame may commoditize his knowledge and role.

> *'Mbah Marijan is not the true care taker, he has been very clever to take advantage of the media during the last eruption',* ***Alef**, Selo.*

It is possible that Mbah Marijan is also being used as an excuse to remain at home during an eruption. During the eruption of the 1997 Soufriere Hills on Montserrat Island, Cashman and Cronin (2008) noted that some of the American ex-patriots used the story of Harry Truman (of the Mt St Helens eruption) as a reason to remain in their homes, if he was allowed to stay why couldn't they? Mbah Marijan was never forcefully removed from his home during the 2006 eruption and his defiance echoes that of Harry Truman at Mt St Helens. The villagers see his defiance and the respect he receives from the authorities and they use this as their excuse to also remain in the village. The actions of Mbah Marijan during the 1994 and 2006 eruption displaced the local sense of risk and danger.

5.3. Summary.

This chapter has reviewed and discusseed some of the key themes that emerged from the interviews, workshops and observations carried out in the main field season. The field season ran from the beginning of July through to the end of October 2007 and during this time period over a month was spent in both of the main field sites of Pelemsari and Batur, in addition to a reconnaissance trip to Mt Agung, Bali. The remainder of the time was spent based in Yogyakarta city, and Selo.

Generally, the villagers refused to evacuate because they are very reliant on their livestock, so much so that even the reality of death seems to be less of a risk than leaving their cattle and fields. Intertwined with socio-economic issues are their traditional beliefs that tie the villagers to Mt Merapi. These traditions explain away death and the hazards that 'take' their friends, perhaps culture is therefore used as an 'excuse' to remain in their homes and a way of explaining certain behavior rather than actual response. This idea is developed further in Chapter 7 when the question of whether culture is driving response is examinined by comparing cultural intensity and evacuation failure.

In Selo, they have no emergency plan and no oral history of volcanic events, and even the official hazard map reiterates their false sense of security. In contrast, those who have experienced the full wrath of Mt Merapi are scared and desperate for help, some are so traumatised that they leave the region forever. In Batur and Pelemsari most villagers are some way between the two extremes. They have realised that they are vulnerable but they are still enacting and drawing upon traditions that tell them that they are safe.

Although the story Mbah Marijan initiated this project, with the media attention during the 2006 eruption, he seems rather supplementary to the real issues of how Mt Merapi's threat is perceived and accomadated. The Pelemsari villagers are entertained by the *Labuhan* and admire Mbah Marijan's bravery but he does not influence their reactions in a crisis and their traditional beliefs are often used in conjunction with official information so that they feel that can make a fully informed decision. Mbah Marijan is regarded in three ways. First, he is a spiritual guide to many and the myth of Mbah Marijan has created a trust in his protective powers. Secondly, and in contrast, the villagers see him as employed by the Kraton to perform the *Labuhan* ceremony and other Kraton/Merapi related traditions. In this role, although he is knowledgeable about the volcano having lived on the volcano all his life, at most he is considered a wise man of the village. Thirdly, he and the *Labuhan* ceremony have recently been considered as a money making opportunity for the village. Cynically some encourage his mystical status.

Overall, the residents of Mt Merapi consider the need to seek a livelihood more central than protecting themselves from volcanic hazards. The 2006 eruption increased local hazard awareness, especially for those living in recently unaffected regions and the increased the distrust towards the government and their faith in traditional knowledge. In conjunction, their beliefs and oral traditions (summarised in Figure 5.12) appear to provide a psychological coping mechanism during and after a crisis, a way of explaining hazard related deaths and the trauma of volcanic disruption. Positively some of the cultural traditions provide, to some extent, a mitigation system which could be developed and used in the future. More concerning, the villagers will not actively evacuate unless they receive traditional warning signs, (this could led to at best delay in evacuation procedures or at worst general evacuation failure.

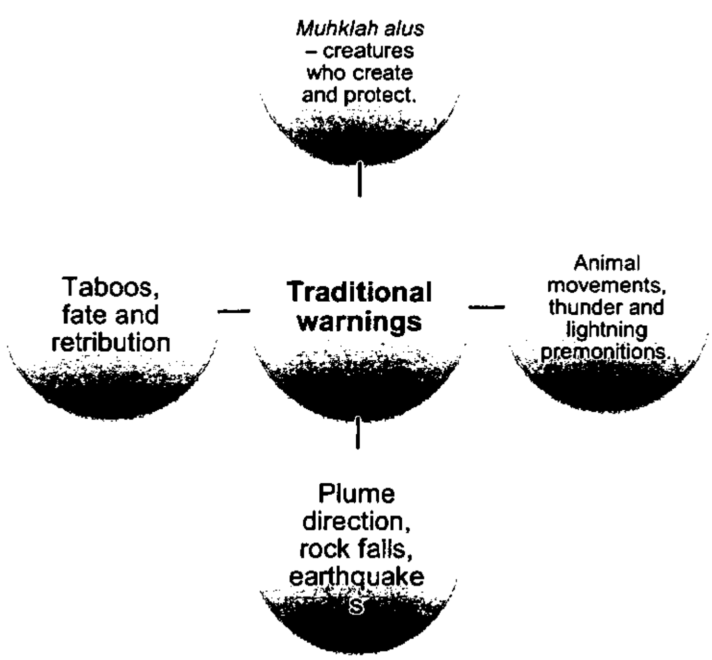


Figure 5.12: A summary of key traditional warning signs extracted from the data collected in 2007.

Other recent research has drawn similar conclusions at Mt Merapi and other Javanese volcanoes (Lavigne *et al.* 2008, Dove 2008) and at Mt Pinatubo, Philippines (Gaillard 2008), Mt Vesuvius, Italy (Barberi *et al.* 2008) and Mt Tungurahua (Whiteford and Tobin 2009). These studies encourage the incorporation of traditional knowledge into disaster management plans but so far very few have attempted to integrate social and geological data. Chapter 6 explores how the social science data can be incorporated within a Geographical Information System with the aim of producing a more concise, practical and socially relevant hazard map.

5.4. Footnotes.

[1] The official hazard map was distributed amongst some of the villages around the volcano yet it seems that it was not accompanied with an explanation or educational outreach. Therefore the more illiterate or those who only speak and read Javanese the map was redundant as an informative item. Often the map could be seen hanging on the villagers wall or would be filled away in some dark corner, or even used as fuel. The maps produced during the workshops were viewed differently because they had been produced by the villagers, and they understood their own symbols and markings. The maps allowed them to discuss the volcano and the hazards, sharing information and knowledge. The maps from the workshops are also at a local scale whilst the hazard map covers the entire region, their village is just a dot.

[2] The term supernatural creature originates from the research assistants interpretation of the villagers overall terminology when referring to the trans-dimensional beings. Generally, the villagers directly referred to the beings by names, such as Mbah Petruk, Mbah Simbaryjo, Empu Rahmadi, Empu Room, Nyai Gadung Melati or Sapujagad Sopu Angin. Often the villagers would add a pre-fix to the name such as grandmother or Mr, this is often a sign of respect. They also referred to the volcano as grandparent e.g. Nyai.

[3] The story of the *Labuhan* ceremony was discussed by Alef, Mbah Marijan's son on the eve of the ceremony in 2007 (12th August) is given in Appendix 2.

[4] Story of Mbah Petruk was told by Bapak Auto, 87 yrs old and a resident of Selo during an interview that was carried out 2nd September 2007:

When Mbah Petruk was of the age of circumcision. He said that although he was happy to ahead with the circumcision he wanted some special food to be cooked beforehand. He also wanted *Dawet*, (a health drink). After the food was prepared Mbah Petruk requested that the food be thrown out into the yard and any visitors should use their tongues to eat it. After this his visitors accompanied the young Mbah Petruk to Ulu (a location on Mt Merapi) and there the young boy disappeared. After one week the boy returned and said that he had been ordered to be one of the creatures of Mt Merapi and that he must live on the volcano's Aunt Mountain. He advised his generation that if they wanted to remain healthy and safe they should offer him coffee, cigarettes and *jadah bakar* (a fried rice based patty) on the Javanese days of Thrusday Liwon and Friday Liwon. Now Mbah Petruk protects and blesses the villagers.

[5] The photograph purportedly showing Simbarjoyo within an ash plume during the 2006 eruption of Mt Merapi was shown to the researcher by Alef (the host) in Selo. Photographs are often used to proved evidence for unusually events or to infer a unnatural catalyst within a disaster, for example the supposed devil's image within the 9/11 impact clouds (http://www.christianmedia.us/devil-face.html) and the apparent face of Elijah in the Mt St Helens eruption cloud in 1980
(http://www.godsgeography.com/america/mtsthelens/mtsthelens.html).

[6] It was noted by the translator and research assistant Aris, that when interviewing the villagers they would often never directly refer to the eruption but rather "that or "it". It could be that this would be tempting fate. To talk about the eruption makes it real; some villagers would not want to talk about the eruption saying it was not a good thing to do, as if talking about "it" may make "it" happen.

[7] It was intimidating walking through these isolated communities, the people at first fled into their houses when I arrived and then slowly as if they had never seen a white person before they peeped round their doorways and windows. As I progressed through their hamlets they would follow me, like a game of hide and seek they would hide if I turned around to view the hundred strong crowds sneaking up behind me. In these communities my positionality changed, I was an 'official' a 'westerner' and because of this I would be ushered into the head man house and he would explain what they required from the government, as if I was going to report back and provide what they needed.

Chapter 6: Geographic Information Systems: hazard mapping and social volcanology.

6. 1. Introduction.

To date, cultural aspects of hazard threats, outlined in chapter 5, have been neglected by a hazard science community that largely relies on information management practices, protocols and technologies. Over recent decades those have been dominated by Geographic Information Systems (GIS). GIS has become integral to any hazard science providing researchers and managers with technological tools to pre-determine and up-date in real time all element of disaster in one system. GIS has become so fundamental within disaster management practices that to overlook its ability to integrate social data and compile hazard information available for the Mt Merapi region would be negligent.

As Zerger and Smith (2002) suggest GIS can be used within each component of risk management in relation to natural hazards: designing an evacuation plan, urban zonation, education tool, risk identification, developing building codes, cost-benefit analysis, and managing post-disaster recovery. In fact, GIS can be effective at all stages of the disaster management cycle, as illustrated in Figure 6.1, and this is why it is vital to use GIS as a holistic tool within this research.

Mapping both the hazards and the social vulnerabilities of a region is vital so that disaster managers and governments are able to efficiently and effectively take action to prevent loss. Therefore the remainder of this research will consider the existing hazard map for the volcano, compiling secondary hazard data within one GIS system and then transforming cultural information into this same system.

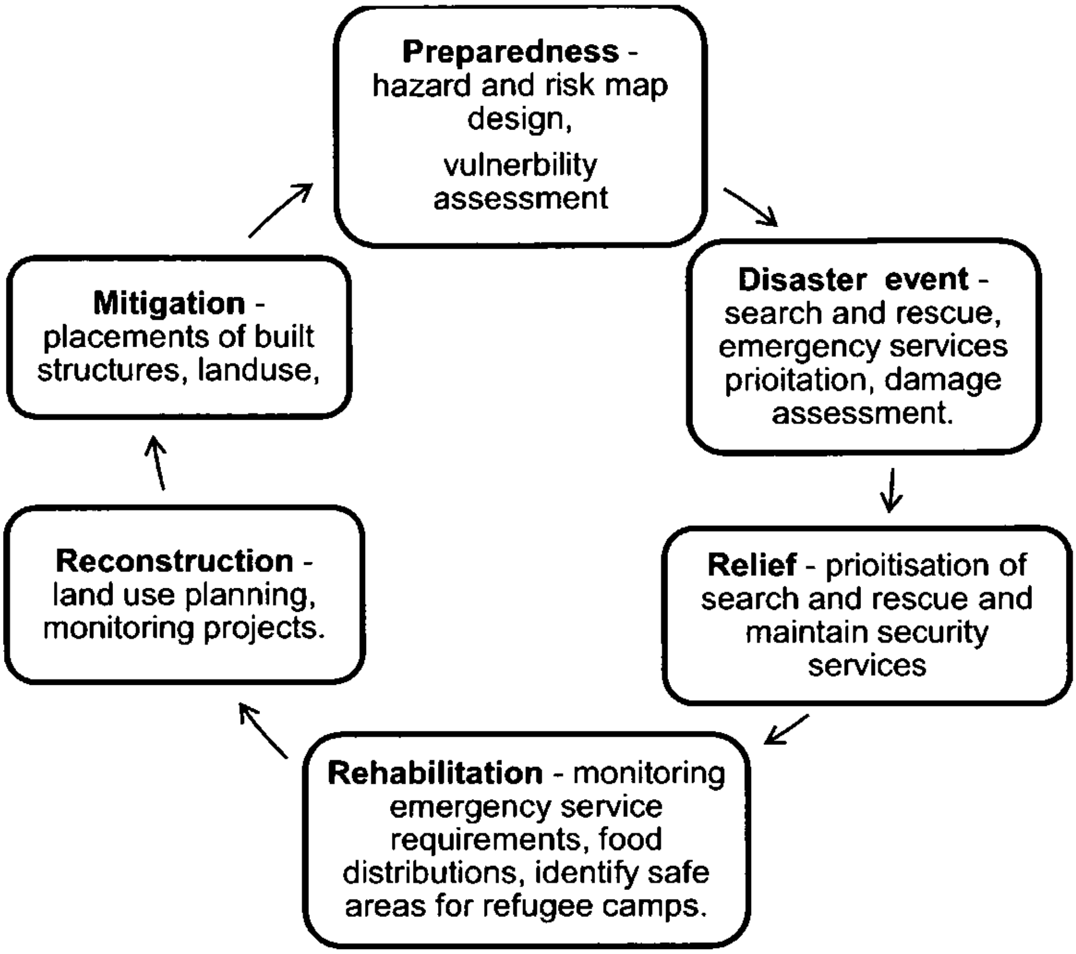


Figure 6.1: The disaster management cycle modified to include application of the GIS tool. Source: derived from van Westen (2002).

This chapter primarily focuses on collating the hazard data for Mt Merapi. The existing hazard map has been distributed around the volcano and is not only used for official evacuation planning but also appears to have a psychological influence on the local people. For example, living outside of the hazard zones appears to reinforce a false sense of security, especially since aspects of the hazard map as underestimating the volcanoes true hazard potential. In the final sections, this chapter provides a bridge between the social data interpretation and the practical application of such data within a risk assessment.

6.2. GIS and disaster management.

> The application of GIS and spatial modelling for natural hazard risk management is an emerging science and the ability to provide a spatial context for risk is critically important for risk reduction. (Zerger 2002:293).

GIS has encouraged flexibility when manipulating visual and spatial data, by overlaying many different maps it is possible to identify patterns, trends, implications and impacts of a potential hazard. This mapping system has therefore been used during major natural disasters to identify vulnerable areas and prioritise the emergency services to those who need it most.

GIS can model and display the location, size, potential path, depth, height, and other essential characteristics of any hazard (Bonham-Carter 1995; Parechi *et al.* 2000; Greene 2001; Skidmore 2002; Sanyal and Lu 2006; Christen *et al.* 2007; Kamp *et al.* 2008). Additionally, historical events can be mapped in order to forecast future hazard locations, frequency and size. For example, the location of active fault lines can be mapped alongside previous earthquake events to reveal areas of high seismic activity or, topography can be displayed in 3-dimensions in order for lahar pathways to be mapped in volcanic regions. Because of all these attributes GIS is now considered a fundamental tool in natural hazard management.

If used to identify the potential impact hazards in conjunction with the incorporation of population density statistics and socio-economic demographics a risk map can be produced. These maps can be used to track the hazard processes and design evacuation routes, aid the post-disaster recovery, identify effective mitigation schemes and their most effective locations.

GIS can be used within all hazard fields to aid the decision making process and it has been particularly effective in landslide mapping (e.g. Carrara *et al.* 1995, 1999; Carrara and Pike

2008; Dai and Lee 2002; Alexander 2008; Kamp *et al.* 2008) volcanic hazard modelling and management (e.g. Carey and Sparks 1986; Wadge and Isaacs 1988; Gomez-Fernandez 2000; Pareschi *et al.* 2000; van Westen 2002; Renschler 2005; Felpeto *et al.* 2007; Spence *et al.* 2008) and seismic hazard and risk assessment (e.g. Gamba and Casciati 1998; Baz *et al.* 2009).

Amdahl (2001) examines a number of disaster response case studies where GIS as been integral in the identification of hazardous regions and the emergency response. He specifically focuses on the 1994 Northridge earthquake, Los Angeles, after which GIS analysts saw that their expertise could provide vital information to the emergency response teams. The GIS teams were able to produce intensity maps from a building and safety structure damage assessment, and identify areas of ground liquefaction susceptibility. In addition to the geological and physical information produced in GIS, it was also possible to identify area of high vulnerability, such as, areas with a high population of non-English speaking residents or the locations of schools, nursing homes or hospitals. The ability of GIS to integrate vast amounts of information and display correlations quickly is vital within disaster management both before and after the event.

One of the most important pre-disaster mitigation tools is a hazard map. A hazard map identifies zones of high to low hazard based on previous hazard data, geology, topography and geographical location. Within a GIS system, areas that have previously experienced a particular hazard or have the potential to have been affected by a hazard (for example over steep unstable slopes or flood plains) can be delineated by overlaying the different hazard attributes into one map. In conjunction, as in after the Northridge earthquake, social information can be added in order to identify regions of high risk. Figure 6.2 diagrammatically demonstrates the simple theoretical process of producing a risk map using GIS.

At present there are certain inadequacies with the GIS system. For example, it relies entirely on the accuracy of the original data, and the system requires a technician or expert to run its applications and therefore 'first responders' do not always understand the system. It also requires a representational quantity of data that is not always available. Moreover, in any disaster scenario data collaboration requires inter-organisational co-operation that is not always possible (Cutter 2006). Yet it is a tool that can quickly merge and represent vast amounts of data and it has the ability to do this in real-time. Despite its drawbacks it is a useful and now global tool, being used to conjoin interdisciplinary and inter-organisational projects. It is these reasons that have motivated me to use GIS within this project, in order to integrate the social and physical data into one output.

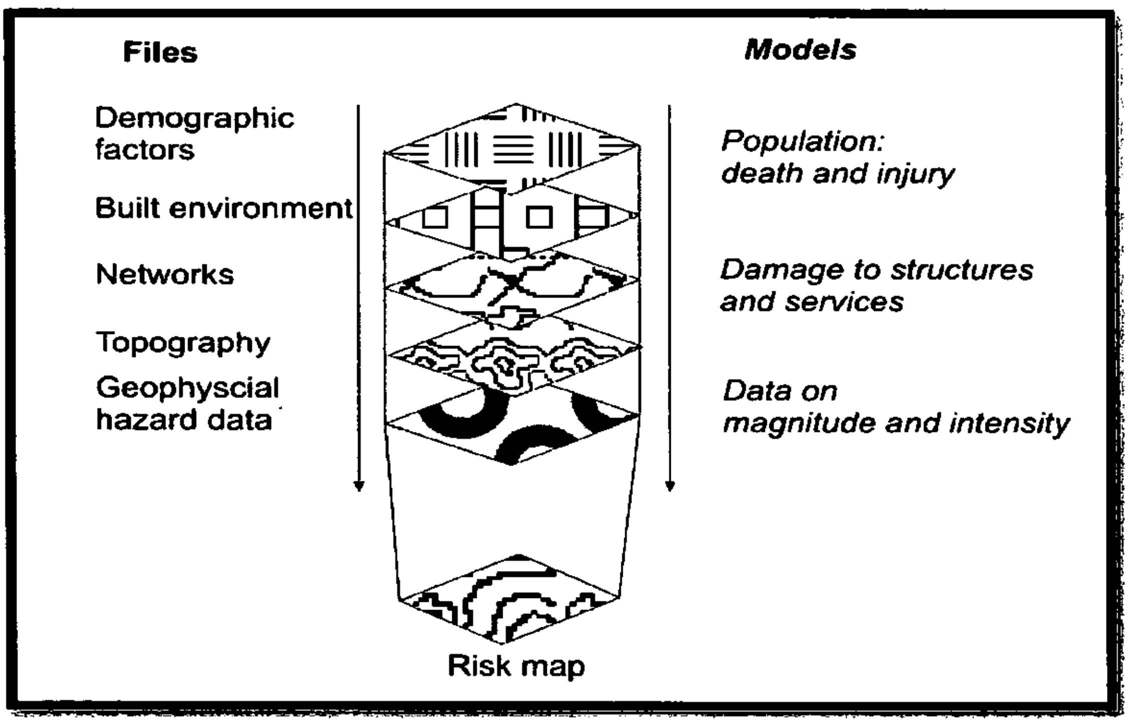


Figure 6.2: Geographic Information Systems overlay thematic maps in order to zone associations between individual maps. Models are output and files are the inputs. Source: Alexander (2002).

6.3. A revised hazard map for Mt Merapi.

In any risk assessment it is essential to examine the potential hazards of that region in order to prioritise any immediate action. As noted in chapter 4, since being designated a decade volcano, Mt Merapi has been the focus for a variety of hazards research and because the main focus of this research is to examine the social impacts of an eruption it was deemed unnecessary to carry out further first-hand hazards field work during this project. Yet, despite this it is important to have an understanding of the eruptive styles and subsequent hazards that impact on the region. This section therefore collates the secondary hazard data from Mt Merapi within GIS in order to re-assess the existing hazard map and suggest future alterations.

6.3.1. Previous hazard maps at Mt Merapi.

> Revisions of the hazard map are desirable...it lacks details necessary to outline hazard zones with accuracy. (Thouret *et al.* 2000:479).

Mt Merapi has a history of hazards research and the first official hazard map for the volcano was developed in 1978, yet in the quote above Thouret *et al.* (2000) implies that this hazard map was ineffective. Based on pyroclastic flow and lahar observations from the 1930 and 1969 eruptions, using techniques highlighted in Table 3.2, the 1978 map contained three main zones: the Forbidden or closed zone, the first and then second zones (Pardyanto *et al.* 1978, Thouret *et al.* 2000) (Figure 6.3). The forbidden zone was a region that could be affected by pyroclastic flows, whilst the first hazard zone was only designated as being impacted upon by 'glowing bombs' despite acting as the buffer between the forbidden and second zones. The second hazard zone was designed according to rain-induced topographically controlled lahar hazards, although this region seems to only be topographically controlled on the south and south-western flanks of the volcano. In addition to the main hazard zones there is also information regarding previous pyroclastic flow activity but without a key it is difficult to confirm this.

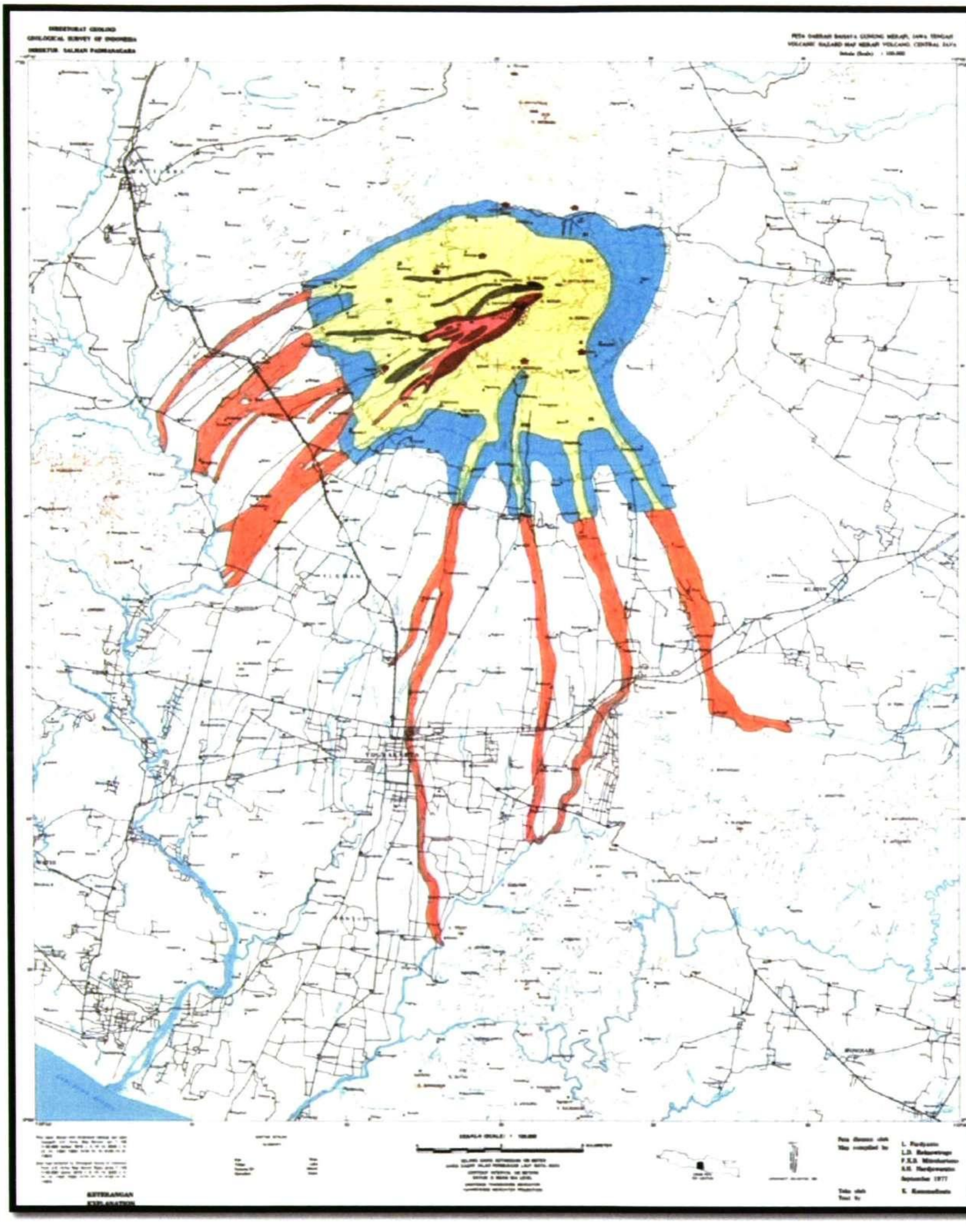


Figure 6.3: The 1978 hazard map for Mt Merapi. The Yellow represents the forbidden zone, the blue the first hazard zone, and the red the second (lahar only) zone. The map scale is 1:100 000 and underestimates the potential hazard size and 'foot print'. Source: Pardyanto *et al.* (1978), TEC (2008).

The explanation accompanying the map is not detailed and does not include all the possible hazards that have and could be erupted from the volcano. Later studies and actual eruptions have shown that this hazard assessment is an underestimation of the potential eruptive power of Mt Merapi.

Despite its shortfalls the original 1978 hazard map was still one of the first maps of its kind produced for Indonesian volcanoes and the fact that it existed at all was encouraging. Yet with such a high population density living on the volcano and an increased interest in the decade volcano the maps errors could not be overlooked. In 2000 the hazards were re-appraised and the results published in a special issue of the *Journal of Volcanology and Geothermal Research* (JVGR) (2000). Within this publication Thouret *et al.* (2000) produced two new hazard maps, one for eruption small to moderate eruption (VEI 2-3) and larger eruptions (VEI 4) (Figures 6.4 and 6.5).

Although they are too technical and complicated for the general public and, realistically, many emergency planners, they do provide good foundation maps. They also are the first maps to acknowledge the two eruptive styles of Mt Merapi that have occurred during the last 200 years, as noted in chapter 3 (Figure 3.7). To recap, during the last two hundred years Mt Merapi has experienced both large explosive events (VEI 3-4) and smaller dome collapse events that have primarily produced pyroclastic flows and lahars (Voight *et al.* 2000a). Thouret *et al.* (2000) and Voight *et al.* (2000a; b) recommend that Mt Merapi should be considered extremely dangerous and that one can not dismiss the possibility of large eruption at the volcano.

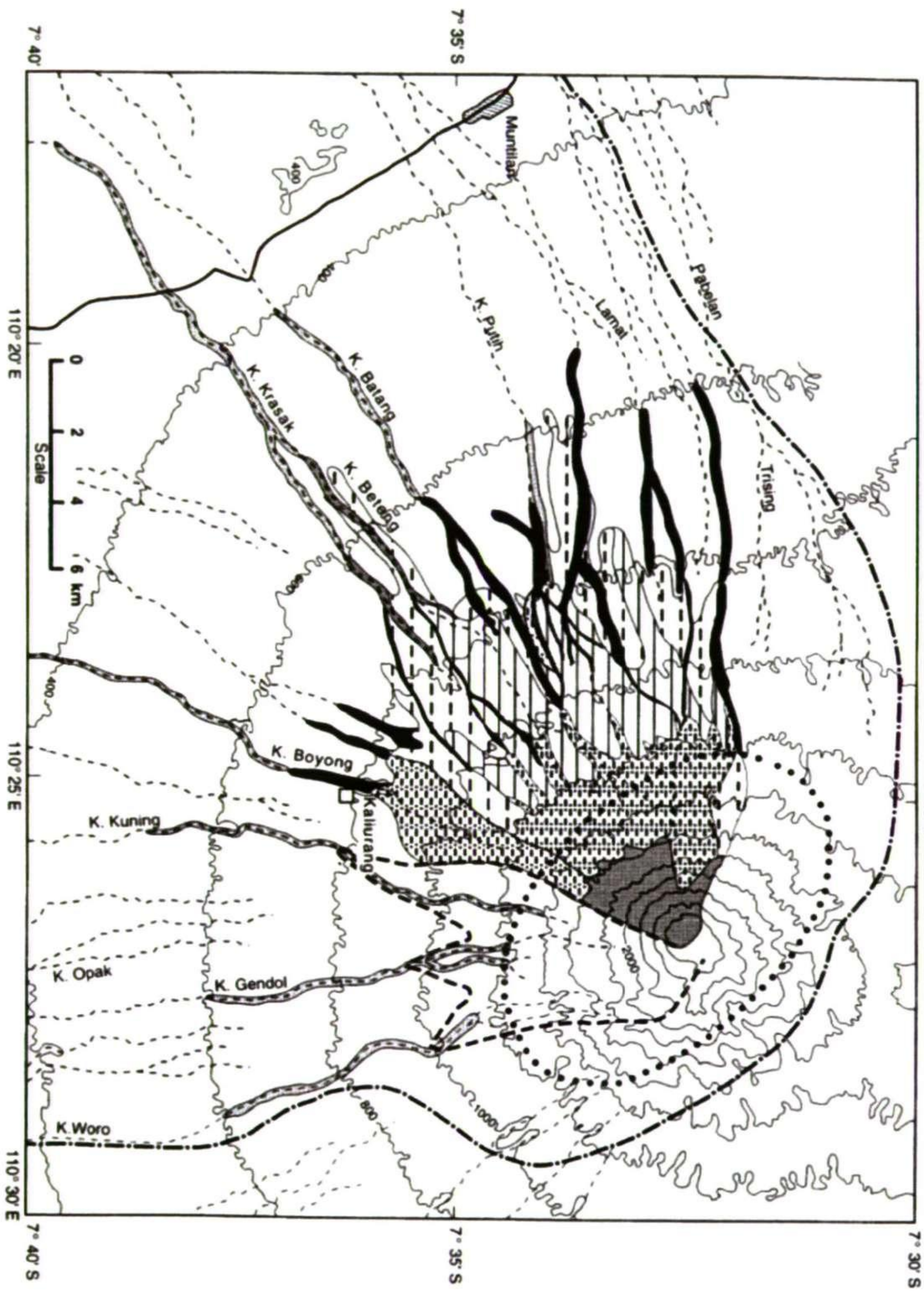


Figure 6.4: Thouret *et al.* (2000) hazard map for Mt Merapi based on a VEI eruption of 2-3.

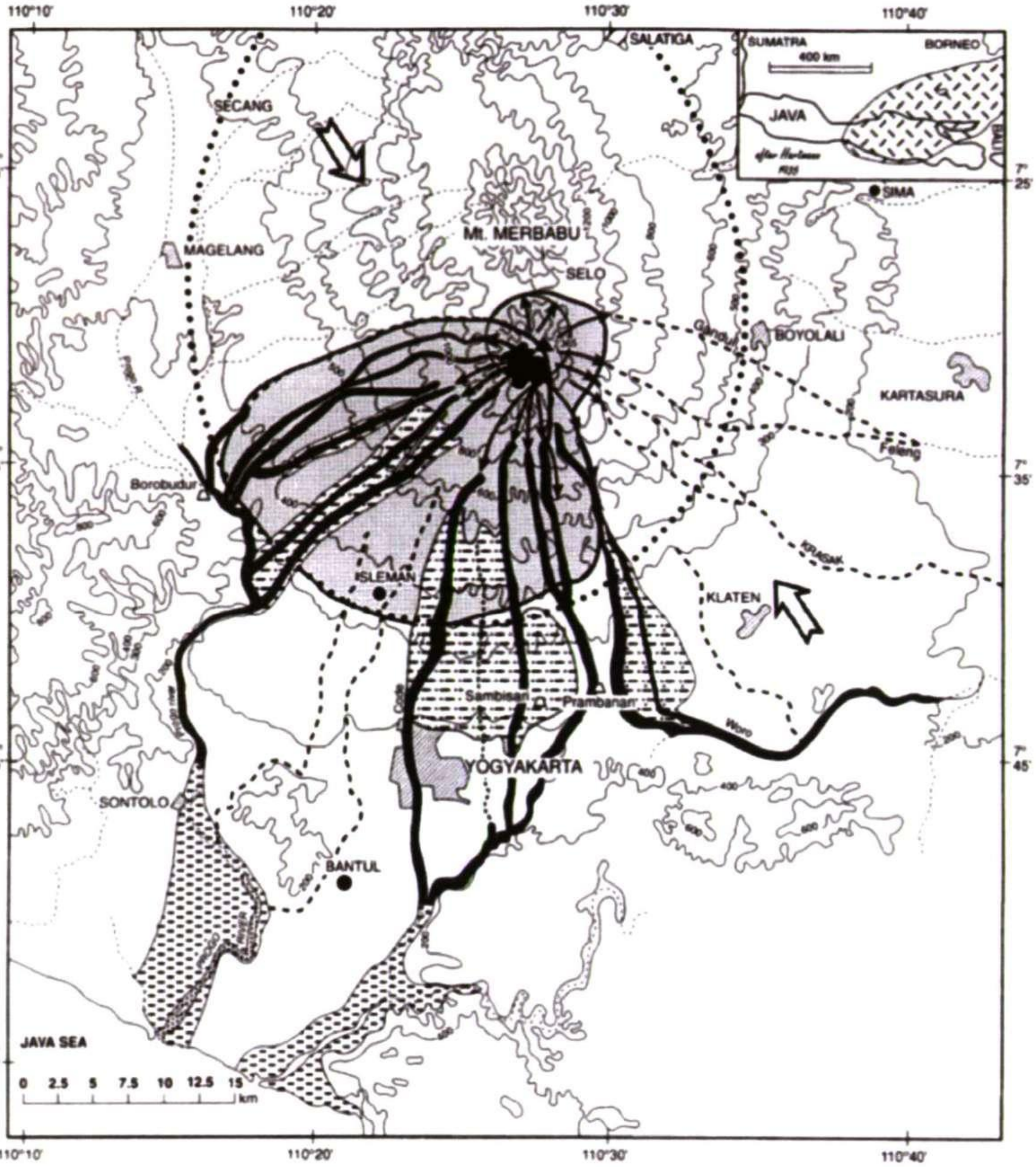


Figure 6.5: Thouret *et al.* (2000) hazard map based on an eruption of VEI 4. The dark thick lines are show the potential lahar pathways, the shaded areas are pyroclastic flow zones, the dashed regions could be inundated with flood water, and the blackened zone at the summit delineates the blast zone.

Despite this warning being published in 2000, in 2002, the 1978 map was revised by the Directorate of Volcanology and Geological Hazard Mitigation (previously the Volcanology Survey of Indonesia) and the new map consisted of three hazard zones based on only the last 100 years of eruptive activity (VEI 2-3) and this was distributed among communities on the volcano (Figure 6.6 provides a simplified version of the current hazards map). A full version of the official 2002 hazards map is provided in Appendix 1.

The 2002 map is remarkably similar to the 1978 version, except for the accompanying description where they have included many more hazards that could affect the highest and second hazard zone (Table 6.1). There is no clear explaination to how this map was constructed, it notes only that it 'is compiled based on geomorphology, geology, eruption history, distribution of previous eruption products, research and field study' Hadisontono *et al.* (2002). Additionally, the accompanying description uses references from the JVGR special publication and indicates that larger eruptions have occurred at Mt Merapi, suggesting that these events occur every 100 years. The description is detailed and not only identifies individual hazards for each zone but also explains what action is required for those residents living in each region. Unfortunately, the version distributed to residents on the volcano does not contain the description, and even if it did the only certain members of each community would be able to understand the explanation as it contains technical terms, demands a certain literacy level and is written in English and Bahasa Indonesia rather than Javanese.

Despite revisions, the 2002 map still underestimates the potential size of an eruption extent, because it is apparently based only small to moderate eruptions that have taken place over the last 100 years. It does not therefore include eruptions of VEI 4 + that have been produced at this volcano in recent geological history e.g. the 1872 eruption. In other words, the worst case scenario at Mt Merapi has not been officially mapped and this may 'blind' the local population and government officials into believing that this volcano only ever will produce small to moderate eruptions. This is reiterated by the map description itself, as it notes that 'the volcanic map is applicable only for normal eruption' Hadisontono *et al.* (2002), referring to a dome-collapse eruption as normal is somewhat misleading.

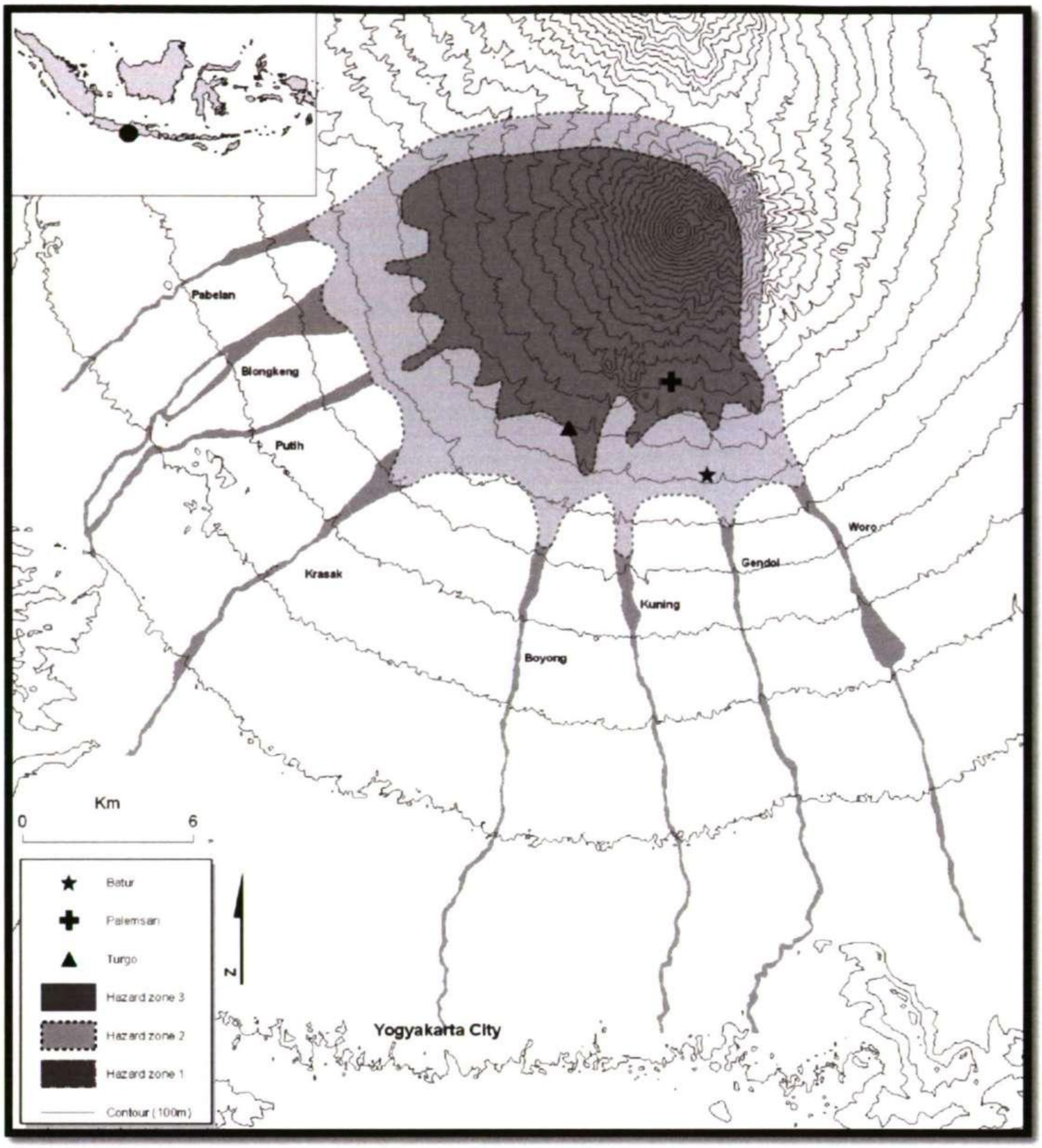


Figure 6.6: The official hazard zones of Mt Merapi, Hazard zone 1 shows an area that could be affected by lahars therefore this zone follows the main river systems. Hazard zone two delineates the region that could be affected by pyroclastic flows, lava flows, and lahars and hazard zone one shows the region that could be affected frequently from such hazards as pyroclastic flows, lava flows, and ejected material. Source: Hadisantono *et al.* (2002). A digital version of the original 2002 hazard map is provided in Appendix 1.

Pardyanto *et al.* 1978	Hadisontono *et al.* 2002
Forbidden or Closed Zone: Pyroclastic flows and should be permanently abandoned (Yellow)	**Hazard 3**: Frequently effected by pyroclastic flows, lava flows, rockfalls and ejected rick fragments. Permanent settlement is not allowed.
First zone – Glowing bombs but not pyroclastic flows (Blue)	**Hazard 2:** Effected by pyroclastic flows, lava, lahars and ejected material
Second zone – Lahars only (red)	**Hazard 1:** Effected by lahars/floods, ashfall and ejected rock fragments.

Table 6.1. A comparison of the zones, hazards and descriptions listed for 1978 and 2002 hazard map of Mt Merapi.

The following desk study will therefore examine the maps produced by Thouret *et al.* (2000) in conjunction with other hazard information from the JVGR special publication and also from more recent hazard assessments carried out at Mt Merapi. GIS provides the tool for collating all available information for Mt Merapi in order to demonstrate the potential hazard impact from Mt Merapi produced from both large and small eruptions. This process also demonstrates how GIS can be used as a database for past and future research findings carried out at Mt Merapi.

6.3.2. Hazard Map Design in GIS: VEI 2-3.

The most dangerous hazards at Mt Merapi during a small eruption are pyroclastic flows and lahars. Pyroclastic flows are the most dangerous phenomena due to their highly variable extent and volume (Thouret and Lavigne 2005, Camus *et al.* 2000, Newhall *et al.* 2000). As previously noted the existing hazard map only takes into account a limited eruptive history within the last 100 years, and according to this map the northern flank of the volcano has not been directly affected by any type of volcanic hazard during this time. But according to the interviews taken in Selo the residents in the north west recollect pyroclastic flows occuring in the 1950's that devastated that area and destroyed the hamlet of Pencar. In light of this, available historical records of pyroclastic flows 'footprints' were overlain in GIS to test whether any pyroclastic flow events had impacted the northern region of the volcano within the last 100 years. Figure 6.7 shows that have been at least four pyroclastic flows that travelled to the north, evidence that expelled pyroclastic material had travelled outside the existing northern hazard zones during the past 100 years. In addition Figure 6.7 indicates that the 1930, and 1911, 1913 and 2006 eruptions have produced pyroclastic flows that have travelled outside hazard zone 3 and in some cases beyond hazard 2. The 1930 eruption produced particularly large pyroclastic flows that devastated a large area destroying 13 settlements, whilst the 1913 eruption produced pyroclastic flows that travelled to the south corresponding with recent activity (Voight *et al.* 2000a). The 'footprints' were taken from a publication produced by the Directorate of Volcanology and Geological Hazards Mitigation and yet it seems they did not take into account some events whilst including others in their final assessment. By not including the pyroclastic events that have impacted on the north western regions they have influenced the sense of safety in this area and arguably have increased the northern people's vulnerability.

Thouret *et al.* (2000) advises that another deficiency in existing hazard maps were that they did not take into account any variability in hazard extent. Because of this uncertainty a 'buffer' zone has been created around the pyroclastic flows trace. In Figure 6.7 the buffer is set at 500 meters and is not topographically controlled because of the possibility for surges to over top topography. The buffer zones demonstrates that the existing hazard zones do not clearly define the potential pyroclastic flow run-out from a small to moderate dome collapse event at the volcano, and recommendations to extend the third and second hazard zone, particularly in the north, are required. In light of the recent 'shift' in collapse direction as noted by Charbonnier and Gerisser (2008) (as discussed in section 3.1.4) it is also advisable to extend the zone in the southern region also.

Volcanic hazard assessment needs to take into account more than just the most frequent and dangerous hazards. Other hazards such as lahars, tephra fall and ballistic projectiles can also be extremely dangerous and therefore need consideration.

The 2002 hazard zone uses the work of Andreastuti *et al.* (2000) to estimate a zone of tephra fall. In order to test this isopach maps designed by Andreastuti *et al.* (2000) were traced in GIS to measure the distribution of average thickness of fall deposit.

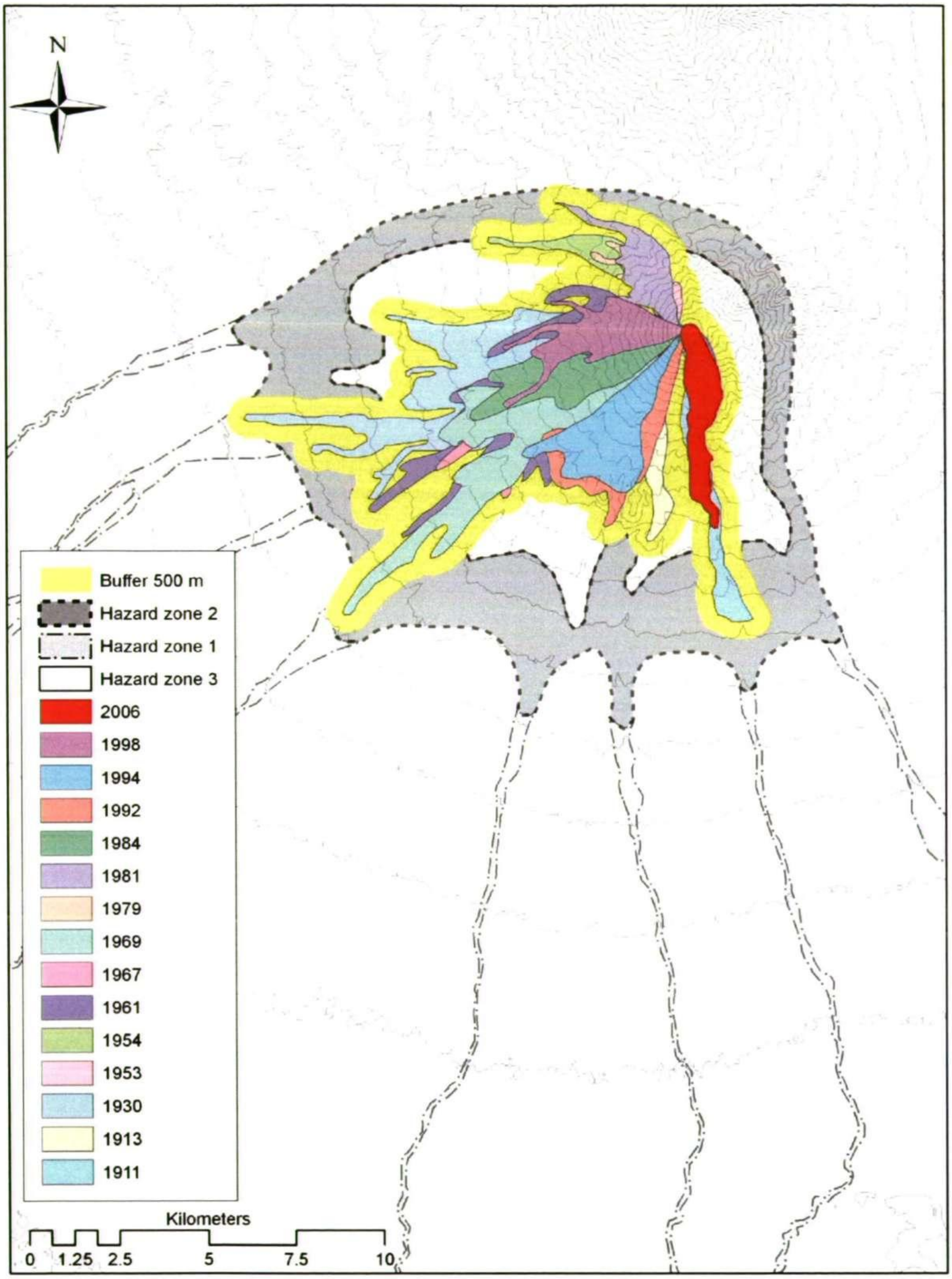


Figure 6.7: This demonstrates that pyroclastic flows from the past 100 years of eruptions could extend beyond exiting zones, especially to the northwest and south. Source: Data modified in ArcGIS derived from Ratdomorpurbo *et al.* (2006), and courtesy of Search and Rescue Yogyakarta.

Figure 6.8 demonstrates this collation and also shows that the tephra fall delineation and accompanying description on the 2002 map is sufficient. Andreastuti *et al.* (2000) notes that these tephra deposits range in size but are generally over 4 mm and figure 6.8 demonstrates that the depth of ejected material can be up to 10 cm thick at a distance of 10 km from the summit, 15 cm thick at 7 km, and 20 cm thick 5 km from the summit. The United States Geological Survey (USGS) describe fall deposits between 5 and 10 cm as extreme and that this thickness of ash, lapilli and bombs can cause severe damage to infrastructure, reduced visibility and respiration problems (Horwell and Baxter 2006, USGS 2008). In the immediate to long term this amount of material or less will destroy crops and lead to livestock starvation and digestive problems (Wilson *et al.* 2007, USGS 2008). Even a thin layer of ashfall can disable a settlement and impair the evacuation of residents. Larger ejected material such as bombs and blocks can reach over a metre in diameter and have been recorded to travel 9 km from the summit during an explosive event (Francis and Oppenhiemer 2004, Naranjo and Polanco 2004).

The lahar events are the most common hazard events at Mt Merapi and can reoccur for long periods of time after an eruption (Thouret *et al.* 2000). According to Lavigne *et al.* (2000a) cold post-eruptive events from small eruptions (VEI 2) have been recorded occurring for up to four years after the eruption. There have been numerous lahar events at Mt Merapi because of its high eruption rate and intense rainy season between November and April. These rain-triggered lahars can be extremely dangerous and have killed 76 people since the 1900s. The most fatal event occurred in the Krasak River system in 1976 when 29 people died. These lahars are relatively fast moving with an average velocity of 5-7m/s at 1000m in elevation (Lavigne *et al.* 2000b). They are a significant threat especially considering that as the lahar loses energy the flow the lahar transforms into a hyperconcentrated flood containing 60-80% water content. These flood events can then travel downstream for many kilometres causing far reaching damage.

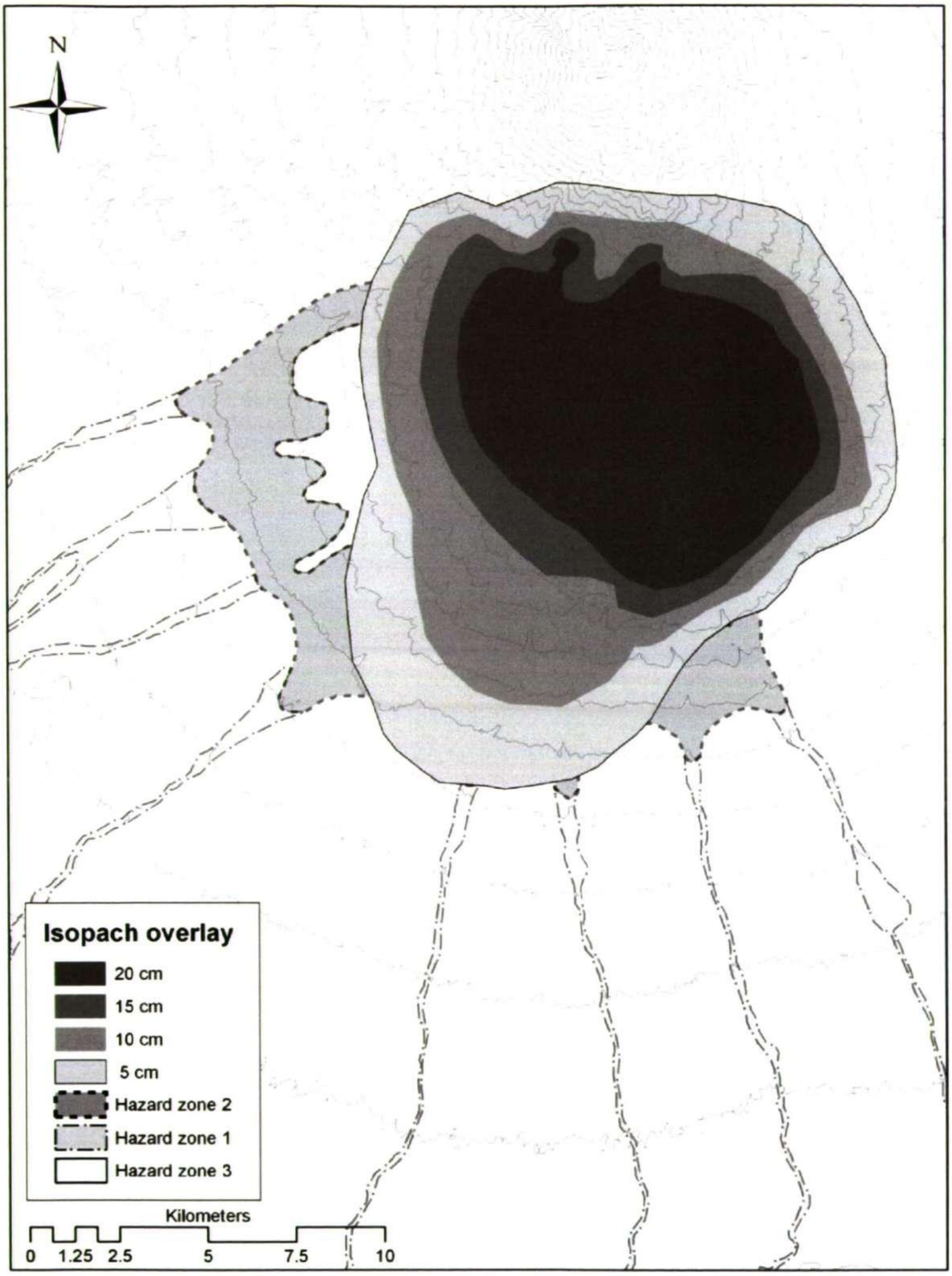


Figure 6.8: A simple overlay of ashfall isopachs for a dome collapse event at Mt Merapi over the official 2002 hazard zones. The resultant isopachs have been designed from two isopach maps modified from Andreastuti *et al.* (2000).

On average channelled lahars like those in the Gendol River system travel up to 14 km from source but the hyperconcentrated flow from these events could travel much further perhaps up to 20 km reaching Yogyakarta city outskirts (Thouret and Lavigne 2005).

From the re-evaluation of secondary sources the hazards that could be produce from a small to moderate eruption (VEI 2-3) at Mt Merapi are varied in frequency and potential impact. By combining all these different resources onto one GIS map enables a basic re-assessment of the potential hazards, and highlights the shortfall of the existing hazard maps. By combining the secondary data it is possible to sketch out the spatial impact of a VEI 2-3 eruption. Figure 6.9 is an example of how secondary data can delineate hazard zones. The red zone corresponds to pyroclastic flow footprints that have occurred during the last 100 years whilst the orange zone is region that could be impacted upon by moderate ash fall, long run out pyroclastic flows, lahars, and lava flow avalanches. The green region delineates an area that could be impacted upon primarily by ashfall but in the case of a large VEI 3 eruption could experience pyroclastic flow run out, lahars and flooding. Although at present this map is not adequate or inclusive to be used as an official hazard map it does exemplify the potential impact of the just a small eruption, and unfortunately shows that the existing 2002 hazard map underestimates the impact of such an eruption.

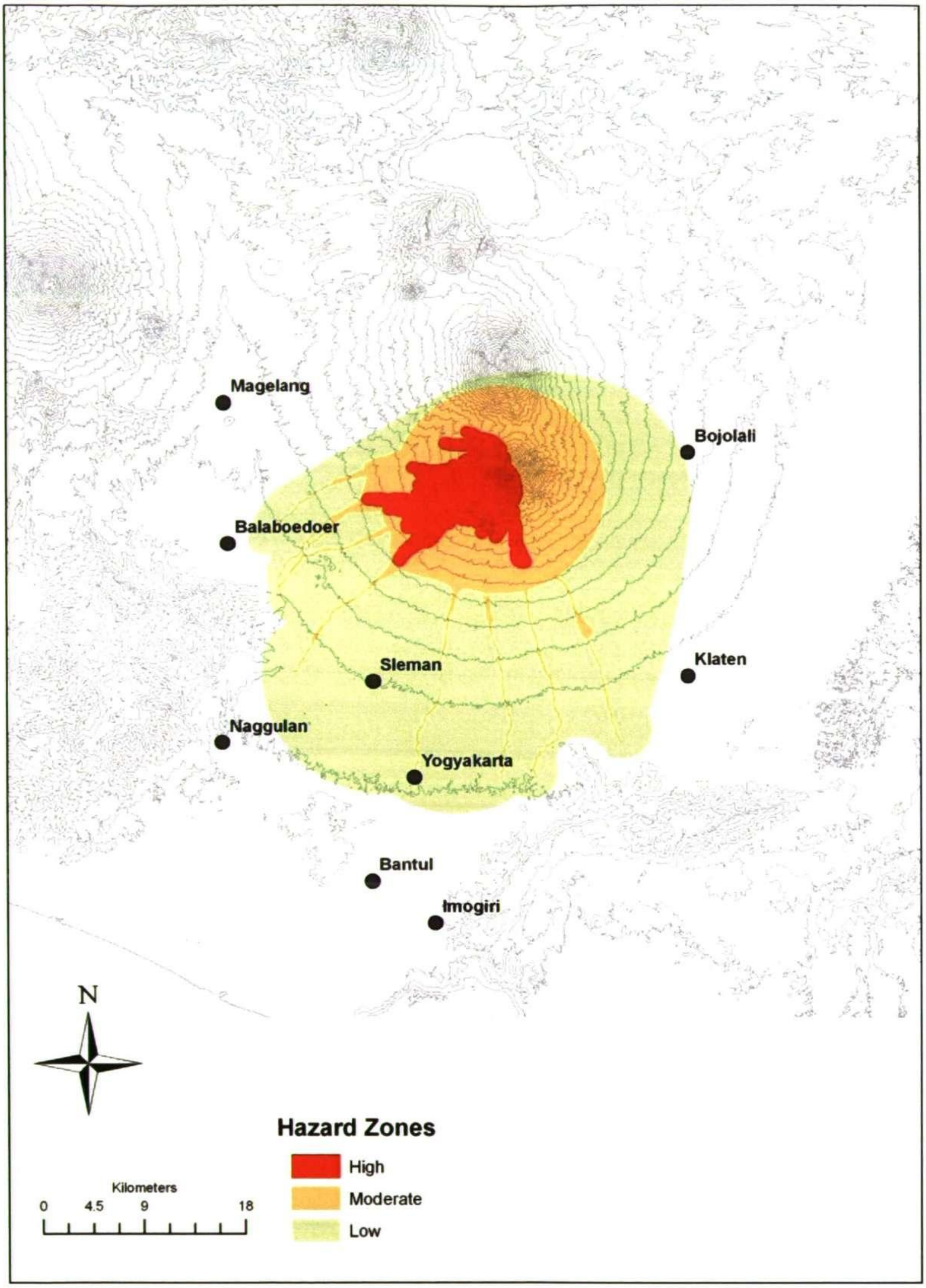


Figure 6.9: Redesigned hazard map for Mt Merapi incorporating new data from 2006 eruption and from a variety of secondary sources.

6.3.3. Hazard Map Design in GIS: VEI 4.

Plinian eruptions (VEI 4) are described by Francis and Oppenhiemer (2004) as the eruptions that make history. They are devastating sustained discharges of material that could continue for hours and produce eruption columns that burst through the stratosphere reaching up to 35 km in altitude. These eruptions are less frequent occurrences at Mt Merapi, yet the devastation and impact of a Plinian eruption in this highly populated region would be catastrophic. There is only one map that depicts the potential impact of a VEI 4 eruption from Mt Merapi and that has been simplified and overlain on the existing 2002 hazard map for scale, in Figure 6.10. It delineates two main areas; those affected by large lahars and floods and large pyroclastic flows.

By incorporating this map within the GIS with settlement data for the region it has been estimated that 1800 settlements are situated within the pink pyroclastic hazard zone alone. Assuming that these settlements are relatively small mountain hamlets such as Batur or Pelemsari each settlement would have a population of approximately 300 people, this would mean that a minimum of half a million people live within this zone.

This simplified map does not show the tephra impact from such a large explosive eruption, but Thouret *et al.* (2000) estimates that >150 000 km^2 would be covered in ashfall and if the eruption was similar to the sub-Plinian event in 1972 ashfall could be found over a 400 km trend in the dominant wind direction.

The sheer scale of such an eruption would devastate the entire region and have nationwide implications. But Thouret *et al.* (2000), Voight *et al.* (2000a) and Newhall *et al.* (2000) also comment on a larger eruption than Plinian that may have occurred during the destruction of Old Merapi. This is described by Throuet *et al.* (2000) as the worst-case scenario and is estimated to occur every 2000-7000 years. This massive eruption would first involve a sector collapse to the southern flanks that could induce a devastating lateral blast and debris avalanche.

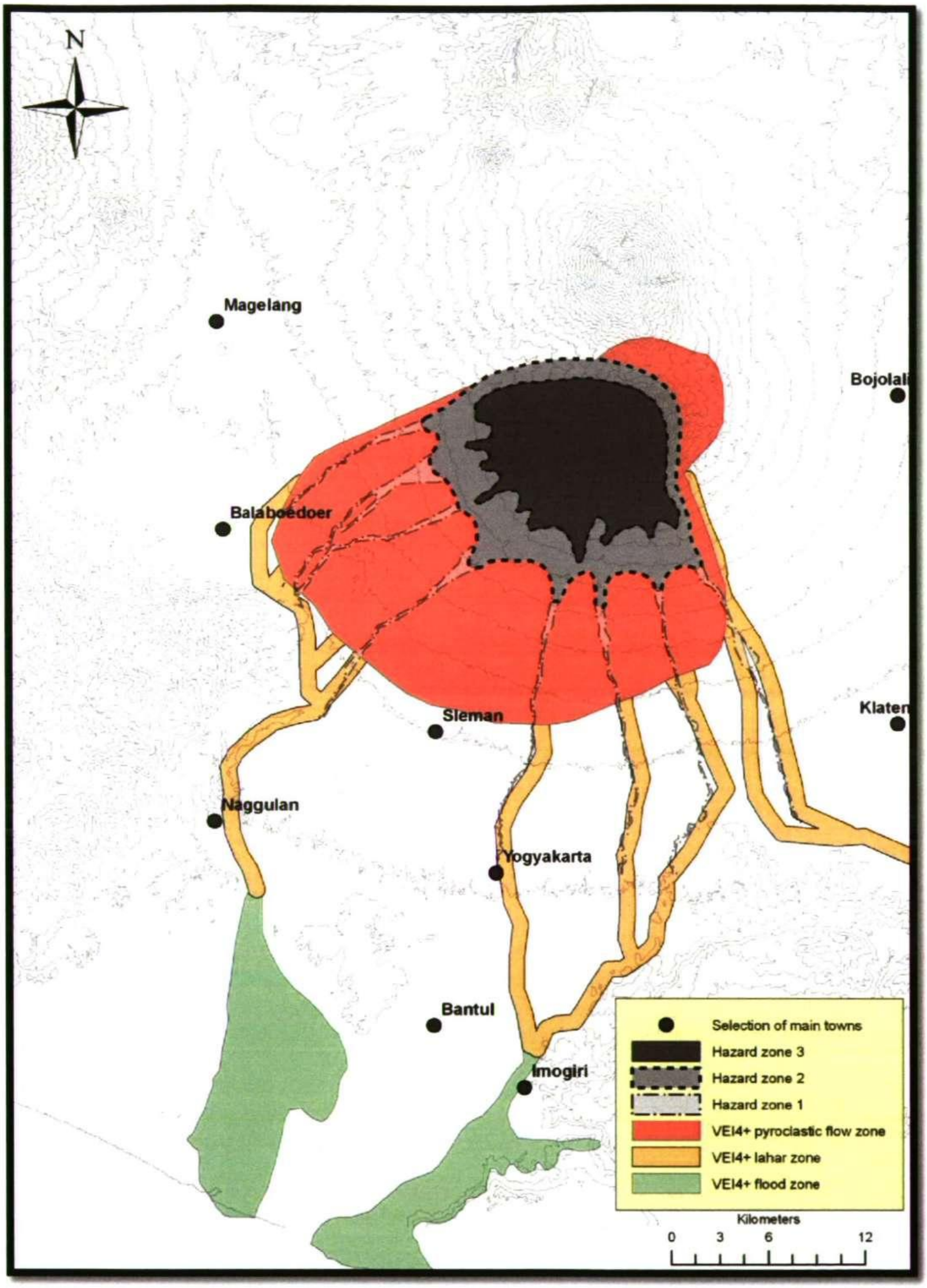


Figure 6.10: This map delineates the main hazards that would affect the special province of Yogyakarta, Klaten, and Magalang districts if a VEI 4 eruptions occurs at Mt Merapi. The 2002 hazard map is also illustrated in grey whilst the pink zone represents the area directly impacted by pyroclastic flows, the orange shows the areas potentially impacted by lahars and the green are areas affected by floods (hyperconcentrated flows). Yogyakarta city (population over 400 000) is in direct flow path of large lahars. Source: derived from Thouret *et al.* (2000).

6.4. Risk mapping.

The previous section demonstrated that although the physical hazards at Mt Merapi are reasonably well recorded, the social impacts of an eruption are not. Wisner *et al.* (2006:5) describes 'Disasters (as) a complex mix of natural hazards and human action', and the resultant interaction of the social and physical elements of disaster is referred to risk. Risk is discussed in chapter 2 and defined by the International Strategy for Disaster Reduction (ISDR 2004:1) as:

> The probability of harmful consequences, or expected losses (deaths, injuries, property, livelihoods, economic activity disrupted or environment damaged) resulting from interactions between natural or human-induced hazards and vulnerable conditions.
>
> Conventionally risk is expressed by the notation **Risk = Hazards x Vulnerability.** Some disciplines also include the concept of exposure to refer particularly to the physical aspects of vulnerability.
>
> Beyond expressing a possibility of physical harm, it is crucial to recognize that risks are inherent or can be created or exist within social systems. It is important to consider the social contexts in which risks occur and that people therefore do not necessarily share the same perceptions of risk and their underlying causes.

Over the last decade risk mapping to aid disaster and hazard decision-making has been increasingly designed using GIS, and because GIS requires numerical inputs the data used is therefore quantifiable (Zerger and Smith 2003). The ability to layer different thematic maps enables the designer to amalgamate all the different aspects of vulnerability into one concise product. As previously noted, GIS is a tool that can be used during all stages of the disaster management cycle from preparedness to reconstruction (van Westen 2002, Cutter 2006), but it is during the preparedness stage where risk mapping is essential.

Recently, GIS has been used to estimate risk in volcanic regions, for example, Lirer and Vitelli (2008) used GIS to produce risk maps for Mt Vesuvius, Italy, potentially the most dangerous volcano in Europe. They layered data showing land value and use, administrative boundaries, building density, population, population density, lava flow inundation maps and number of houses. Although this was a self-confessed relatively un-inclusive assessment of risk, it did demonstrate the potential for GIS as a risk evaluation and monitoring tool. Lirer and Vitelli (1998) implied that their evaluation of risk at Mt Vesuvius lacked the incorporation of more complex and qualitative social data and declared that, unlike their work, 'research on risk is multidisciplinary'. Indeed, Zerger and Smith (2003:125) also comment that a lack of studies that incorporate the political, social and human dimensions 'may be a greater barrier to successful implementation of a GIS than the technical impediments commonly presented'. Risk mapping and evaluation should therefore include all elements of risk. But is this possible within a GIS format that is based on quantifiable numerical data when some aspects of vulnerability are not considered easily quantifiable? One of those aspects is the role of culture.

6.4.1. Previous Risk mapping at Mt Merapi.

In contrast to the reasonably large amount of research carried out on the hazards and eruption processes at Mt Merapi, there has been little work focussing on vulnerability and risk. Thouret and Lavigne (2005) note that there is a need for a holistic hazard and risk assessment, and they therefore produced a basic risk assessment for the volcano. Their assessment was carried out at two scales, one small-scale analysis of the entire volcanic region using GIS, and one at a large scale, a micro-zonation focussed on lahar hazard based on a previous study carried out by Lavigne (1998, 2000). Their study collated hazard maps, population vulnerability data, and potential loss information (property). Although they noted that cultural factors can reduce or amplify the effects of natural phenomenon, their indicators of vulnerability are based on key conventional indicators such as population density, access to transportation and hospitals. A village survey was carried out in 1998 in order to collect the relevant information, and remarkably, collected data from 296 villages, an astonishing feat in this logistically difficult environment.

Figure 6.11 is this vulnerability map and implies that the residents of the southern flank are less vulnerable than those living in the west, east and significantly the north. In fact it is the northwest that has a high risk (the combination of hazard and vulnerability). To explain this Thouret and Lavigne (2005) propose that, in addition to those in highly populated regions, the people who are most vulnerable are those who live in remote villages on the upper slopes (>600 m), where traditional bamboo housing still exists. One of the most important aspects of vulnerability highlighted in their study was access; access to transport and road conditions that can improve or impede evacuations. As experienced in 2007 during this research, access to the north-western villages was still difficult 10 years after Thouret and Lavigne's survey, as the roads are in poor condition and cross potential lahar pathways (rivers). Although the 1998 survey might now be considered 'out of date' some aspects are still be relevant today and it should not be entirely discounted. However, vulnerability patterns do change over time and so an official up-to-date vulnerability assessment that takes into account all elements of vulnerability at Mt Merapi is still required. But the question remains: how to incorporate seemingly unquantifiable social information into a vulnerability and risk map?

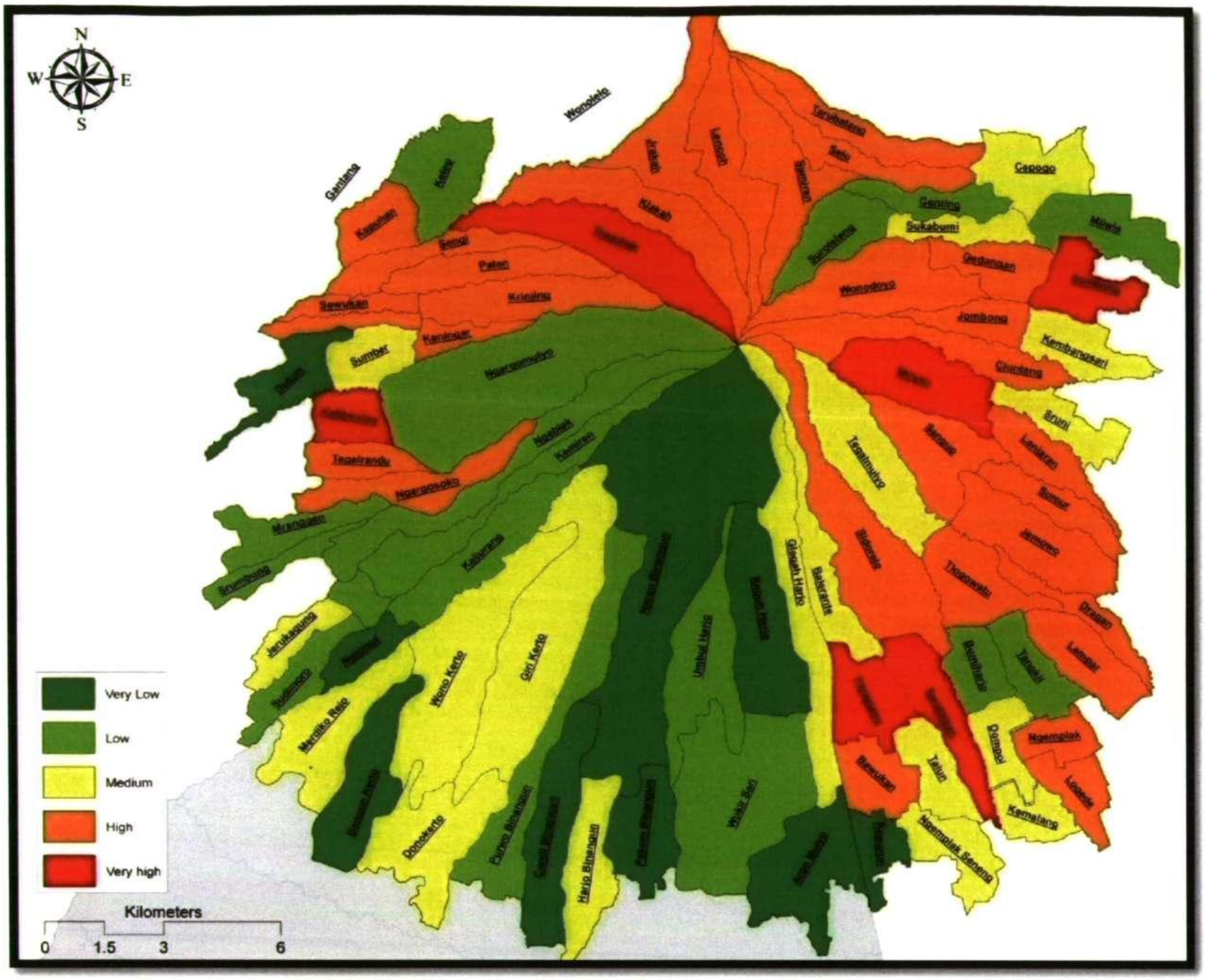


Figure 6.11: A vulnerability map for Mt Merapi, designed from quantitative data collected in 1998 and analysed through a ranking system. Source: derived from Thouret and Lavigne (2005).

6.4.2. Quantitative and Qualitative risk analysis for natural hazards.

To recap briefly, the majority of volcanic risk maps are based on quantitative statistical data that can be computed easily and will produce ordered and measured results. These results can then be manipulated in GIS in order to visualise zones of vulnerability in comparison to zones of hazard. The core aspects of vulnerability that are commonly used to assess risk are population density, morbidity, literacy, poverty, age, gender, and disability (Cutter *et al.* 2006, Wisner *et al.* 2006, Trujillo *et al.* 2000). But as chapter 5 indicates, it is not only easily quantifiable aspects of vulnerability that cause a community to be at increased risk.

Cultural values or/ and a willingness to cooperate, trust, risk perception and attachment to place can all increase, or in some cases decrease, vulnerability and yet they are rarely included in quantitative vulnerability appraisal because they are more difficult (or in some case perhaps impossible) to quantify and display (Cutter *et al.* 2006). Ferrier and Haque (2003)

discuss the integral quantitative nature of risk assessments and explain how traditionally assessments are based on probability and equations. They go on to explain that this purely measurable probabilistic take on vulnerability and risk it perhaps insufficient. Although it is vital to examine the statistical socioeconomic indicators King (2001) warns that there are disadvantages to collecting and using vast amounts of statistical demographic data. Using large databases leads to problems relating to scale, data decay (aging of data), relevance and most importantly 'the way in which 'our' definitions of community and vulnerability affect our selection of indicators' (King 2001:148). Young (1998) urges that a vulnerability assessment must include both socio-economic data and knowledge of the environment and local hazard (hazard perception). Yet as King (2001:152) suggests it is the data that is 'easily and cheaply available' and that is easy to 'aggregate, manipulate and analysis' that are most often used to discern vulnerability. King (2001) does acknowledge the comments of Buckle (1999) who proposes that the complexity of society automatically creates categories of vulnerability such as management capacity, access to services, pre-existing stress factors and cultural attitudes and values.

So, despite improvements in statistical analysis and visualisations of the results, people still refuse to evacuate during a crisis. What the 2006 eruption of Mt Merapi demonstrates is that although there is a substantial amount of monitoring and hazard analysis at Mt Merapi, adjusting and improving the hazard map, it is the seemingly unquantifiable characteristics of the local people that motivate their reactions during a crisis. This means that the ‘conventional’ quantified methods of risk analysis may not be as usefully applicable at Mt Merapi as initially thought.

6.5. A new concept: mapping qualitative vulnerability.

The qualitative theories developed in chapter 5 have the potential to guide disaster managers during a volcanic crisis to areas that are at increased vulnerability. The remainder of this chapter will explore how these informative findings might be incorporated into risk assessments. What emerged from Chapter 5 was the realisation that various social characteristics are interlinked, each influencing one another and collectively shaping a local community’s reaction to the volcanic threat. Attempting to ‘map’ these elements of vulnerability has not been done before at Mt Merapi, nor to my knowledge has it been attempted in any region affected by natural hazards. This section will introduce the concepts that will subsequently be practically applied in the following chapter. It is important to acknowledge that this facet of disaster management at Mt Merapi, by examining a holistic vulnerability, is a difficult and contentious approach.

6.5.1. GIS and social sciences: Qualitative data in a quantitative system.

In social sciences GIS has traditionally been used to display geospatial data relating to purely quantitative information. Maps displaying population patterns, or gender distributions are extremely useful yet arguably detached from their subjects (Kwan and Knigge 2006, McLafferty 2002, Pavlovskaya 2006). In other words, quantitative data does not communicate the ‘whys’ and ‘hows’ of that information. It is therefore the qualitative knowledge that is essential in fully understanding, for example, why a population is distributed in certain patterns or how it is possible that gender or age distribution is clustered. Qualitative data can therefore provide the substance behind a map and as Pavlovskaya (2006:19) argues, that although the raw data has to be quantifiable, manipulations of data within GIS is dominantly a qualitative process. She argues that the simple mathematical processes require complex 'spatial imagination skills and logical thinking'. Steinburg and Steinburg (2006) agree, explaining that GIS provides an excellent opportunity to integrate both types of data into one comprehensive data base. They propose that GIS can be used to display data collected through a range of qualitative methods, such as participant observation and oral histories. This is because most human activity has some kind of spatially to it. Over the last ten years, human geographers and social scientists have begun to use GIS to display and analysis qualitative data sets. By displaying social data spatially otherwise unseen patterns emerge and to display this data in a map form is a powerful tool of communication.

A few geographers have utilised GIS in order to produce dynamic cross-disciplinary research areas. In particular feminist geographers, who have typically advocated qualitative methodologies, use GIS as a tool for representing women's daily experiences and geographical accessibility (McLafferty 2002, Kwan 2002, Pavlovskaya 2002, 2006). Feminist geographers have seen GIS as a way of empowering women activists and displaying gendered spaces in modern society. McLefferty (2002) describes how GIS was used to explore spatial clustering of breast cancer on Long Island, New York. This study was implemented by anxious residents and incorporated door-to-door interview information. This case study shows the potential empowerment and public participation created through GIS.

The infiltration of GIS into human geography was not a smooth process. During the 1990's many scholars critiqued GIS and its users on grounds of positivism, epistemological issues, power imbalance, methodological exclusion, ethics, surveillance, privacy and language divides, to name but a few issues (Schuurman 2000, 2004). GIS is by no means a pure subject of knowledge making - there are ethical and methodological considerations that are integral to its design. GIS has even been described as strengthening the 'grid of control' on society (Haraway 1991, Pickles 1995) and because of this researchers need to be more open and accountable about their data gathering and manipulations (Knigge and Cope 2006). Accountability and responsibility is certainly the main issue described by Smith (1992) when he implies that geographic technologies are responsible for the deaths of 200 000 Iraqi during the first Gulf war (1990-1991). Understandably, the 'science wars' during the 1990s (described thoroughly by Schuurman (2000)) and negative case studies, such as the Smith's (1992), have led to increased ethical awareness in GIS research. Yet GIS systems have positively contributed to qualitative research and the critiques have assisted in enhancing its application.

Examples of qualitative data integration within GIS (that have provided a guide for this research project) are given by Knigge and Cope (2006) and Steinburg and Steinburg (2006). Knigge and Cope (2006) adapt grounded theory in order to integrate qualitative data within GIS. This is possible because grounded theory and GIS have similar processes, as both techniques allow researchers to code data in order to reduce data size and analyse patterns (Miles and Huberman 1994, Stauss 1989). Knigge and Cope (2006) explain that grounded theory and GIS are compatible because both are exploratory, iterative and deal with the particular and the general. Both techniques allow the researchers to equally look at the small and large issues within a spatial dimension. In a grounded theory approach Steinburg and Steinburg (2006) advocate that socio-spatial grounded theory using GIS can be an effective visualisation tool as long as the ethos of grounded theory is adapted to incorporate GIS from the initial data collection. They provide a step-by-step guide to using grounded theory methodologies such as interviews or participant observation within GIS. They and other researchers have also suggested that GIS visualisations can be enhanced qualitatively through sound clips, video, 3D models photographs, and other multi-modal methodologies that are becoming increasingly popular within qualitative data collection and representations (Knigge and Cope 2006, MacEachen 1994).

Qualitative data collection allows for imaginative data analysis and using GIS can be a catalyst for reporting results in an innovative and instructive format. Because of this GIS can be used to create maps based on the data retrieved from the field seasons and provide maps that demonstrate any relationships between culture and hazard perceptions at Mt Merapi.

6.6. Summary.

This chapter has attempted to bridge the gap between the physical examination and representation of hazards at Mt Merapi and the qualitative assessment of information that emerged from Chapter 5.

To date, physical hazard assessments have been the priority at Mt Merapi, and manifest as the series of hazard maps produced by the Directorate of Volcanology and Geological Hazards Mitigation and other researchers. Although, Mt Merapi is still one of only a handful of Indonesian volcanoes that have a hazard map, it has basic limitations and underestimates the potential impact of a moderate eruption, let alone a larger explosive eruption.

Furthermore, there is no official vulnerability or risk assessment that exists for Mt Merapi and yet this is vital for prioritising action before, during and after an eruption. The findings from chapter 5 indicate that a conventional vulnerability assessment might not be sufficient at Mt Merapi because of the many complex social elements that are influencing vulnerability. To confront this, this chapter has laid the foundation for the next stage of this research, to incorporate cultural information into a GIS database underpinning conventional quantitative risk assessments in order to more confirm whether culture is making the Mt Merapi residents more or less vulnerable.

Chapter 7: Mapping cultural intensity.

7. Introduction.

The aim of this chapter is to map the cultural intensity surrounding Mt Merapi. Although the data collected in 2007 indicated that there appears to be a mix of factors affecting motivation of people at Mt Merapi, it is their cultural beliefs that are difficult to incorporate into a quantitative risk map. By attempting to transform the qualitative information it may be possible to incorporate cultural vulnerability within conventional quantitative risk assessments in volcanic regions.

It is first necessary to determine whether local knowledge is causing an increasing or decreasing in residents' vulnerability. From the first field season (chapter 5) the suggestion emerged that as traditional beliefs and customs intensified, a reluctance to evacuate during a crisis seemed to increase, so implying that traditional culture increases the vulnerability of local people. To examine this possible link, cultural intensity (the degree of cultural customs, faith and local knowledge) needs to be compared with evacuation failure information, and one way to do this is to map this information within GIS.

This chapter explores this idea through a spatially extensive survey of settlements surrounding the volcano (carried out in 2009) using semi-structured interviews and converting the resultant qualitative data into GIS compatible information. GIS software enables the user to visualize and compare various suppositions in order to support or discount a hypothesis. In other words, the visualisation of spatially variant social phenomena, such as culture or hazard perception, provides an increased appreciation of relationships between data patterns and improves hypothesis testing (Schuurman 2004, 2008). Therefore, in this chapter, mapping relates to the visualisation of traditional beliefs and refusal to evacuate (or evacuation failure). Visualisation of the 2009 survey data makes it possible to evaluate how culture correlates with evacuation failure, and whether the traditional beliefs generate a more resilient or a more vulnerable community.

7.1. Taking the analysis forward by returning to the field.

> Cultural analysis is guessing at meanings, assessing the guesses, and drawing explanatory conclusions from the better guesses, not discovering the Continent of Meaning and mapping out its bodiless landscape. (Geertz 1973:20).

As this quote from Geertz (1973) highlights, ethnography and cultural analysis relies upon the researcher's interpretations of behaviour, and captures the essence of what the following section of this project attempts to undertake. Taking account of 'new' interview data from a second field season, this chapter seeks to map customs at Mt Merapi. Designing a process that could map these elements of culture potentially allows more qualitative aspects of vulnerability or resilience to be integrated within conventional risk analysis.

In Chapter 5, along with some key concepts, two core themes emerged from the analysis of the interview and workshop data and personal observations. These themes are:

1. Hazard perception (related to the informants' experience) appeared to vary according to geographical location on the volcano.
2. A willingness to evacuate during a volcanic crisis seems to relate to both location (experience) and faith in traditional beliefs and customs (the 'intensity' of culture).

Because these two ideas are linked by the common theme of geographical location, these patterns could be mapped using GIS and the spatial relationships analysed.

Mapping cultural intensity for disaster management is distinctive to this project and could highlight the importance of cultural reactions to geological hazards. However, although mapping aspects of vulnerability is a reasonably well known and an applied process (e.g. Marrow 1999; Cova and Church 1997; Bankoff *et al.* 2004), mapping cultural vulnerability is not.

7.1.1. The geography of hazard perception and influence of culture.

Chapter 5 concluded that at Mt Merapi local hazard perception was influenced by location, specifically the experience of different hazards, with varying levels of loss apparently depending on the location of their village. From the brief pilot survey (carried out in September 2007) it appeared that those in the north had little direct hazard experience and so believed that they were safe and protected, whilst those in the west appeared to have a 'better' hazard perception and were more willing to prepare and evacuate during an eruption. It seems that hazard perception and hazard experience influences willingness to evacuate. Maps visualising this relationship would indicate the level of cultural influence in this region and therefore provide a template to aid disaster preparedness. If this relationship holds then local authorities would be able to concentrate their hazard awareness and evacuation efforts in regions that are less likely to self evacuate or follow instructions.

Chapter 2 discussed the concept that the more willing a community is to prepare for a disaster and to follow instruction, the less vulnerable they are. Conversely, if a community is not willing to evacuate (like some villagers in Batur and Pelemsari), then regardless of their quantitative factors of vulnerability (such as literacy, age, or gender), they will automatically increase their vulnerability. Mapping out cultural intensity and evacuation failure using GIS could test whether elements of culture increase or decrease vulnerability and is original to this project.

Mapping culture, however is not a straightforward or unproblematic. As Geertz (1973) implies in the opening quote, cultural analysis does not easily lend itself to traditional cartographic mapping exercises, yet mapping culture has been attempted by many historians, social scientists and geographers. Approaches to mapping culture vary from more traditional cartography through to more sophisticated mental maps and lexical mapping of emotion (Heider 1991). For example, Mercer (1997:11) describes cultural mapping as 'the identification of local cultural resources', he goes on to list the features that could be 'mapped' including specialist crafts, local traditions of sociability, and anthropological heritage. Mercer (1997) has used local customs to map out certain characteristics of culture and the idea of taking aspects or key indicators (or codes as in grounded theory analysis) of culture is one that could be used in this study.

Cashman and Cronin (2008) specifically use oral histories in order to better undertand societal response to volcanic hazards, yet findings noted in Section 5.2.7 imply that the local oral history relating to Mt Merapi is unexpectedly short. The oral histories appear to be generational lasting no longer than 60 years coinciding with the same length of time Indonesia has had its most recent independence, and the eruptive history included in the official hazard map. Collectively these political and social factors have shaped the short oral eruption histories that reinforce a false sense of safety. It is necessary therefore to use indicators of culture that are longer lasting and have been passed down through the generations beyond the political turmoil and recent scientific maps.

To examine the practical application of the ideas noted above and to aid the design of interview questions, GIS techniques required and key aims of the survey, a pilot mapping exercise was undertaken.

7.1.2. Pilot maps: initial ideas.

A pilot culture map was created using observations taken during the 2007 field season, when briefly visiting the northern and western flanks. These observations, or indicators, were then categorised and quantified according to 'levels' of culture. For example, if a region regularly carries out ceremonies, that is more than two times a year and individual households hold regular ceremonies directed specifically at appeasing the volcano then this region is allocated a high score from a range of 1 – 5. In addition if a region has a strong tradition of storytelling relating to the volcano and they have incorporated their own village and community within these stories then they also receive a high score. Table 7.1 gives the full categories with explanations. These categories are very simple at this preliminary stage and are used only to develop the theoretical and practical implementation for developing a culture map.

Score	Description
1	Does not know any stories about the volcano or hold any ceremonies relating to the volcano.
2	Has knowledge of traditional stories but does not hold any ceremonies relating to the volcano.
3	Has knowledge of the traditional stories and believes them to be true but does not hold regular ceremonies for the volcano.
4	Has knowledge of the stories believes them and has incorporated their village within the stories. Holds ceremonies but not regularly.
5	Has knowledge of the stories believes them and has incorporated their village within the stories. Holds regular ceremonies as a community and as households.

Table 7.1: Pilot survey scoring system for cultural intensity.

This scoring system is used to transformation the indicators into numerical data. The score increases as the faith in local knowledge and application of customs increase. Once the scores had been allocated, and then processed using GIS, the points were interpolated so that 'missing' data could be predicted and a smooth continuous map produced (Figure 7.1). Under examination the pilot survey map indicated that those living in the south and north have an increased cultural intensity than those in the west and east. In contrast, Figure 7.2, created using demographic statistics only, from Utami (2008), designates the southern regions as having a low vulnerability.

Assuming that an increase in culture increases vulnerability, a comparison of Figures 7.1 and 7.2 demonstrates that using a purely quantitative vulnerability analysis could provide an unrealistic result. On the southern side of Mt Merapi communities regularly hold ceremonies and have a strong oral history. These communities evacuated on a 'part-time basis' during the 2006 volcanic emergency (see chapter 5) implying a moderate to high culturally vulnerable community and yet the quantitative social vulnerability score is very low.

Comparisons of these basic maps highlight the need for a more robust dataset to confirm whether traditional beliefs and customs do indeed make the communities at Mt Merapi more or less vulnerable. The key to this is to design a method by which to coherently integrate qualitative and quantitative elements of vulnerability.

The pilot map exercise revealed that what is important in the process of mapping is the range of indicators (codes) and the methods by which 'codes' are transformed into quantifiable data. The method of scoring needs to be concise and designed relative to the cultural practices at Mr Merapi, therefore the ranking categories can only be designed after the data has been collected. Moreover, scoring appears to be subjective, and so by allowing the informants to identify regions they believe are more culturally intense or more likely to refuse to evacuate may reduce that bias. Equally, in order to improve the reliability and validity of the data interpolation it is necessary to undertake a survey covering as much of Mt Merapi as possible.

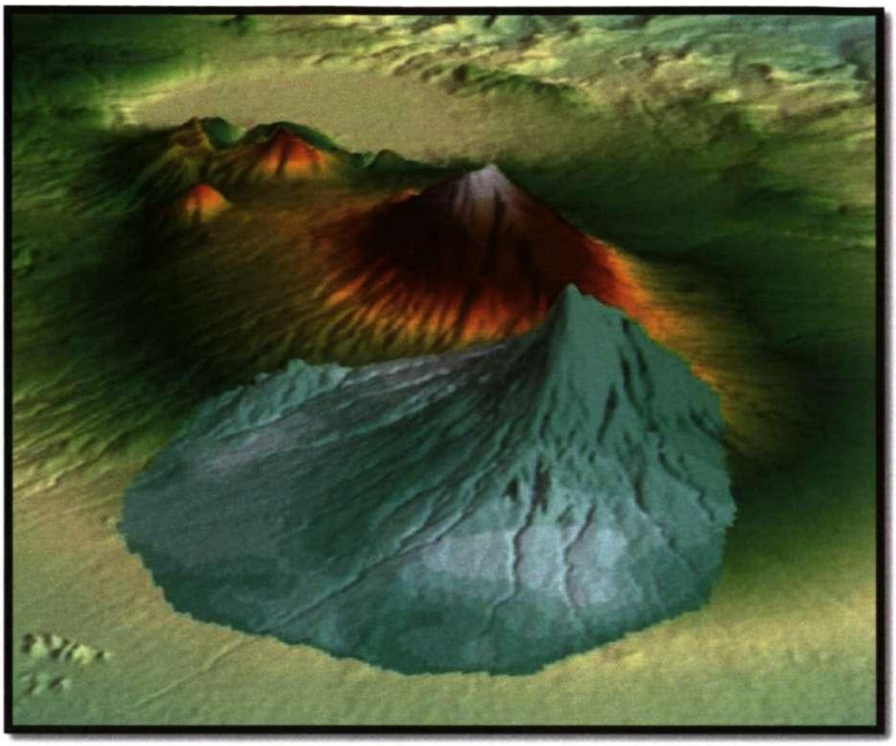


Figure 7.1: Interpolated pilot map displaying the cultural intensity scores created in ArcGIS displayed in 3D. Dark green refers to high cultural intensity and light green refers to low cultural intensity.

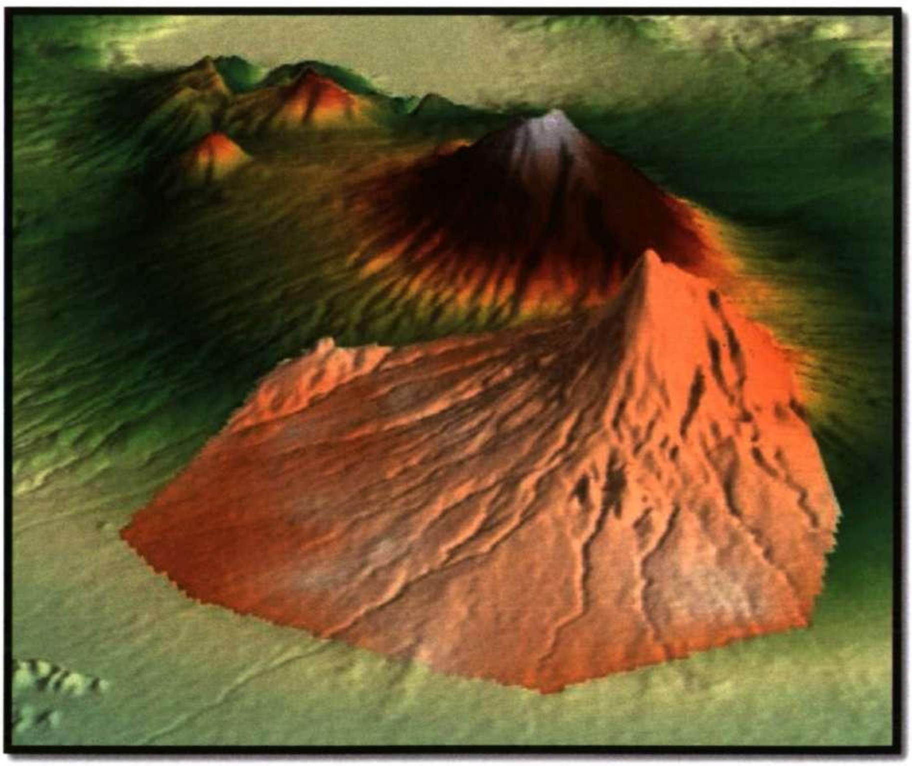


Figure 7.2: Interpolated pilot map for quantitative vulnerability analysis in 3D Source: modified from Utami (2008). Dark orange refers to high vulnerability and light orange refers to areas of low vulnerability.

The pilot map represents just a small sample of settlements and in unvisited regions such as the east the uncertainty of interpolated information is high. In order to overcome this, a wide spread of settlements around the volcano must be sampled and these settlements must chosen impartially, without focussing on regions renowned for their strong traditional beliefs.

In summary, completion of the pilot exercise confirmed that:

- A more concise and robust set of cultural indicators is required.
- The qualitative data must be quantified in order to be developed using GIS and choice of visualization considered carefully
- An unbiased range of settlements must be sampled based on their geographical location rather than their culture or previous hazard experiences.
- Guiding questions must be broad, flexible and adaptable and semi-structured interviews should be used to allow the interviewee a 'voice' (as discussed in chapter 4) so that as many indicators as possible can be identified.

7.2. Mapping Culture.

Although culture has been examined and debated for many years across the social sciences, quantifying and 'mapping' the complex nature of culture is not a common practice. In absence of a methodology, this section draws inspiration from the handful of case studies that have tackled this issue.

A few scientists have used the concept of mapping culture to draw out social distinctions at local and regional scales. In mapping the cultural differences between selected nations, for example, Hofstede (2001) explored five aspects of culture: individual versus the collective (tendency to look after yourself and family before society); power distance index (the acceptance of unequal power distribution), uncertainty avoidance index (the degree of acceptance to certain or uncertain situations); masculinity (aggressiveness and assertiveness); and long term orientation (Hofstede 2001, O'Connell 2008). Although Hofstede's cultural mapping techniques were initially designed for business studies, his method is multi-disciplinary.

A very different 'global cultural map' is that designed by Inglehart and Welzel (2005) shown in Figure 7.3. They scored nations on certain elements of culture such as family relationships through to financial contentment. These scores are based on questionnaires conducted in a continuing global survey of social and political values (http://www.worldvaluessurvey.org/). The resultant map depicts what Inglehart and Welzel (2005) define as two dimensions of cross-cultural variation: traditional versus secular-rational values and survival versus self-expression values (Inglehart and Welzel 2005). According to the authors the traditional/secular rational values distinguish very religious societies from non-religious societies. This value incorporates a wide range of 'assumptions'. For example, a society close to the traditional pole is more likely to emphasise the importance of 'parent-child' ties, 'absolute standards and traditional family values, and reject divorce, abortion, and suicide'(Inglehart 2006:1). According to Inglehart and Welzel (2005), these societies are also patriotic and have respect for authority, whilst those who are mapped as secular show contrasting characteristics. Values of survival and self-expression relate to a transition to industrialisation whereby industrialised societies have shifted from an emphasis on survival to one of wealth and quality of life, creating a culture of self-expression and taking survival for granted. 'Self-expression values give high priority to environmental protection, tolerance of diversity and rising demands for participation in decision making in economic and political life', this produces a culture of trust, freedom, and self-expression - precisely the attributes vital for democracy (Inglehart and Welzel 2005:56).

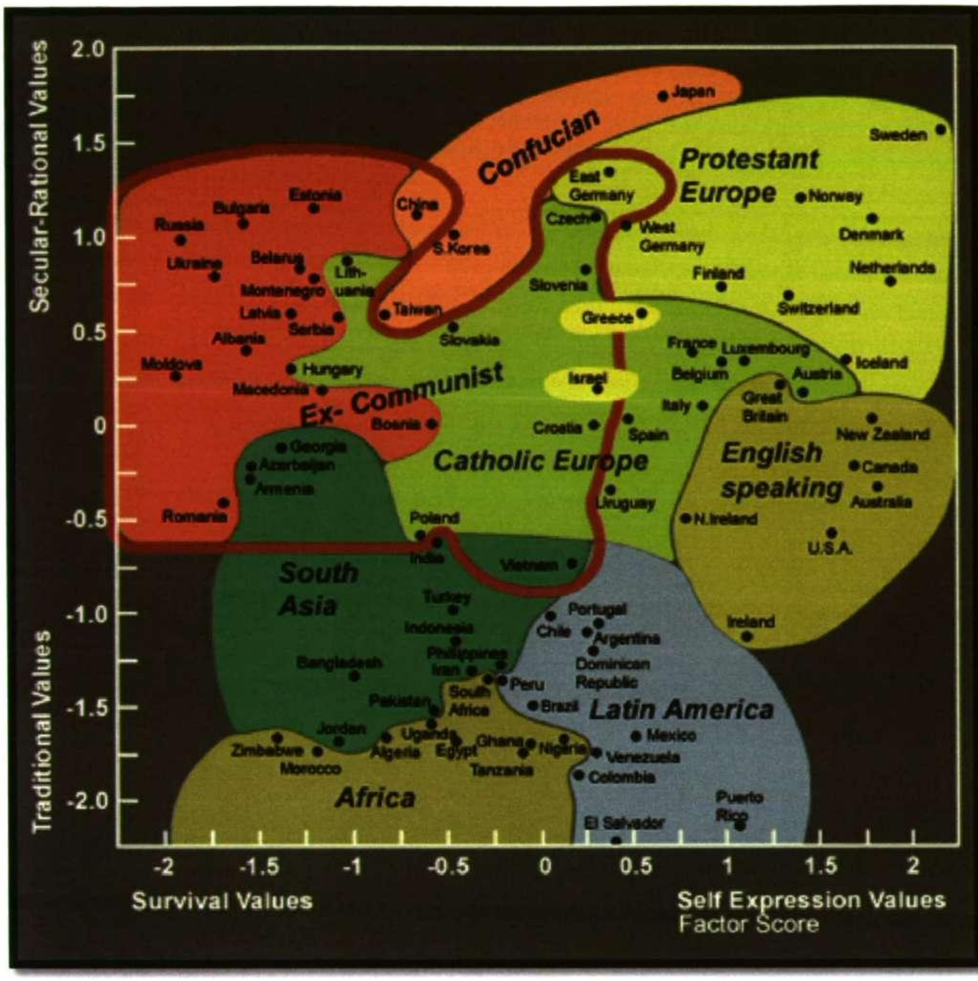


Figure 7.3: The Inglehart-Welzel cultural map of the world. A breakdown of individual country scores are available at: http://www.worldvaluessurvey.org/ Source: Inglehart-Welzel (2005).

Inglehart and Baker (2003) have concluded that as a society becomes industrialised there is a shift away from the traditional values, yet they also note that changing cultures are shaped predominantly by their cultural heritage. So despite industrial change the traditional beliefs and values of a society in terms of culture do not change at a basic level. Adapting such an approach for use at a local level, such as at Mt Merapi, means that it is indicators of traditional culture that should be examined.

Specific cultural indicators used in this study are inspired by Mercer's (1997) list of cultural resources, by research on indigenous knowledge (e.g. Cronin *et al.* 2004a) and by a compilation from other secondary resources of traditional practices for Java in relation to mountains and hazards from various resources. By better understanding the common customs and beliefs relating to the Javanese relationship with mountains and hazards it is possible to design a series of indicators of relative culture. This acquired indigenous knowledge provides a background for framing questions whilst also providing a baseline to judge levels of culture that can be categorised quantitatively.

7.2.1. Javanese customs and traditions: Indicators of Cultural Intensity.

1. Ceremonies: Most literature on Javanese religion and culture describe a ceremony that is integral to all Javanese, especially those rural *abangan* (more traditional indigenous folk). This ceremony is called *Slametan* or *Kenduren* and is held in response or prior to any important event such as birth, marriage, death or illness, harvest or, supplication of the village guardian spirit' (Geertz 1960:11). The *Kenduren* is a community feast prepared by the women but presented and eaten by the men. It sustains harmony, social links, and mystic unity within the village (Forshee 2006, Beatty 1999). Although it has incorporated readings from the Koran and Islamic prayer, its basis remains within the ancient rituals to protect against evil spirits (Forshee 2006). According to Geertz (1960:14) holding a *Kenduren* ensures that local spirits will 'not bother you, will not make you feel ill, unhappy or confused'. One of the Javanese interviewed by Geertz (1960:15) explains that 'at a *Slametan* all kinds of invisible beings come and sit with us and they also eat the food. This is why the food and not the prayer is the heart of the *Slametan*'. The local people interviewed in this study often referred to the spirits that live on the volcano and so it is the *Kenduren* that is regularly held in order to appease these spirits. It was also reported that Mbah Marijan held a special *Kenduren* during the 2006 eruption of Mt Merapi in order to appease the angry spirits that had initiated the volcanic activity (Wahyuni 2006). Holding regular *Kenduren* ceremonies that are directly related to Merapi or the spirits that live on the volcano would seem a good indicator of the intensity of the traditional belief system.

2. *Less frequent but more elaborate ceremonies:* Although the *Kenduren* is the most common ceremony held in rural Javanese communities, it is also important to consider other special ceremonies which are directly focussed on Mt Merapi (and related hazards), such as the *Labuhan* ceremony (see section 5.2.5). The number, knowledge and frequency of these focussed ceremonies will be important indicators.

3. *Spirits:* Another indicator that relates to the ceremonies, are the stories relating to the creatures/spirits that protect and punish the villagers. According to the work of Geertz (1960:16) there are three main kinds of spirits: *Memedi* (frighteners), *Lelembut* (ethereal ones) and *Tujul* (spirit children), but as Geertz (1960:17) notes this is just one explanation and 'there is no doctrine in these matters'. There are many stories relating to spirits and all seem to vary according to locality (Geertz 1960; Schlehe 2008, 1996; Forshee 2006; Beatty 1999, Wahyuni 2006). The spirits are considered driving forces for an eruption and so village stories relating to the spirits and their relationship with Mt Merapi are deemed valid indicators of cultural intensity.

4. *Traditional signs and warnings:* It is believed that the spiritual creatures of Mt Merapi can not only provide warnings of an eruption, but that they can also create an eruption. According to Schlehe (2008) and Wahyuni and Hardoyo (2006), it is not only spiritual warnings that are used as precursory signs, others include sounds from the crater, lightening, and unusual animal movements. These signs are also discussed in section 5.2.8, as they were a common theme in the 2007 data. Traditional warning signs and their use is therefore the fourth indicator of cultural intensity. The number and significance of the signs can be quantified and ranked to be integrated within the culture map. However, the relative significance of these signs is most important as although some villagers may know of the signs they may not believe in them. It is therefore important to attempt to gauge the

local community's level of belief and trust in their traditional philosophy. This is extremely subjective, but, by retaining a bottom-up ethos it is possible to improve data objectively.

5. Wise men: An indistinct but useful indicator is a community's apparent reliance and trust in spiritual leaders or wise men, such as Mbah Marijan. People from near and far visit wise men to receive blessings for wealth, health, or guidance. Mbah Marijan appears to have the most widespread reputation and influence and his actions appear to guide those who truly believe in his relationship with Mt Merapi. The widespread media attention that has been given to Mbah Marijan may distort people's perception of his spiritual powers; hence it is acknowledged that this indicator is arguably less reliable than the others above.

These five initial indicators provided the basis of the framework for the interviews (Table 7.2), though it was recognised that throughout the field season new indicators might discovered and incorporated within the study (corresponding with the flexible, creative and reflexive ethos of social science methodologies). For example, indicators might conceivably include the incorporation of myth within the stories and oral histories of each settlement. Oral histories, taboos and traditional warning signs all contribute to the cultural tapestry of this volcano. Whilst a personalisation and adaptation of the myths demonstrate an intensity and reliance on their traditional beliefs.

Frequency and focus of *Slemetan/Kenduren*
Frequency and intensity of other Merapi/hazard focussed ceremonies
Variety and village incorporation into spirit related stories
The knowledge of, beliefs in and use of traditional warning signs
Trust in and belief in Mbah Marijan (Mt Merapi's spiritual leader).
Trust in another wise man or spiritual leader

Table 7.2: Indicators of cultural intensity, to be used as guidelines for interview framework.

7.3. Collecting indicators of cultural intensity: the 2009 survey.

Sampling: Over two months, from the beginning of February to the end of March my research assistant Aris Suriyanto and I carried out 217 interviews whilst travelling around some of the highest settlements on Mt Merapi. Initially, 20 settlements were to be sampled from communities that encircled the volcano and were within the highest village regions. However, it became clear very early on that this number was not sufficient. Each village region is elongated up the volcano's flanks, as shown in Figure 7.4, so choosing just one representative settlement from each village would not necessarily provide the range of results required (but in some instances there was little choice due to time restraint).

Cultural intensity, beliefs and hazard perception appeared to change with remoteness and so settlements at the lowest part of the village seemed to have a significantly different culture and attitude towards the volcano from those at the top. In order to try to overcome this issue the village boundaries were not used as a means of sampling and instead a mixed sampling method combining opportunistic and snowball techniques were used (Kemper, Stringfield and Teddlie 2002). These methods involved carrying out interviews whenever possible (opportunistic) and with guidance from the previous interviewees, using their recommendations for the next informant or settlement to sample from (snowball). Figure 7.4 displays the resultant settlements visited during the field season in 2009 and the numbers refer to the name of each settlement given in Table 7.3.

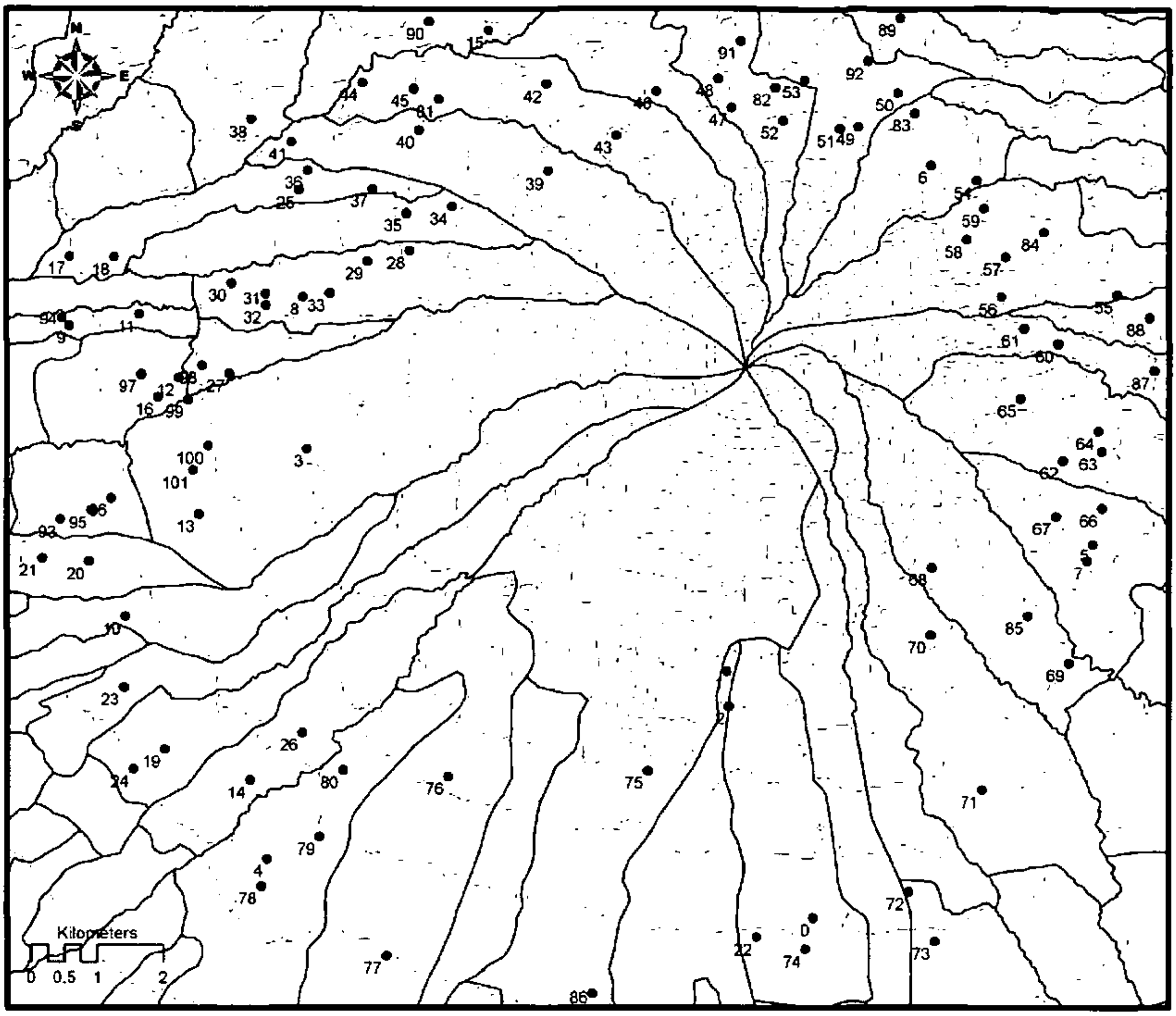


Figure 7.4: Basic map with the locations of all the sampled settlements, (numbered corresponding to table 4), and village boundaries for sampled area.

No.	Name	No.	Name
0	Batur	51	Salam
1	Kinarejo	52	Plalangan
2	Palemsari	53	Blumbangsari
3	Kepit	54	Bulu Kidul
4	Benjasari	55	Kalitengah
5	Baturtuwo	56	Lendong
6	Bulu Kulon	57	Kujon
7	Gadung	58	Wonodoyo
8	Krajan	59	Pedut Kulon
9	Mangusoko	60	Tutup
10	Ngargosoko	61	Jelok
11	Kacangsoko	62	Kawengen
12	Banaran	63	Ngaliyan

13	Batur Ngisor	64	Mriyan
14	Kaliurang Selatan	65	Gobumi
15	Sanden	66	Sangup
16	Gumuk	67	Beling
17	Candi Tengah	68	Pajegen
18	Candi Duwur	69	Gondang
19	Jamburejo Dua	70	Deles
20	Pule	71	Bonor Lor
21	Tegalrandu	72	Gumukrejo
22	Kepuharjo	73	Panggang
23	Jengglik	74	Pagerjurang
24	Kemiren	75	Kaliurang
25	GowokSengi	76	Ngandong
26	Sumberejo	77	Mencor
27	Keningar	78	Bedoklempong
28	Trayem	79	Gondoarum
29	Gendelan	80	Tunggularum
30	Ngagllik	81	Klakahduwur
31	Dadapan	82	Temusari
32	Semen	83	Suroteleng Kulon
33	Tempel	84	Wonosari
34	Babadan Atas	85	Pucung
35	Babadan Bawah	86	Pantiasih
36	Gowokpos	87	Cluntang
37	Gowoksabrang	88	Dukuh
38	Klampahan	89	Selo
39	Stabelan	90	Windusabrang
40	Karang	91	Lencoh
41	Tlogolele	92	Samiran
42	Bangunsari	93	Kalibening
43	Sumber	94	Grogol
44	Klakah Ngisor	95	Demo
45	Klakah Tengah	96	Windusari
46	Sepi Tengah	97	Ngargotontro
47	Kedung	98	Gondangrejo
48	Congkolngisor	99	Karanganyar
49	Pojok	100	Gemer
50	Kuncen	101	Tanendeso

Table 7.3: Names of all sampled settlements, numbers correspond to Figure 7.4.

Procedure for access and interviewing: When entering a new village area it was necessary to go to the village office initially in order to confirm that our official permission (completed in advance by The Inter-cultural Institute Yogyakarta) had been processed. Following this, a visit to the head of the village was made to seek his advice regarding suitable hamlets in which to conduct interviews and to recommend individuals willing to be interviewed, with knowledge of the volcano and the local customs and beliefs. This meant that new ground was covered more efficiently and areas that were in the high hazard zones or had previously refused to evacuate could be targeted. It also enabled better access to key members of the community and as the head of Kepit on the western flank explained *'not every villager would be able to answer our questions or be able to cope with guests, or talk with us'* (Suyono, Kepit). In other words the villagers' isolation meant that some people would be overwhelmed and disturbed by our presence. Asking the head of village and head of hamlets for guidance enabled polite and efficient interviewing of a broad range of local people, who are most importantly were happy to speak with us and had a good knowledge of the area, the volcano and the people who live there.

Gender bias: As in 2007, the interviewees were predominantly male, yet they were representatives of the local community, involved in all aspects of community life and were, therefore, willing to discuss the volcano and their beliefs without complaint or lack of understanding. The lack of women in the sample could be considered a significant issue, and although this thesis does not attempt to explore gender issues in Java, it is important to be reflexive and aware that these factors of society could influence the final information received. Herod (1993) suggests that gender relations are an important dynamic when using semi-structured or open-ended interviews. In this male dominant society interviewing an even sample of men and women was extremely difficult (as described in section 4.5.2) despite Kusujiarti and Tickamyer (2000:416) finding that in rural Java 'women and men often share tasks, resulting in a relatively equal status and power'. Although men and women appeared to share menial tasks, official business such as being interviewed by a foreigner is the responsibility of the men. Attempts to interview women shifted this balance making the residents uneasy and often leading to difficult ethical situations. Numerous experiences of gender bias in 2007 and 2009 leads me to disagree with Kusujiarti and Tickamyer (2000) because it was extremely difficult to interview women, except opportunistically.

Guiding the interviews: Table 7.4 gives an overview of the guideline questions that framed the 'conversations with purpose'. The method of interviewing and note taking followed the same model as the main 2007 field season, discussed in chapter 4 and 5. Aris would facilitate the interview in Javanese and then either translate in real time or later that day, and I would help Aris during the interview if required, feeding in additional and complementary questions whilst also note taking.

The resultant 217 interviews were then processed for analysis using NVivo 7 and conventional analysis coding methods described in section 4.9 (Copies of all transcripts can be found on the attached CD at the back of this thesis, labelled 2009 Interview Transcripts). Appendix 5 gives the key details (gender, age, interview location, data and time) of each informant in 2009. Coding the interviews enabled key themes to be extracted from the data and these codes were the foundation for designing a scoring system utilised to transform the quantitative data into a GIS compatible quantitative system. The scoring system design will be discussed in more detail in section 7.4 following discussion of the key themes.

Order	Question	Comment
1	Does your settlement hold a special ceremony specifically for Mt Merapi/ creatures?	This would often lead on to discussions along themes such as: other ceremonies, creatures, offerings, ceremonies held in other settlements, personal belief in customs.
2	Why do you hold these ceremonies?	
3	Have you heard of any strange or mystical stories about Mt Merapi?	This led to conversation about creatures, and perhaps taboos
4	Do you know the story of the creatures (or specific name if already mentioned)?	
5	What happens before Mt Merapi erupts? Are there any signs that the volcano will erupt?	
6	Do you know of Mbah Marijan?	This would led to discussions about whether there is a local Wiseman like Mbah Marijan or Mbah Marijans position and influence.
7	What happened in 2006?	This opened questions about evacuations
8	Did you evacuate? And would you do it again in the future? (Why/ why not?)	
9	How many times has Mt Merapi erupted?	Would sometimes lead to discussion based on which hazards normally affect this area and general eruption experiences.
10	Have you had any training/ or education about Mt Merapi?	
11	Are there any other problems living here?	Answers would often include landslides, water shortage or wind.

Table 7.4: Guideline question used to steer the conversations/semi-structured interviews.

7.3.1. Key themes – Customs, beliefs and reactions to the volcano.

A number of key recurring themes emerged as the interview transcripts were processed and coded. This additional information shed new light on aspects of the original themes from

2007 and also produced new elements integral to analysing the customs at Mt Merapi and creating a 'picture' of the local people. This 'picture' is presented in two forms – visually as GIS coded maps of the spatial patterns found, and discursively in terms of discussing the main characteristics. Three key themes are outlined: 1) ceremonies, 2) traditional warning signs and 3) wise men.

7.3.1.1. The frequency and focus of Kenduren and other volcano ceremonies.

Because ceremonies are expensive and time consuming, this practice provides a measure of a community's desire to 'prove' their faith and ensure that they can live in safety and harmony with their environment and for this reason it is argued here that ceremonies are the most important indicator of cultural intensity.

The initial aim was to establish if the individual or the community carried out any regular ceremonies relating directly to Mt Merapi or the supernatural creatures. This initial question opened up a variety of conversational branches and revealed the basic beliefs of the informant. Most replied with no difficulty, describing their regular ceremonies in detail; listing their purpose, the months during which the ceremonies are held, the offerings and the creatures' names that they chant. Some other informants went on further to describe the inclusion of certain special offerings for Mt Merapi and its creatures incorporated within their 'normal' ceremonies, such as *Kenduren*, wedding ceremonies or circumcision ceremonies. These seemingly 'special' offerings became a recurrent discussion point as they appear to be pivotal to the purpose of certain ceremonies. One particular 'special' offering called *Sekul Gunung* consists of cones of rice that represent the volcano and seem to be central during a ceremony linked with Mt Merapi and the creatures. *Sekul Gunung* feature in many ceremonies held around the volcano (Plate 7.1).

Plate 7.1: A typical *Kenduren* held on the north western flank of the volcano.

Here the rice cones are the centre piece at the *Kenduren* ceremony. *Kenduren* offerings are prepared by the women, whilst the ceremonial chanting and dividing of the offerings are performed by the men. Women are not allowed to take part in the actual ceremony. This particular ceremony photographed was held to bless the construction of a new stable within the hamlet. Here the men gather and chant a mix of Islamic prayer and relevant Javanese, such as the names of the creatures who live on the volcano and protect that particular area. After the offerings have been 'presented' they are divided between the men and either eaten immediately, or more commonly, they are taken back to their families. In the centre are the two rice cones wrapped in banana leaves, other offerings include smaller cones of rice, a potato and coconut stew, a whole boiled chicken and a variety of rice crackers.

Kenduren ceremonies are held regularly within the settlements on the volcano and are a mix of Javanese ritual and Islamic prayer. This smaller, more intimate, ceremony bind communities together and are common in across Java (section 7.2.1). The difference at Mt Merapi is the informants specifically chant to the volcano and the creatures for protection from the hazards.

Chanting for protection within the *Kenduren* is more common than holding specific ceremonies for Mt Merapi, as it is less expensive but still shows a degree of respect and fear for the volcano. The various different types and adoptions of chanting and ceremonies held around Mt Merapi for the volcano has provided a scoring category with many divisions. For example, number of ceremonies held each year, knowledge of offerings required, the purpose of the ceremony and the performance of extra ceremonies during an eruption. These divisions are listed in the score sheet (Table 7.5) used to quantify the interview data and is discussed in section 7.4. Different divisions indicate a different level of faith where holding expensive specific ceremonies indicates a strong faith whilst chanting during regular ceremonies indicates a lesser commitment to protective volcanic customs.

Figure 7.5 illustrates the distribution of those who hold ceremonies and those who just chant. The pie charts indicate that the locations with specific ceremonies and chanting concentrate on the north flank and at higher altitude, whilst those areas that just chant within regular *Kenduren* are more widespread. This initial map could indicate two possibilities: that the northern regions are more spiritual or possibly wealthier. Clearer reasons for certain patterns will appear as other indicators are compared. Settlements where the informants did not hold any form of ceremony have not been plotted; these areas are predominantly in the south-west. There seems to be a stronger Islamic presence in the south-west and this may have caused the reduction of traditional animistic customs.

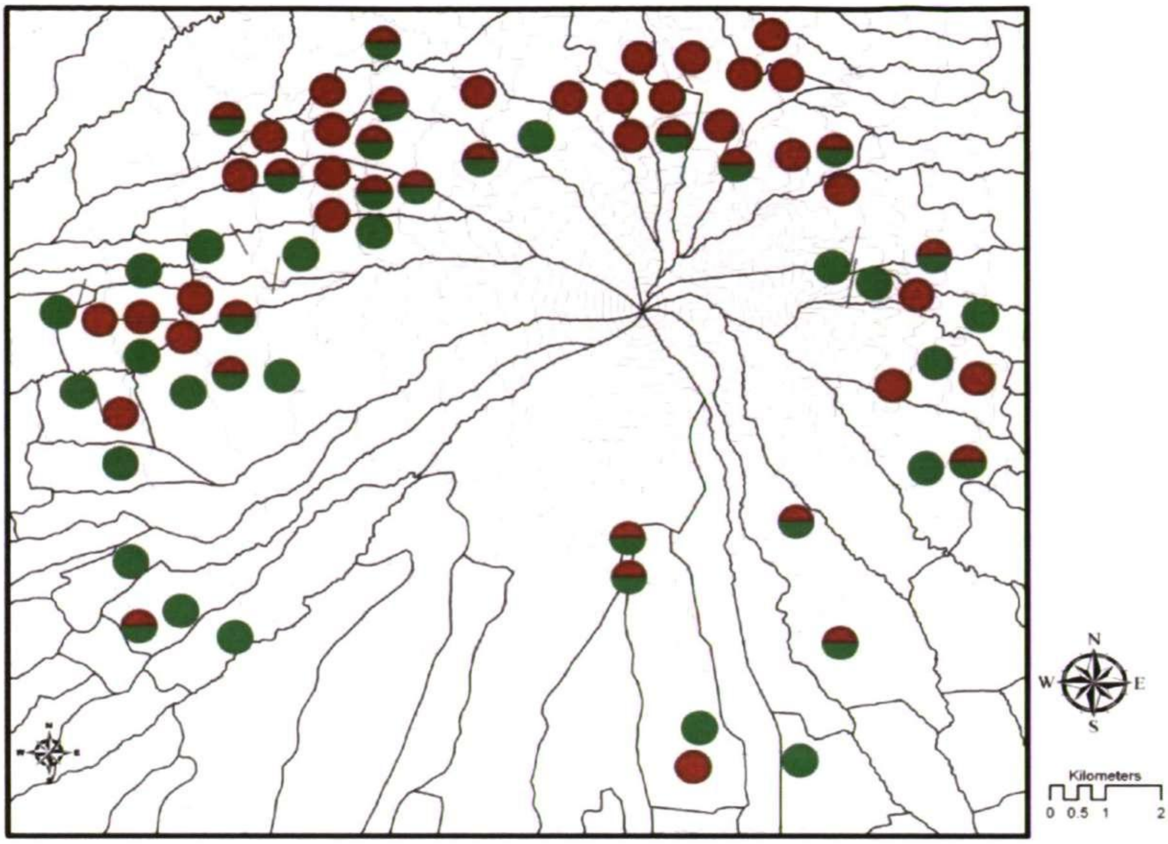


Figure 7.5: Plotting the areas that hold specific ceremonies in comparison with areas that only include the volcano and its creatures within their regular ceremonies. Pie charts display areas that have special ceremonies in red, and those that chant for Mt Merapi only in regular/ more general ceremonies in green, some areas have both.

The larger ceremonies specific to Mt Merapi have been recently developed as a tourist attraction by the government. The *Labuhan* ceremony (organised by the Kraton of Yogyakarta) held in Pelemsari and coordinated by Mbah Marijan is one of these events (see section 5.2.5). Another large ceremony that has been designed to not only appease the creatures and re-direct that hazards but also to increase tourism takes place annually in Selo. A purpose built tourism area hosts the ceremony and the event includes traditional dances and performances. The ceremony also includes the sacrifice of a buffalo, whose head is then carried to the summit of the volcano and buried. The ceremony is often referred to as a *Labuhan* because it was originally performed by the Kraton of Solo, but now it is organised by the local tourism department and the popular consensus is that it is largely for the tourists rather than the people. Local residents in the saddle between Mt Merapi and Mt Merbabu complement this more 'touristy' ceremony with their own hamlet or individual ceremonies that are often held in similar months or seasons. Despite this, taking the sacrifice to Mt Merapi is still an extremely important part of local belief and if done incorrectly incurs severe punishment. Samto from Plalangan in the Selo area describes what happened when the head of the buffalo was swapped with an inferior sacrifice:

> *"Usually they sacrifice head of buffalo but some bad person changed the head with a cows head and therefore Merapi erupted. Merapi was quiet when they sacrificed the head of buffalo. It also happened when it was replaced with head of a goat.*
>
> *Also a person whose job it was to take the head to the summit did not. He became ill and could not eat and drink and he died. Another time the person who took head of buffalo did not put it in the normal place, and therefore he could not walk for many years". **Samto**, Plalangan hamlet.*

The ceremonies are sometimes linked with an instruction given directly from the creatures through premonitions and dreams. A common story from the north western flank around the village of Klakah is that of Pencar, that is a hamlet area that was destroyed by a pyroclastic flow in 1954 that devastated the area. Although Pencar was never rebuilt (it was forbidden by the government) the survivors relocated approximately 500m from the original site because of the need to be close to their land. It seems that in order to cope with the threat from Mt Merapi they have created an oral history about this disaster that explains why their people were killed. Repeatedly, I was told that the creature came to Pencar before the eruption in the form of a child and went to a man working in his stable. The creature requested his favourite offerings of tea, coffee and *jadah bakar*, and in some versions actually told the man that he should move as '*simbah*' (meaning grandparent, commonly used as a respectful title for the volcano (Wahyuni 2006) wants to pass this way. The man refused and scolded the child, and within minutes Pencar was destroyed.

This story created the custom for including the creature's favourite offerings within a ceremony, and to respect strangers who pass through their settlements, especially unknown children. This links with the theme of victimisation that came out of the 2007 field data.

Ceremonies and stories, such as those described above, preserve the link between the people, the creatures and the volcano in the hope that warnings can continue to be observed and communicated from the creatures and the volcano. Around the volcano, regardless of the frequency of ceremonies, the knowledge of various traditional signs remains constant. It seems that traditional warning signs are an example of a spatially continuous oral history at Mt Merapi, and one that has a huge influence on the people.

7.3.1.2. Traditional signs and taboos.

Figure 7.6 shows the settlements that predominately use premonitions, dreams and possessions as their main precursor to an eruption. Belief in these creatures as protectors and punishers appears particularly intense in the northern and north western regions. As one travels south along the western flank, the number and variety of signs increase (depicted as increasingly multi-coloured pie charts), indicating that these settlements use a variety of different precursors, and therefore potentially improving their ability to forewarn against an eruption. Yet these regions appear to be dominated by two recurring signs, premonitions and animal movements.

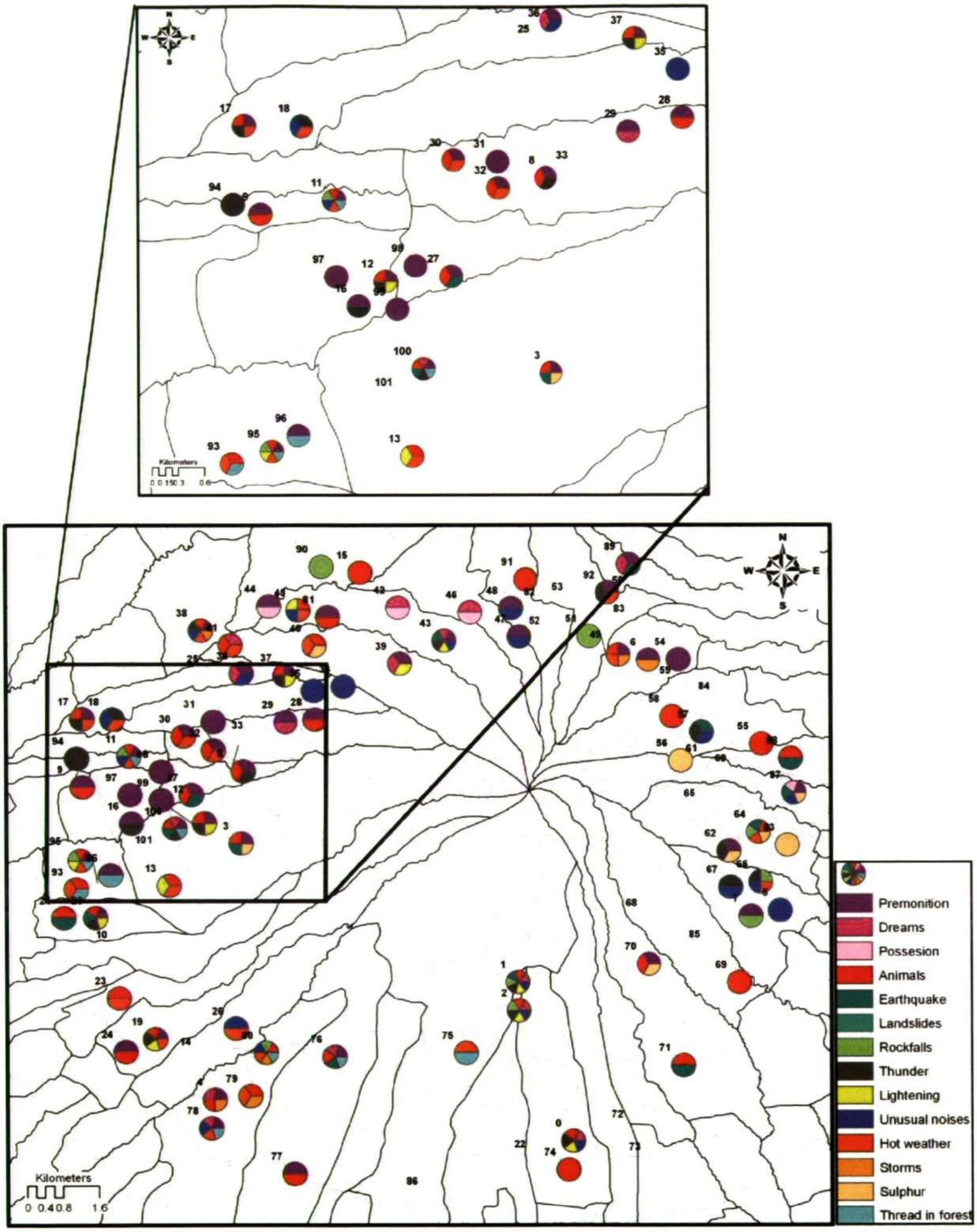


Figure 7.6: The distribution of traditional signs around Mt Merapi displayed in mini pie charts, the northwest section has been highlighted in more detail as this is the region that has a dominant reliance on premonitions.

Figure 7.7 maps the use of premonitions as warning signs as an interpolated surface using a Nearest Neighbour correlation. Interpolating the data creates a predicted trend surface that can provide a clearer pattern when using a small sample (see section 7.6).

> *"In 2006 the head of hamlet received premonition – an old lady came to him and said 'if you want to be safe you should make segul gunung".* ***Mulyorejo,*** *Klakah Ngisor*

Mulyorejo from Klakah Ngisor suggests that the locations that have knowledge of premonitions and those that hold ceremonies are linked and this is confirmed by comparing Figures 7.5 and 7.7. Both indicators dominate in the north-western area which is geographically isolated and holds the majority of ceremonies for the volcano.

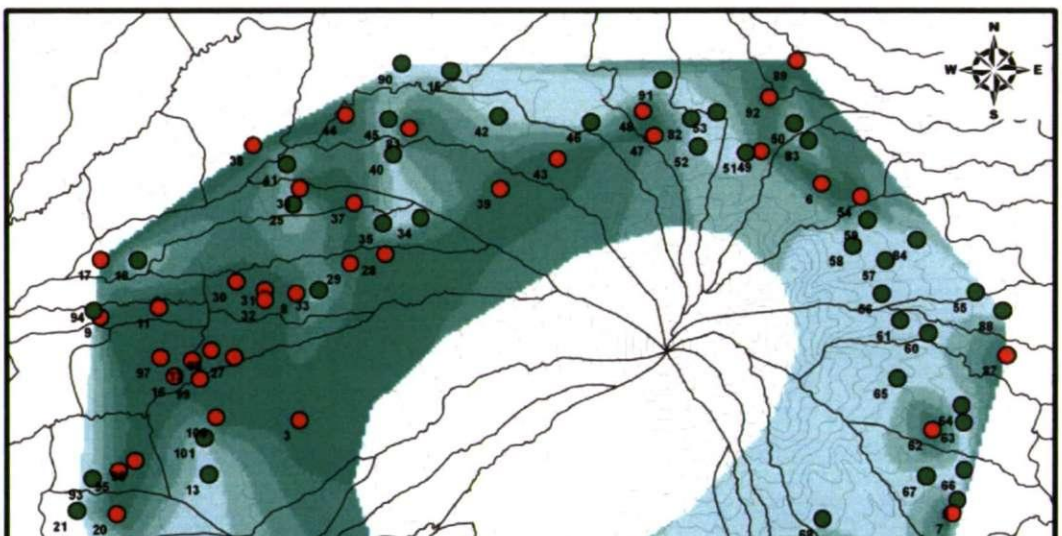


Figure 7.7: The distribution of premonitions as a traditional precursor, where 0 or green points correspond to areas that do not use premonitions and 1 or red points correspond to areas that do. These points have been interpolated using the Natural Neighbour tool to create a map surface that illustrates clearly the pattern distribution.

The other widely reported precursor around Mt Merapi is unusual animal movements (Chapter 5). The 2009 interviews shed more light on this tendency, describing that prior to volcanic activity descending animals will not eat the crops (animals that do are not real indicators). The area where the animals descend too is therefore considered safe. The distribution of this belief is mapped in Figure 7.8 and shows a slight shift in pattern from the premonitions towards the southern flanks. Monkeys and deer seem to be the most widely used precursor for volcanic activity at Mt Merapi, important even in regions that appear to have no other traditional customs or beliefs (southwest). Perhaps this is because rather than linked with any specific belief system animals are considered more sensitive to nature, therefore animals are still observed as precursors in regions that appear more Islamic (southwest and more distant regions).

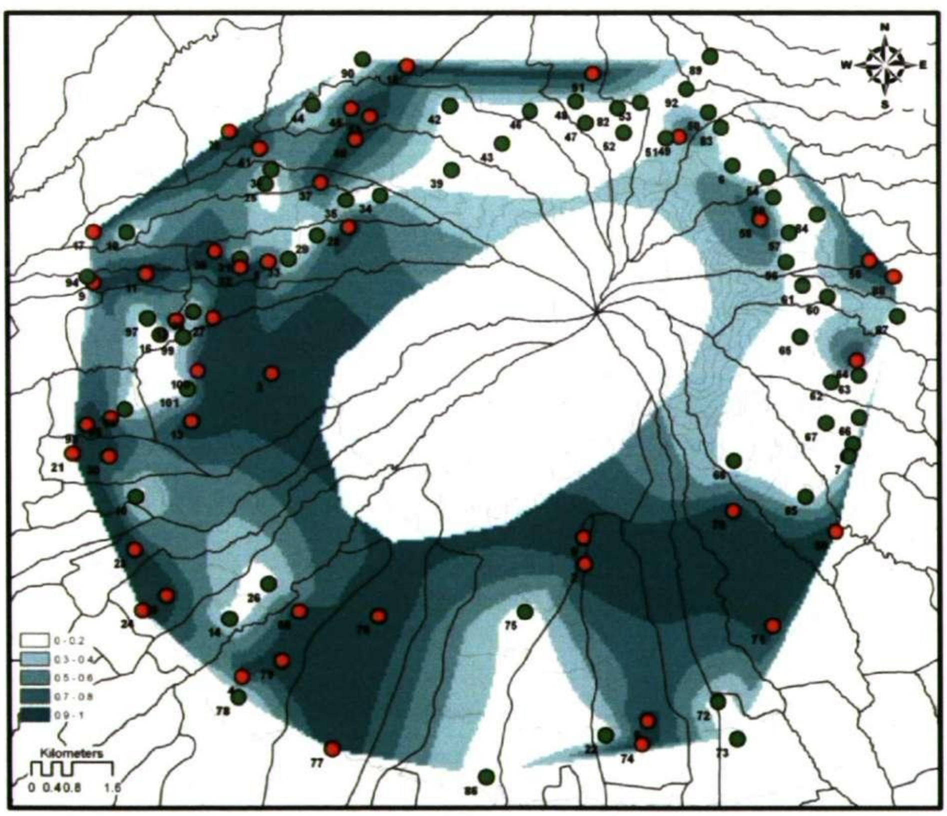


Figure 7.8: The distribution of the use and belief in animal precursors around the volcano. This is a combination of plots using simple points (red symbolising a use and knowledge of animal precursors and green does not) and Natural Neighbour interpolation.

Other signs include feeling hot, experiencing earthquakes and noting an increase in thunder and lightning storms (section 5.2.8). The earthquakes and storms are unlikely to be extremely localised events and often do coincide with an eruption. Therefore it is likely that these events will be felt and seen by most inhabitants within the proximity of the summit regardless of exact location, therefore informants who have not been directly affected by an eruption may still use these signs as precursors. Signs, like lightning, that are related to actual volcanic mechanisms could be useful precursors that should be encouraged and could potentially increase a community's resilience.

The local people also have a variety of taboos that they use to protect themselves during an eruption and also when they climb the volcano (Wahyuni 2006). Supplementary to chapter 5, section 5.8.2 discussing the personification of Mt Merapi, the 2009 survey found that it is believed that, like a person or animal, if you shout and scream Mt Merapi's hazards will turn and follow the noise. So the residents warned us that, during an eruption, you must remain silent, stay still and not point or distract the hazard from its original route. These taboos seem to have formed from previous experience of eruptive events. The actions of those who have been killed are noted and become taboo, so much so, that on the western flank villagers refuse to make any sound, even refusing to ring the *Kendongan* (a hollow tree trunk that is traditionally used as a siren) or shout a warning to relatives working in nearby fields during an eruption. The reliance on taboos is seemingly more dominant in isolated communities and those who have recently been directly affected by an eruption, such as Klakah village in the northwest region (see Figure 7.6), home to Pencar.

In the east there seems to be a lack of traditional signs that corresponds with the lack of ceremonies. Here they believe they are protected from Mt Merapi by a ridge called Gunung Bibi/Ijo (Aunt/Green).

7.3.1.3. Trust in wise men and spiritual leaders: protection by the elders.

A theme that emerged from the 2007 field season was of 'respect' (see sections 5.2.1 and 5.2.3) and in 2009 the informants expanded on this discussing both human and environmental peers as influencing their actions during a volcanic crisis.

Respecting your elders is a dominant aspect of Javanese culture and the story of Gunung Bibi is a good example of this. Plate 7.2 is a photograph of Gunung Bibi taken from Sangup on the eastern flank. It dominates the skyline and you can barely see the summit of the volcano behind. Gunung Bibi is regarded by the scientific community as a 'residual hill of volcanic structure older than Ancient Merapi' (Camus *et al.* (2000:3), but while the local community also believe that this ridge is older than the modern volcano, but they describe the ridge as Mt Merapi's Aunty 'who' as an 'older family member' demands the respect of Mt Merapi.

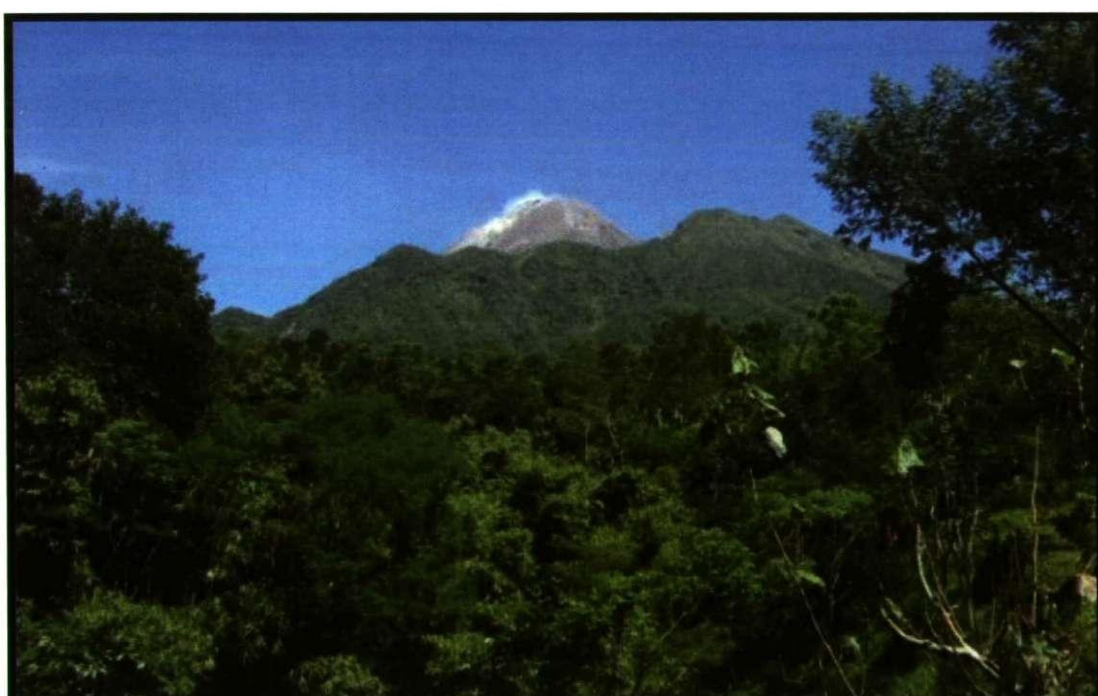


Plate 7.2: Gunung Bibi (also known as Ijo) dominates the flank on the eastern side of Mt Merapi. Merapi's dome can be seen behind the 'protective' ridge line.

"Here Gunung Bibi protects this area, it is the aunty of Merapi and thus is more sacred because it is older than Merapi". ***Sukiman,*** *Delus*

In this quote from Sukiman, a villager from Delus in Sidorejo village region, he explains that out of respect for 'his' elders Mt Merapi would not dare erupt to the east because Mt Merapi would have to 'go over' Gunung Bibi. The head of Pandun hamlet in Sangup village on the eastern flank goes further describing that Gunung Bibi would *"whip the eruption with her belt and protect this area"* if Mt Merapi even dared to erupt to the east.

Respecting ones elders or peers is a theme that occurs throughout the interviews, appearing in many seemingly different threads and linking them all. In 2007 and 2009 I was often told that I should speak to the older people, or that they used to have ceremonies but the old people died and the knowledge died with them. It was generally the old people who would know the offerings in detail.

Again, as in 2007, Mt Merapi is also seen as an elder and given the title *Mbah*, or *Simbah* meaning grandparent. The creatures are also referred to as grandparents and so is Mbah Marijan, the gate keeper of the volcano. Mbah Marijan was the key motivation for choosing Mt Merapi as a field site but during the course of the initial research his influence appeared less dominant than originally implied by the media. To examine this, Mbah Marijan was included in the interview framework. The informants were asked if they knew of Mbah Marijan and if so what was there opinion of him? The results, mapped in Figure 7.9, demonstrate that Mbah Marijan's influence is dominant close to his home (Kinarejo/Pelemsari) whilst those who live in the north actually were more likely to suggest that Mbah Marijan is taking advantage of his recent media attention and subsequent popularity.

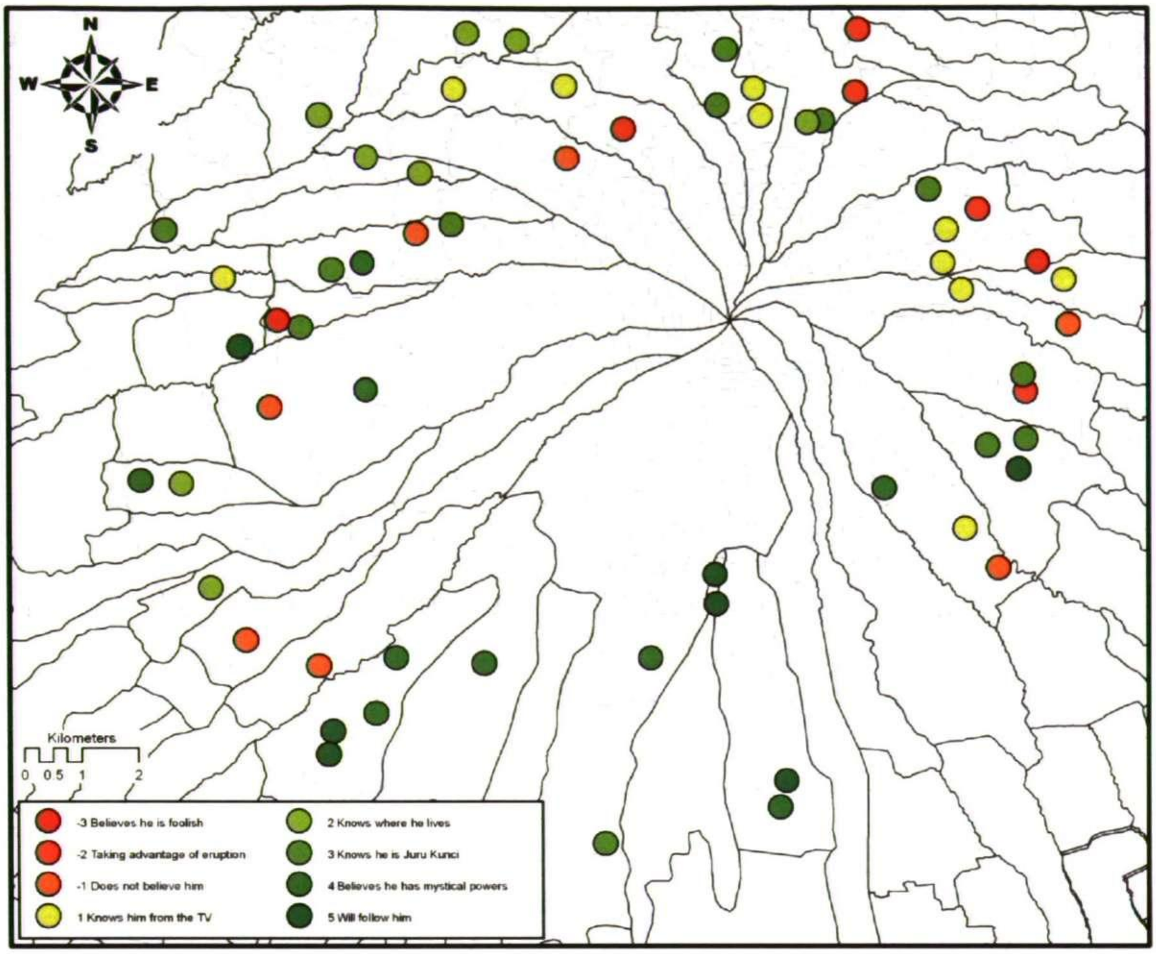


Figure 7.9: Plots showing Mbah Marijan's influence. The different responses were ranked according to belief and trust in Mbah Marijan. A score was then allocated to each settlement. Dark green and a score of 5 corresponds with strong belief in his position as spiritual leader for Mt Merapi, scores of 2-4 symbolises those regions that know of him, the ceremonies he holds and his relationship with the volcano, orange and a score of 1 correspond to those who know of him only from the television. 0 relate to those who don't know who he is at all and these regions have not been plotted. Reds and a score of -2 to -3 correspond with a belief that he is not mystical and is actually taking advantage of the last eruption to money.

> *"He doesn't know Mbah Marijan only from the TV. Mbah Marijan is stubborn and naughty but he did not want to evacuate even though the danger will destroy". **Suyanto,** Kalitengah.*

Evidently, most people believed that Mbah Marijan is just one of many people who have a special relationship with the volcano, and that Mbah Marijan has been 'lucky' enough to have survived the eruption in 2006 and it was his refusal to evacuate that caught the attention of the media. The eastern regions that feel the Mbah Marijan is actually taking advantage of his position (red plots) are also areas that either have their own strong traditional beliefs (northeast) or that are more synical about the volcanic belief systems (east).

During the 2007 and 2009 seasons it was observed that Mbah Marijan received hundreds of visitors every week, who had journeyed from regions beyond the flanks of the volcano. It appears that in distant regions those who had seen and read about Mbah Marijan in the media were more willing to believe in his spiritual relationship with Mt Merapi than those who had their own beliefs and connection to the volcano.

Informants in 2009 confirmed that the desire to respect elders and peers (section 5.2.4) also in some cases was applied to their relationship with the government. Many felt that they must appease not only the creatures of Mt Merapi but also the government. This means that during an eruption some heads of hamlets will turn to their elders for advice and most will attempt to oblige the government by evacuating a token number of residents. Mitro from Gadung in Sangup, Boyolali, describes this complex situation as they attempt to please and respect all their elders and peers:

> *"He will not refuse the government order to evacuate but he will come back during the day. The government is like the visible god. But Gunung Ijo (Bibi) will protect them so they will not have to evacuate".* ***Mitro Dimejo,*** *Gadung, Sangup*

Years of authoritarian rule in Indonesia will have compounded this complexity, the government as both distrusted and feared leading to inefficient actions during a crisis. Therefore these complex intertwining motivations are most apparent when discussing evacuations.

7.4. Evacuation Failure.

This final subsection describes some of the various arguments and complex reasoning behind the local people's motivations to evacuate or not. During the interviews the topic of evacuation failure was introduced by asking the informants about the 2006 eruption and their movements during this small eruption. The responses were often quite complex indicating that it is not just one factor influencing an evacuation. For example, previous findings from Pelemsari and Batur indicated that those who were willing to evacuate only did so on a part-time basis, and those that refused to evacuate did so not only because of their traditional beliefs but also the need to protect their homes and belongings. Away from Pelemsari and Batur the 2009 interviews confirmed that these are still key motivating factors. In other words, across the Mt Merapi area a part-time evacuation is certainly considered the norm, if an evacuation is deemed necessary at all:

> *"It is impossible for Merapi to spit to the east because this is the back bone. We have never evacuated from here. It is impossible for Merapi to spit to this area".*
> ***Harno,** Bulu Kidul*

Harno's dismissal of an evacuation as necessary corresponds to the broader disbelief suggesting it is impossible for Mt Merapi's hazards to impact on their region. In the north and eastern regions this attitude is especially common. In the east, it corresponds to faith in Gunung Bibi's protective power, while is the north it is the belief that they are living on the volcano's back. This is compounded by the fact that the north and especially the east have rarely been affected by any hazard except minor ash fall in living memory, consequently the northern and eastern residents have low hazard awareness and a lack of motivation to evacuate.

Interviews and observations in the field revealed that the motivation to evacuate can change dramatically within just a few kilometres. For example, interviewees from the settlements of Kepit, Batur Ngisor and Karanganyar in the west explained how they would refuse any attempts to evacuate them, yet less than 1 kilometre away the residents in Tegalrandu village described that they will comply with any order to evacuate as long as they can return during the day to feed livestock and care for crops. As Gimar and Siti note, in Kepit, Batur Ngisor and Karanganyar there was a great concern about being permanently moved from their homes:

> *"It was difficult in 2006 (to evacuate) because in the past they evacuated for 1-2 years and they were persuaded to transmigrate whilst the head of the village sold their land".* ***Gimar and Siti Parmain,*** *Batur Ngisor*

The experiences of Gima and Siti, described in the quote above, and other similar stories undermine trust in the local and regional governments. Local people believe that the governments have an alternative corrupt motive for organising an evacuation. In Kawengan, the RT was extremely angry with the local government officials who ordered them to evacuate in 2006. In his opinion the local officials only evacuated the hamlet in order to gain compensation from the regional government. Because of this resentment only 51% of settlements interviewed evacuated in 2006 or would evacuate in the future in order to obey or appease the government. In fact 45% of settlements sampled would only ever consider evacuating the most vulnerable people or on a part time basis. Martono implies below, that although they sometimes have to obey the government they do not really agree with the orders, and instead they trust their cultural beliefs:

> *"We physically obey the government but our hearts trust the creatures".* ***Martono,*** *Gowokpos*

Another widespread belief is that *"disaster happens anywhere, so why move?"* (Hadi Sugito RT, Pule) especially when the volcano provides rich soils producing multiple harvests. Wider access to the media (such a television) has expanded the residents' knowledge of the world beyond Mt Merapi and the regular coverage of Indonesia's frequent disasters has led the people of Mt Merapi to believe (and arguably correctly) that every region has its hazards. Again this attitude connects with the residents' way of weighing up the risks against the benefits of living on an active volcano.

Throughout this survey it became clear that the motivations behind co operating with an evacuation are complex. Overwhelmingly the people are afraid to leave their belongings, but alongside this are fears that the government will move them permanently and are making money by evacuating them. They believe the hazards will never come to their area because they are protected (by various supernatural creatures, or because they are living on the back of the volcano). The head of a hamlet treads a difficult line between keeping the government and his residents happy, whilst also up holding his own beliefs. Commonly under difficult circumstances he will evacuate only the vulnerable leaving the majority of residents to make up their own minds.

Figure 7.10 summarises the main motivations leading to the past and potential future actions of that community during a volcanic crisis. Each response has been colour coded according to whether the community would evacuate or not. Those coloured yellow are areas most likely to refuse an evacuation order. The pink regions represent areas that would prefer to observe the situation for themselves before evacuating or would wait for traditional signs before evacuating. Those that are dark pink are communities that are willing to evacuate under certain conditions and those that are blue are regions that have never evacuated.

The data in Figure 7.10 suggest spatial differences in the motivating force for evacuation failure. In the northern region of Mt Merapi residents are more likely to refuse an evacuation because they consider it completely unnecessary, whilst in the west they are likely to find an evacuation concerning because they are worried about the governments motivations and leaving their livelihoods behind. This is because most settlements in the north are outside the official hazards zones and also have a strong reliance on their belief that they are protected, this combination reinforces a false sense of safety. In constrast the west is a region that has been more frequently evacuated over the last 100 years and has experienced extensive loss of land, settlements and population because of the eruption and subsequent government restraints, so although they are more aware of the volcanic hazards they face, they are also aware of the dangers that accompany an evacuation.

It seems that further away from the summit the more likely the residents will evacuate, this could be because they have never experienced the trauma of an evacuation and do not really understand the full implications. Equally, from the lower slopes the view of the volcano is improved and they can see the eruption clearer than those living within the more vegetated steeper slopes. Here they can watch the pyroclastic flows travel down the flanks and view the glowing lava in the evenings; ironically despite living further away from the summit these residents have a clearer idea of these hazards, there size and potential for destruction. Being able to see hazards apparently provides a community with an increased hazard perception.

Those regions that have never evacuated (the dark blue on Figure 7.10) appear to have two contrasting attitudes. The dark blue segments, on Figure 7.10, are either linked with orange segments that symbolise a belief that an evacuation is deemed impossible or with a purple segment indicating that the residents would be happy to evacuate. This means that regions that have not had to evacuate within living memory either, as noted previously, do not fully understand the implications of an evacuation and are therefore happy to obey the government if necessary, or in contrast believe that because they have never had to evacuate in the past and they will never have to in the future. This second perspective reinforces the idea that settlements that have 'lost' an oral volcanic history beyond 60 years (section 7.2.1) have no understanding that a large eruption could ever occur. They do not believe that an eruption could ever impact on their settlement and yet they live within 10 km of the summit dome of a volcano that has expelled pyroclastic flows that have travelled over 20 km within the last 100 years (section 3.1.3).

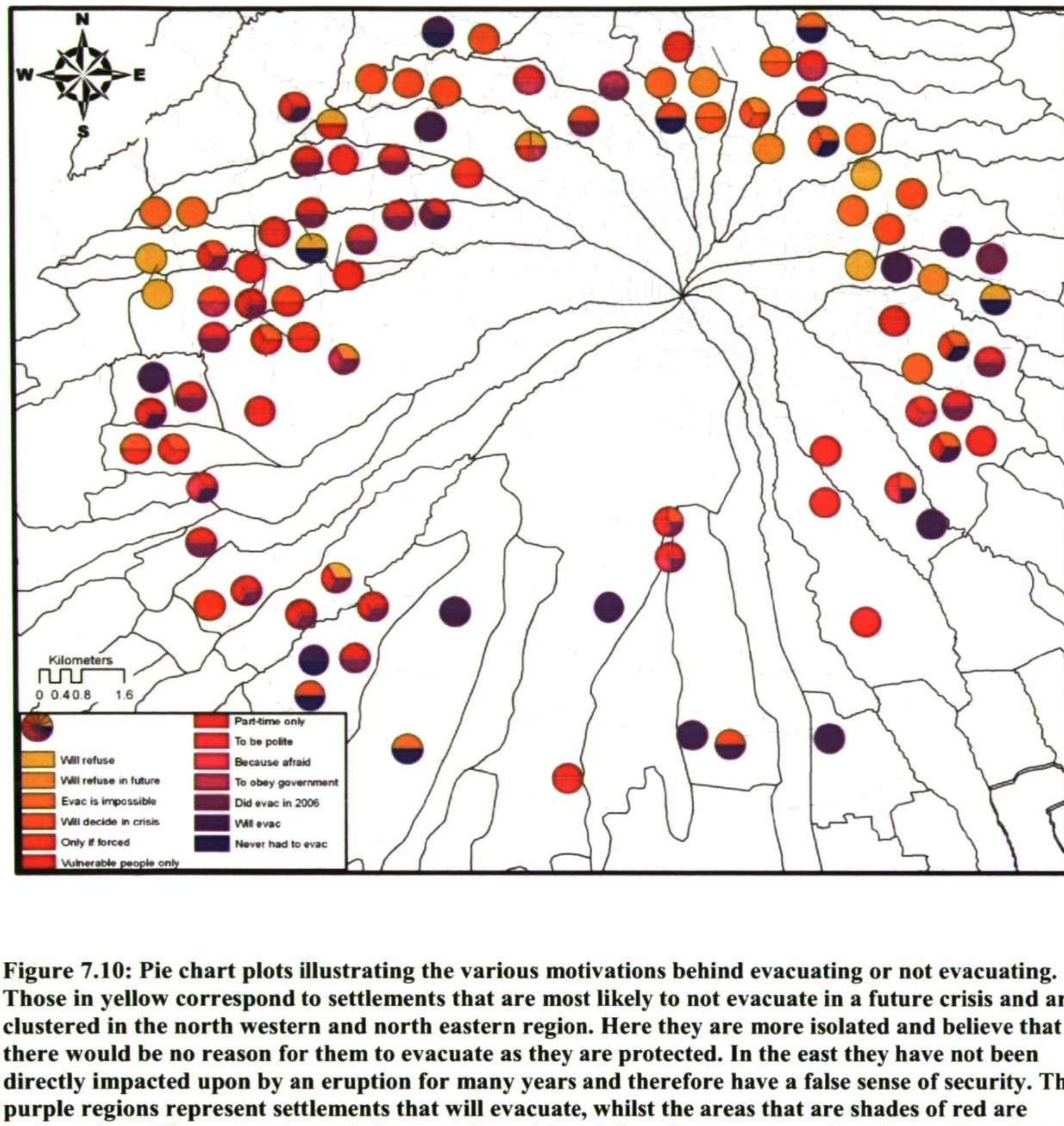


Figure 7.10: Pie chart plots illustrating the various motivations behind evacuating or not evacuating. Those in yellow correspond to settlements that are most likely to not evacuate in a future crisis and are clustered in the north western and north eastern region. Here they are more isolated and believe that there would be no reason for them to evacuate as they are protected. In the east they have not been directly impacted upon by an eruption for many years and therefore have a false sense of security. The purple regions represent settlements that will evacuate, whilst the areas that are shades of red are regions that will evacuate but only because they wish to follow the government's orders so they do not get into trouble. These regions are afraid for both the government and the hazards and although they are likely to evacuate they is also an element of distrust towards the government, leading to part-time evacuations or only evacuation a token number of vulnerable people.

7.5. Qualitative to quantitative: visualising elements of traditional culture through GIS.

The key cultural indicators, described in section 7.3, provide the template for designing a code based scoring system that enables the interview information to be converted into numerical data compatible with GIS. This process was originally inspired by the work of Cutter *et al.* (2003) who designed an index of social vulnerability to environmental hazards called the Social Vulnerability Index (SoVI), the basis of which is a numerical scoring system used to condense and map quantitative aspects of vulnerability. The basic principle here lies in scoring the key themes according to interpretations of cultural intensity and the will to evacuate. Although clearly a subjective interpretation of their world, this approach seems the most effective way of preparing the qualitative interview data for visualisation. Given that this process is experimental, and that it rests on various questionable assumptions a critique and reflection on this process is provided within chapter 8.

The interviews were coded according to key themes (Miles and Huberman 1994) and subsequently were chosen to form the basis of the scoring system displayed in Table 7.5. Scores were allocated to each theme or aspect of a theme relating to its influence and importance to the residents, for example, holding regular large ceremonies were allocated a high score.

After allocating scores to all the interview transcripts and then applying an additive process, the final score was calculated as a percentage of the highest mark (by using this method, these scores are specific to Mt Merapi). Once the final scores had been calculated (Table 7.6) it was possible to allocate them to each settlement within the original GIS base map for Mt Merapi.

Key Theme							
Culture	Code	Score	Additional Score	***Evacuation***	Code	Score	Additional scores
Ceremonies							
Muslim chanting for protection from volcano	A	1		**Would evacuate without any problems if government ask**	OO	1	
Having a wind /water ceremony	B	2		**Would evacuate without any problems as do not want to get blame or abandonment from government**	QQ	2	
Contributing or taking part in an other areas ceremony	C	3		**Would evacuate but believe it to be unnecessary**	RR	3	
Individual ceremonies	D	4		**Would obey government to be polite**	SS	4	
Hamlet ceremonies	E	5		**Would only evacuate vulnerable people if government ordered**	TT	8	
Village ceremonies	F	6		**Would only evacuate vulnerability and on PT basis**	UU	6	+ 1 for each of the following: **to feed livestock** Protect from thieves **It is safe** Fear of Creatures **Don't trust government** Boredom in evacuatation site
Regional ceremonies	G	7		**Would evacuate only PT**	WW	7	Same as above
Names of ceremonies	H	8		**Would wait, and watch eruption before deciding to evacuate**	XX	8	
Knowing and creating relevant offerings	I	9		**Would wait for signs before evacuating**	YY	9	
Knowing /believing the ceremonies are for protection	J	10		**Would wait for creatures to allow evacuation**	ZZ	10	
Doing additional ceremonies when there is an eruption	K	12		**Would never consider an evacuation as an option**	AB	11	
Chanting during regular Kenduri	L	13		**Refused to evacuate in 2006**	AC	12	
Ceremony includes an animal sacrifice	M	14		**Would never evacuate**	AD	13	
Regularity of	N	15	1 /yr - 1 2/yr - 2	**Government made**	AE	4	

ceremonies			3/yr - 4 4/yr - 8 1+month/3 5 days- 16 1+ week - 32	**them evacuate even though they believe it is safe**			
Creatures				**Will wait for both traditional and government warnings before evacuating**	AF	10	
Knowledge of creatures	P	1					
Knowing the names of main creatures	Q	2					
Knowing the names of additional creatures	R	3					
Belief in creatures ability to protect/punish/warn	S	4					
Having a local creature	T	5					
Knowing the stories of the creatures' origin	U	6					
Knowing the favourite offerings of creatures	W	7					
Knowing the locations of the creatures	X	8					
Knowing stories of creature – human interaction	Y	9					
Experienced creature – human interaction	Z	10					
Miscellaneous							
A knowledge of Gunung Bibi's relationship with Merapi	AA	1					
A belief that Gunung Bibi protects area	BB	2					
Knowing how Gunung Bibi protects area from Merapi	CC	3					
Calling Merapi a respectful name – grandparent	DD	4					
Calling an eruption a respectful name	EE	4					
Signs	FF						
A knowledge of one or more signs	GG	5	+ 1 point for each additional sign noted				
Experience in using/seeing these signs	II	7	+1 for use or observation of signs in 2006				

A reliance on the signs	JJ	8					
Taboos	KK						
Have a knowledge and use of taboos when climbing	LL	5	+ 1 for each taboo				
Having stories that relate to the origins of taboo	NN	7					

Table 7.5: Score guidelines designed from key themes and codes.

Hamlet	Cultural Intensity	Refusal to evacuate	Hamlet	Cultural Intensity	Refusal to evacuate
Bangunsari	48	7	Keningar	94	8
Batur	31	6	Kinarejo	90	9
Banoran	39	7	Ngandegan	7	1
Batur D	23	6	Ngargomulyo	35	8
Batur Ngisor	16	16	Ngargosoko	1	8
Bebedan D	75	13	Ngargotonto,	30.5	7
Bebedan A	64	11	Pagerjurang	23	6.6
Beling	15	7.5	Pajegan	11	7
Benjasari	17	1	Panggang	13	1
Blumbangsari	22	11	Pantiasih	3	4
Bojong	41	11	Pentongan	67	11
Bono Lor	33	7.3	Pedut	60	12
Bulu Kidul	42	13	Pelesari	67	7
Candi duwar	8	8	Plalangan	48.6	10.2
Candi Pos	7	8	Pojok	75	13
Candi Tengah	16	8	Pucang	9	2
Cangkol	59	8	Pule	15.6	3.7
Cluntang	14	8.5	Puncang	7	8
Dadapan	22	5	Puntang Sari	63	10.5
Delus	40	10	Salam	34.3	8.6
Demo	25	5.5	Samiran	54	5.75
Dukuh	13	2	Pentongan Bojok /Kuncan	37	8
Gadung	19.6	6.6	Sanden	72	9
Gemer	65	13	Sangup	14	3
Gendelan	54	7	Selo	37	11.2
Cluntang	13	8	Seman	26	8
Gobumi	4	9.5	Candi duwer/pos	15.5	7.5
Godang	16	1	Sepi	44	11
Gondangrejo	44	7	Soko	15	5.5
Gondo Arum	10	2	Stabilan	72.4	9.6
Gowoksengi	38	8	Sumber	52.2	7
Gowopos	55	4.6	Sumerejo	6.5	6.6
Gokosabrang	50	7	Suroteleng	63	8
Grogol	13	12	Tegalrandu	5.5	4
Gumuk	48	5	Tempel	14	7
Gumukrejo	27	4	Temusari	50	8
Jamburejo	28.5	6	Tenan	32	7
Jelok	62	4	Tenusari	23	3
Jengglik	5	4.3	Tlogolele	58	6

Sepi	35	4	Trayem	63	8
Kedung	35	7.5	Tunggularum	14.4	6.5
Kacangsoko	21.5	7.3	Tutup	47	13
Kalibening	25	7	Windusabrang	53	7.5
Kalitengah	27	2	Windusari	60	7
Kaliurang Lor	25.5	6	Wonodoyo	8	11
Kaliurang	0	1	Wonosari	21	8
Kamiran	46	13			
Karang	41	6			

Table 7.6: Resultant scores for settlement.

According to Table 7.6 the most culturally intense settlement is Keningar that is located in the north-western sector of the volcano. Keningar is extremely isolated and positioned high on the volcano, they chant and hold ceremonies for Mt Merapi every 35 days and if necessary they hold additional ceremonies for extra protection. The residents of this remote settlement also rely on both premonitions and animal movements as precursors to an eruption. Despite their isolation and proximity to the summit, the residents would wait and watch an eruption before deciding whether to evacuate or not. Keningar therefore appears to be socially vulnerable, due to their isolation, and also culturally intense.

The most likely to refuse an evacuation order is Batur Ngisor located on the western flank just south of Keningar. Batur Ngisor is a settlement that has had a previously bad experience during an evacuation, as, according to an informant the government tried to steal their land whilst they were evacuated, and on returning home found everything had been sold. So despite being in a region that has been more frequently affected by eruptions they distrust the government to such an extent that they would rather stay in their threatened homes than evacuate.

In order to evaluate whether there is a statistical correlation between cultural intensity and a refusal to evacuate the data was processed using Statistical Package for Social Sciences (SPSS). Initially the data sets are examined individually and then various bivariate correlation statistics can be applied, such as Pearson's product-moment correlation, Spearman's rho correlation or Kendalls's correlation. Figures 7.11 and 7.12 are the provide the distributions of each data set and from appearances it seems that the evacuation data form a normal distribution, yet, according to the Kolmogorov-Smirnov test the cultural intensity scores ($D(113)=0.095$, $p<.05$) and the refusal to evacuate scores ($D(113)=0.148$, $p,<.05$) are both significantly non-normal. Because of this Spearman's correlation coefficient and Kendall's tau can be applied to identify whether the data is correlated. According to Spearman's Rho coefficient there is a significant positive relationship between cultural intensity and a refusal to evacuate, $r_s = .43$, $p<.05$, whilst Kendall's tau (used there are many scores with a tied rank) confirms this, $\tau=.31$. $p<.05$ (Table 7.7).

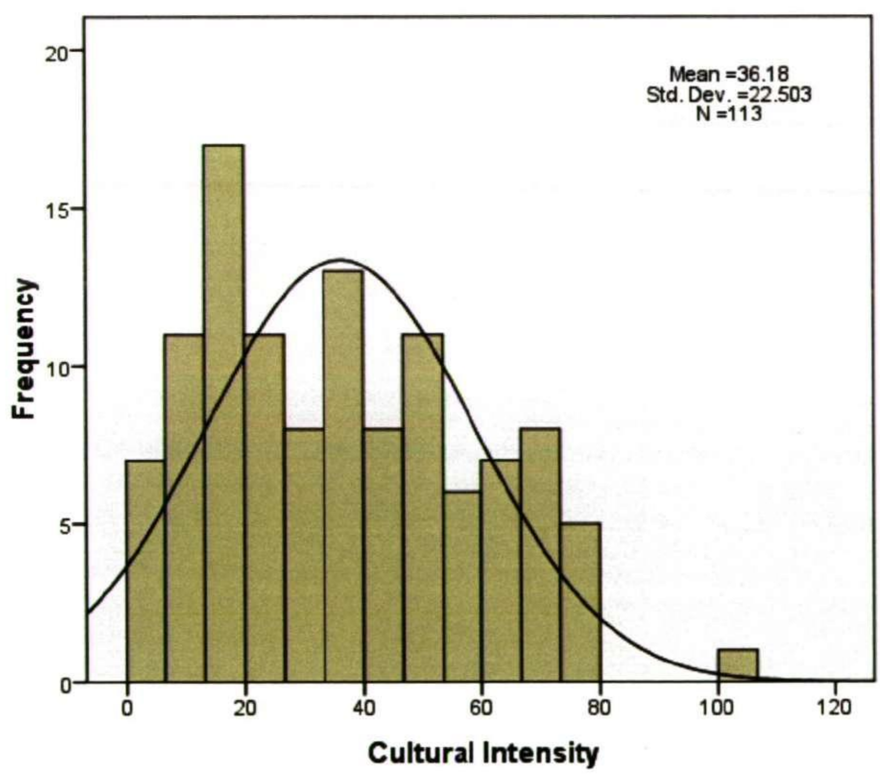


Figure 7.11: Distribution of cultural intensity scores designed in SPSS.

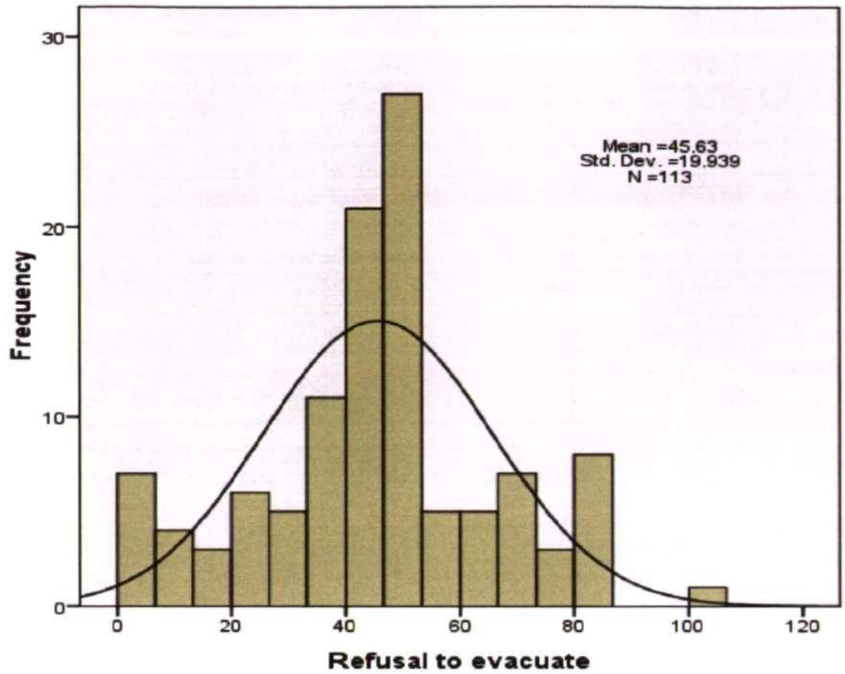


Figure 7.12: Distribution of the refusal to evacuate scores designed using SPSS.

Correlations

			V7	V8
Kendall's tau_b	Cult. Int.	Correlation Coefficient	1.000	.318**
		Sig. (1-tailed)	.	.000
		N	113	113
	Evac.	Correlation Coefficient	.318**	1.000
		Sig. (1-tailed)	.000	.
		N	113	113
Spearman's rho	Cult. Int.	Correlation Coefficient	1.000	.434**
		Sig. (1-tailed)	.	.000
		N	113	113
	Evac.	Correlation Coefficient	.434**	1.000
		Sig. (1-tailed)	.000	.
		N	113	113

**. Correlation is significant at the 0.01 level (1-tailed).

Table 7.7: Statistical correlation output for Kendall's tau and Spearman's rho coefficient.

Although according to Libarkin and Kurdziel (2002), qualitative data is not usually 'testable' by standard statistical means it is important to provide a full evacualtion of the data. Yet representing this data in a table or statistically is not as visually effective as displaying the information in a map format, therefore the following section examines the transformation and comparison of this data in a map.

7. 6. The Maps: Visualising qualitative data.

The initial hypothesis, based on the 2007 field season results, suggested where there was strong traditional belief system there was also a lack of motivation to evacuate. This hypothesis can now be tested through the comparison of the maps of final cultural intensity and refusal to evacuate maps. Figures 7.13 and 7.14 are the resultant maps displaying the cultural intensity and refusal to evacuate scores.

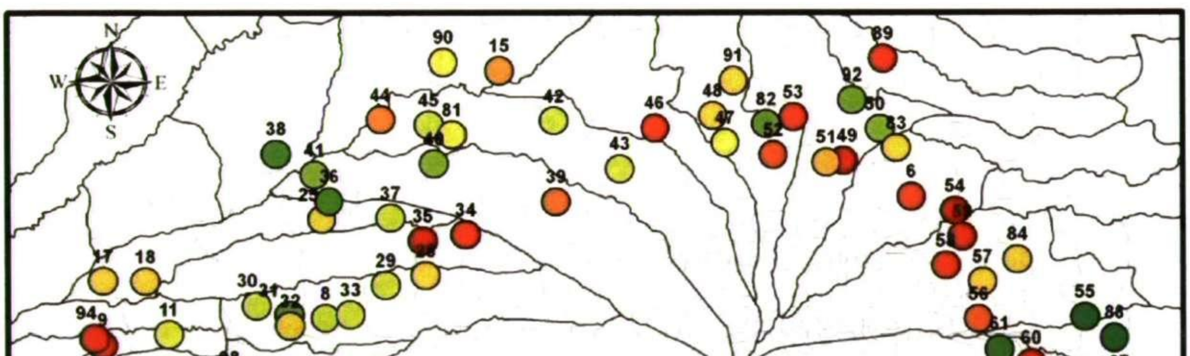


Figure 7.13: Resultant plot of the refusal to evacuate. Red areas are more likely to refuse to evacuate (with a score 70-100) and dark and light green areas are more likely to evacuate when ordered (with a score 0-20 dark and 20-40 light green).

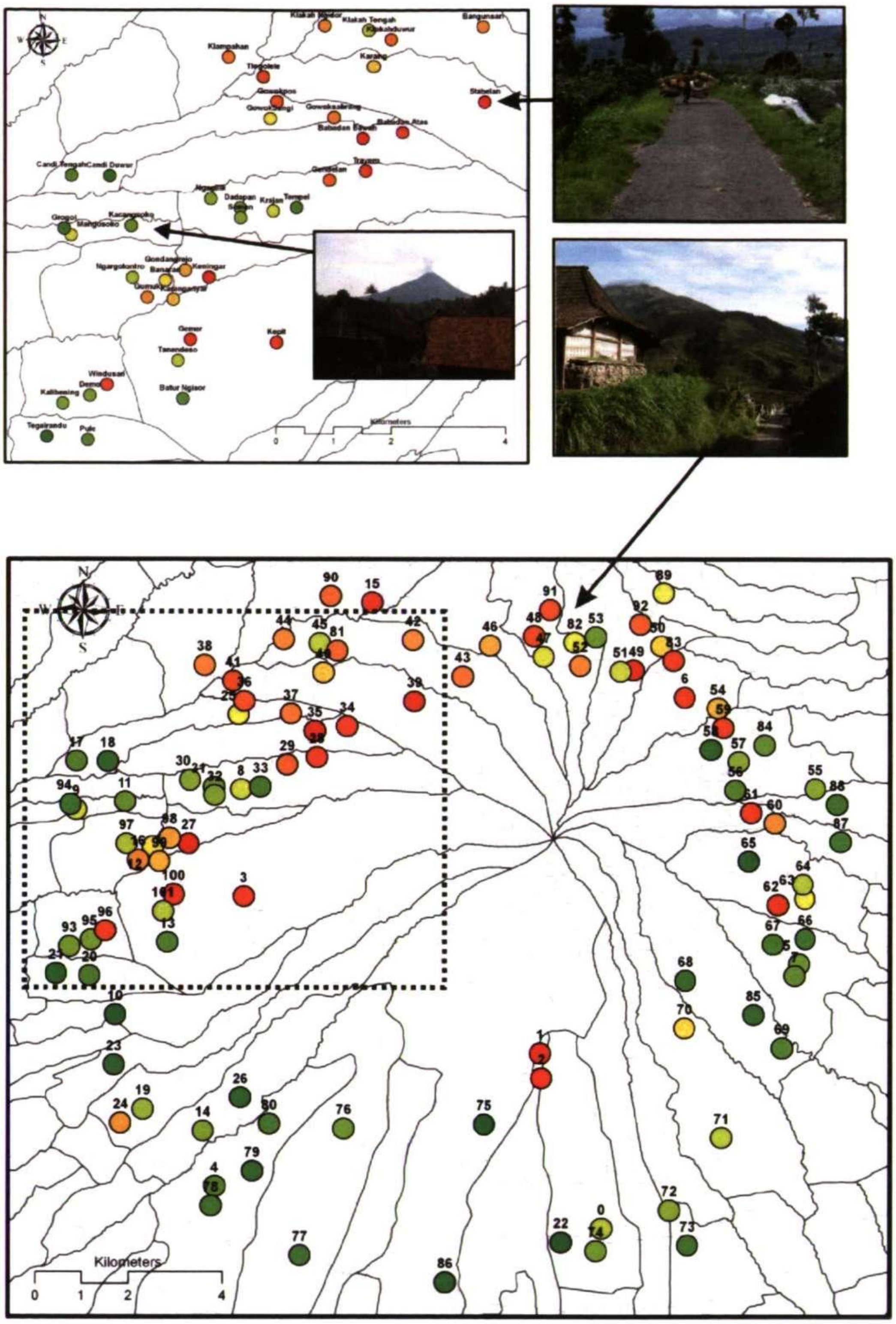


Figure 7.14: Resultant plot of cultural intensity scores. Areas that are red to orange have a very high to high relative intensity (Score 60-100), those that are yellow to orange have a moderate cultural intensity (scoring 30-60) and those areas that are dark to light green have a low to no cultural intensity (score 0-30). The photographs illustrate the remoteness (proximity to the summit) and quality of infrastructure in the northern regions. Near Stabilan roads are narrow and in poor condition, whilst in the north there is only one access road that links the villages.

The different methods used to visualize data are important and can have a large influence on interpreting information. Although using GIS to visualise data spatially is necessary in order to identify relationships and integrate various information there are concerns that using sophisticated modelling such as certain an interpolation process, could increase the uncertainty of the information displayed (Cloke *et al.* 2004). Various concerns relating to the use of quantitative analysis to examine and display social information is considered in section 6.5.1, and it is important to reconsider the uncertainties of displaying information through mathematical manipulations and visualizing the results via a map format. A noted in section 6.5.1, Pickles (1995) is described by Cloke *et al.* (2004) as viciously attacking the use of GIS, and although perhaps his arguments are extremely direct they do highlight fundamental issues with GIS and geocomputation.

MacEachen (1992:10) explains that by visualizing data the researcher is representing just a snapshot of the 'real world' and that there is a tendency to 'treat both maps and computers as less fallible than the human who make decisions they are based upon'. Cloke *et al.* (2004:280) are more direct, contending that 'GIS users know how to operate the system but not how it is conceived or how it works in detail'. In other words, perhaps the ability and desire to produce smooth, unflawed, aesthetically pleasing maps through readily available GIS packages has led to rapid widespread use of GIS throughout all disciplines without the epistemological development that conventionally accompanies the slow expansion of new methods and theories. Crampton (2001) notes that the infallible nature of computer generated or manipulated information is not a recent concept born out of modern computing but one that is fundamental to cartography. Wright (1942:527) discusses this issue stating that a well prepared and drawn map leads to an 'air of scientific authenticity that may or may not be deserved'. Although this research does not attempt to explore the flaws and ethics of mapping or GIS and certain visualisations in vast detail, it is important that these issues are acknowledged and openly discussed. It is worth considering issues such as uncertainty, GIS as a top-down approach, the subjective nature of data manipulation, the flawed expectation of geo-computerised information, or the modelling of raw data beyond recognition and therefore validity, as the final maps are discussed in order to appreciate that maps are just subjective representations of our interpretation of the world.

There are numerous methods of visualising knowledge through cartography and therefore various ways in which to manipulate information through mathematical process or cartographically, by changing symbol displays, colours, multiply attribute displays or zoning (MacEachren and Kraak 1997; Skupin 2004). The previous section demonstrated the various visualizations possible for this data varying from the use of pie chart plots (for example Figure 7.10) to natural neighbour interpolation (for example Figures 7.7, 7.8). The simple plots are preferable in comparing individual indicators and producing a more realistic representation of the original data, without predicting missing information or manipulating the scoring systems. These simple plots reveal spatial relationships through the use of colour and symbols rather than mathematical, resisting the positivism of mathematical modelling (Barnes 1996).

The simple plot maps, Figures 7.13 and 7.14 have been designed to allow direct comparison of the scores through colour association. Areas where there is a strong variation within a small spatiality can be compared with the original interview transcript and observation in order to identify why these areas are so diverse. Although the maps have generated many interesting spatial themes the following section will discuss only three main ideas that could explain anomalies and clustering of intensely cultural regions.

Previous traumatic evacuations increase future evacuation failure: According to Figure 7.13 the south western section of the volcano is dominated by a willingness to evacuate (represented by a green symbol), yet there is one red plot that contrasts with the general pattern (settlement 24, Kamiran). According to the original hypothesis, where an increased cultural intensity is correlates with an evacuation failure, this settlement of moderately low culturally intensity, shown in Figure 7.14, should be 'happy' to co-operate if the government order an evacuation during a crisis, yet according to Figure 7.13 they are not willing to evacuate. One explanation of this outlier is that Kamiran village is made up of only three hamlets (Jengglik, Jamburejo and Kamiran) because all the hamlets above the existing ones were destroyed by eruptions in 1930 and 1960. The head of Jengglik described how the residents returned to the destroyed area illegally and rebuilt their homes and started to cultivate the land again. The desire to return to their homeland and the fear of being forcibly transmigrated outweighed the danger. According to the head of the village, residents of Kamiran have experienced "traumatic" evacuations in the past. These include being forcibly removed from their village and some have had to transmigrate to Lampong in Sumatra. It seems that these experiences have made the Kamiran villagers more resolute and determined not to be forcably moved from their homes again.

Kamiran has been identified by the local officials as at high risk and have been targeted for evacuation drills. Chapter 8 will discuss these educational methods at at Kamiran village in an attempt to raise hazard awareness and encourage future corporations during an eruption.

Lack of hazard experience creates an unrealistic notion of safety: The eastern flank residents have had a lack of direct volcanic hazard experience, with no recorded pyroclastic flows since 1100-1600 BP (chapter 6) and the dominance of Gunung Bibi leads to an unrealistic belief that their region is safe. The maps represent this through an increased failure to evacuate on the north eastern and eastern flanks shown in Figure 7.13. There is a varied level of cultural intensity on the eastern flank but generally there is a lack of traditional belief related to the volcano, however according to the transcripts there are ceremonies held for the other hazards that affect this region, such as strong winds and drought.

Clustering of intense culture: The north-west flank of Mt Merapi has a cluster of culturally intense settlements (Figure 7.14) from Stabilan (39) south to Kepit (3). As with Keningar, it appears that the higher and more remote a settlement is, the more culturally intense it seems to be. Stabilan was not only identified as culturally intense through interviews and observations but was also renowned amongst other informants for its strong spiritual connection with Mt Merapi. According to some it is home to an important supernatural creature, which will not allow the villagers to leave during an eruption. The people of Stabilan have a reputation for 'braving' the hazards until the creature allows them to leave.

The relationship between isolation and cultural intensity can be examined by mapping the trends of the data. Figures 7.15 and 7.16 have been produced by the trend calculation using the trend tool within ArcMap. A trend surface is a useful way to represent a broad variation through a smooth function (Haining 2003). It is produced by mathematically defining a surface using the existing data points that intercepts the majority of data points thereby reducing the difference between the real data and the interpolated results (Heywood, Cornelius and Carver 2006). The user can then adjust the 'smoothness' of the visualization according to the polynomial setting.

When applied to Figure 7.14 the cultural intensity appears to increase with altitude and produces a bull's eye pattern centred just north-west of the summit. Applying the same modelling technique to the evacuation scores produces a slightly different pattern skewed by the cluster of hamlets on the high western section of Mt Merapi. This shows that the areas more likely to evacuate are areas that have been regularly affected by volcanic hazards, such as the western flanks (swept by pyroclastic flows every 8- 15 years and

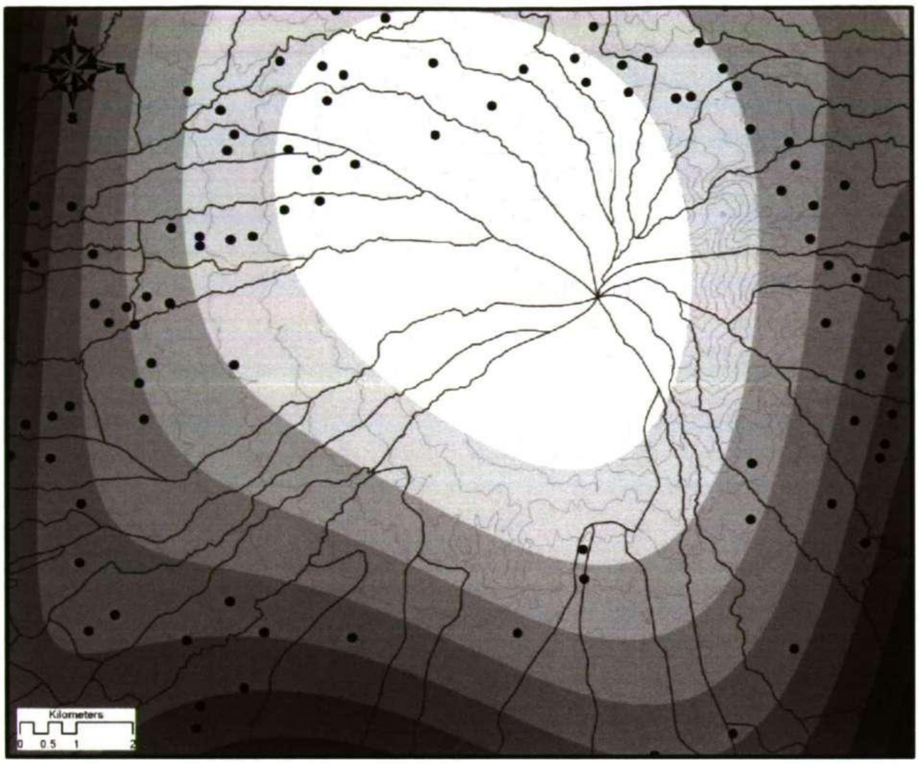


Figure 7.15: Cultural intensity scores visualised using a trend model with 9th order polynomial setting. The trend visualises the idea that with altitude cultural intensity increases. Therefore regions that are already isolated and as such socially vulnerable are additionally culturally vulnerable.

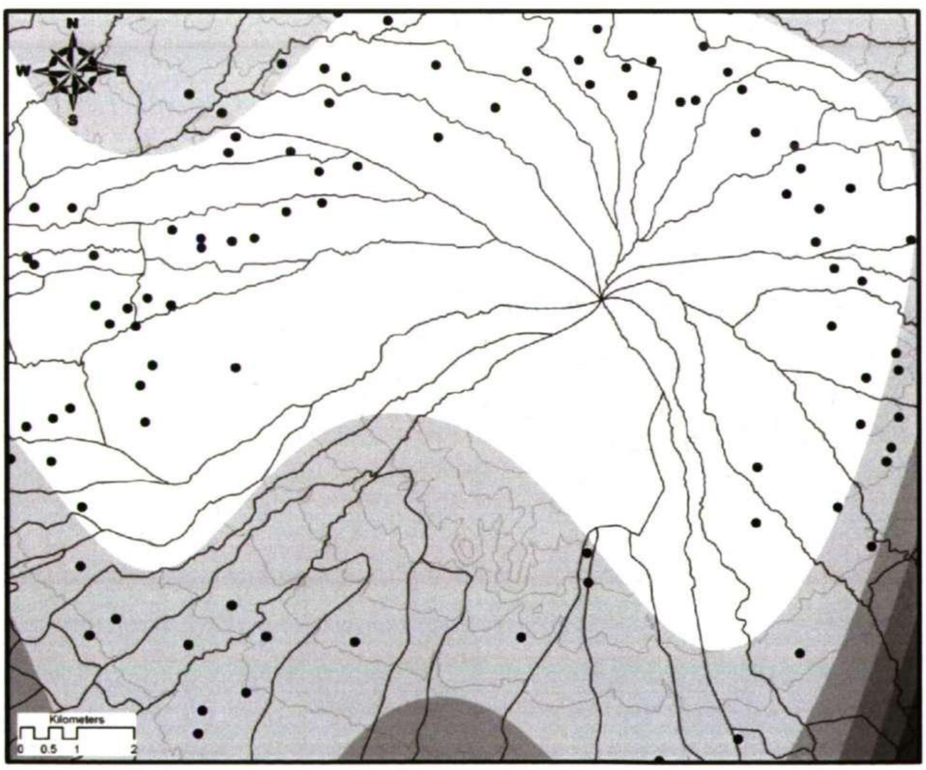


Figure 7.16: The will to evacuate is visualised using a trend model with 9th order polynomial. Here the trend indicates that the north and north-western regions are less likely to evacuate than the southern areas.

lahars every 2-4 years according to Thouret *et al.* 2000). The use of trend surface analysis purposely smooths relationships reducing mathematically 'insignificant' anomalies in the data and allocating predicted numerical values where information has not been sampled. Consequently these maps should only be used in correspondence with simple plot maps and raw data, and not considered as a true representation of the data. Instead, they demonstrate how mathematical modelling can alter visualizations without changing the underlying relative reasoning.

Overall, through various representations, the data from 2009 suggests that high cultural intensity does correspond with regions of high evacuation failure. This in turn, indicates that the traditional cultures at Mt Merapi are adding to the residents' vulnerability. Although, other influences such as remoteness, economic dependencies and authoritative trust issues, are considerable, at Mt Merapi local customs would appear to be an important supplementary factor of increasing vulnerability. In order to take this information forward and allow it to be useful, it is necessary to compare and integrate this spatial information with other elements of vulnerability and risk. In other words, cultural vulnerability can be, and should be taken into consideration during risk map production.

7.6.1. Preparing cultural vulnerability for integration with risk maps: Predicting the missing data.

The number and location of samples within this survey are not sufficient to produce a spatially complete map needed for risk analysis, and therefore it is necessary to predict results in non-sampled areas. Interpolation of data in order to predict missing point information can provide a useful estimation, especially in spatially large field sites, such as Mt Merapi. In disaster management it is necessary to have information on entire areas of high hazard not just sampled points. When producing risk maps for volcanic regions, data is interpolated in order to visualise information that covers the entire area leaving no zones of ambiguity. This concept was trialled during the pilot survey using the natural neighbour interpolation tool within ArcGIS (section 7.1.2). In order for cultural vulnerability to be incorporated into risk maps it is therefore necessary to generate a cultural vulnerability map that is spatially complete, even if that is only derived through a process of interpolation. In this case there is an irregular sample and using an interpolation process could allow an estimate of data between sampled points (Gold 1989, Stein 1999, Haywood, Cornelius and Carver 2006).

7.6.1.1. Interpolation.

Interpolation techniques vary from using Theisson polygons to Triangulation to a combination of both called Natural Neighbour interpolation (Webster and Oliver 2007). Natural Neighbour interpolation designed by Sibson (1981) initially seemed like a logical choice for this survey data, as every point is calculated by its natural neighbour nodes and it has the ability to handle spatially irregular data sets (Sambridge, Braun and McQueen 2007). Natural Neighbour is calculated from the following equation:

$$G(x,y) = \sum_{i=1}^{n} W_i f(x_i, y_i)$$

Equation 7.1: The Natural Neighbour calculation used for GIS interpolation.

Where $G(x,y)$ is the estimate at (x, y), w_i are the weights, determined through Delauney triangulation (Lee and Schechter 1980) and $f(x_i,y_i)$ are the known data at (x_i,y_i). This mathematical model produces a smooth surface everywhere except the original sites. This means that an estimated surface is produced without removing the sampled data points.

Figures 7.17 and 7.18 display the cultural intensity scores and the refusal to evacuation data once it has been processed using the Natural Neighbour tool in ArcGIS. The interpolation is shown in a 'doughnut' pattern encircling the volcano's summit because there are no settlements at an altitude higher than 1700m and approximately 110m in the south west, and therefore no social data (in addition as data is predicted further away from actual data points uncertainty increases and the predicted data becomes increasingly invalid). The maps are displayed using a natural jenks categorisation (10 jenks natural breaks in the data) in order to visualise a more realistic and emphasise data patterns. Using this visualisation emphasises the areas of high cultural intensity and refusal to evacuate. It also demonstrates the variable culture on the eastern flank and tendency of higher altitude settlements to defy an evacuation order.

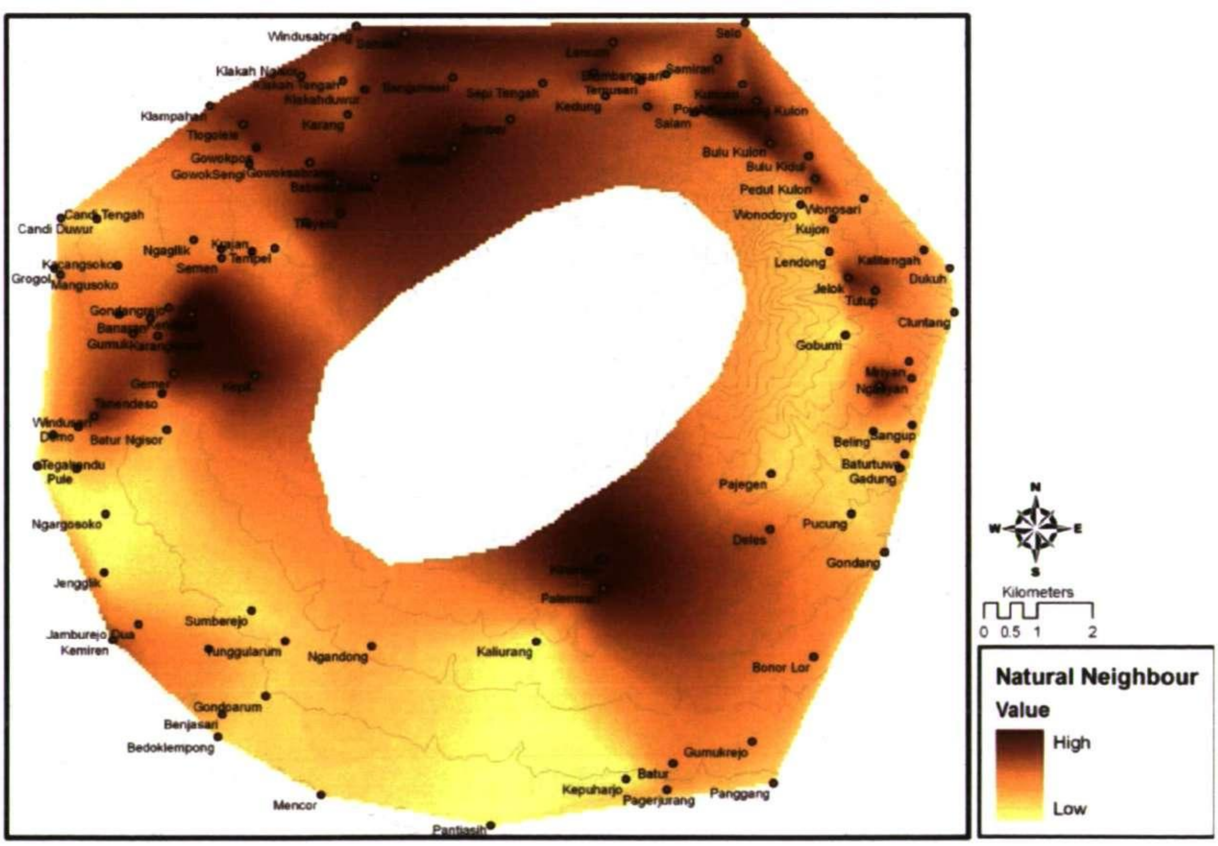


Figure 7.17: Cultural intensity displayed using a natural neighbour interpolation and natural 10 jenks categorisation.

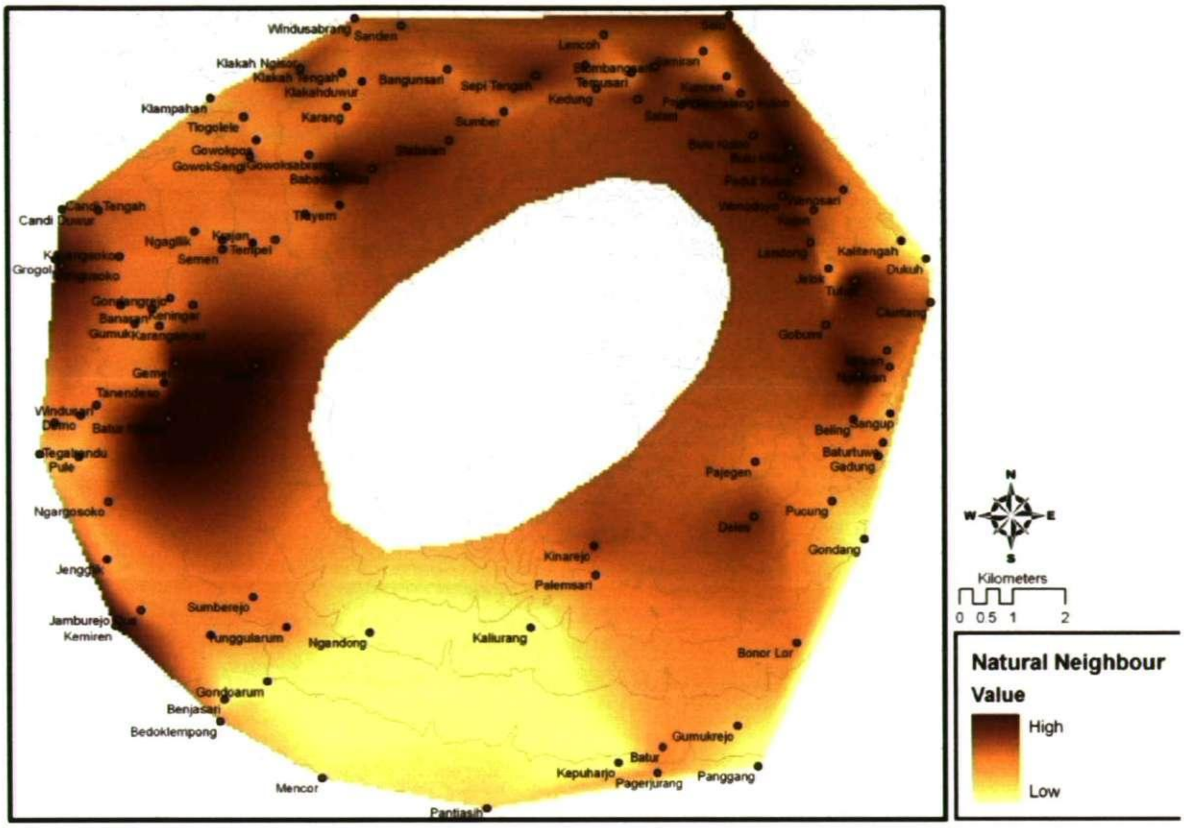


Figure 7.18: Refusal to evacuate displayed using a natural neighbour interpolation and natural jenks categorisation.

Although the interpolated and other GIS manipulated maps produce smooth continuous plots the level of error and uncertainty is considered relatively high (Brown and Heuvelink 2008). Openshaw (1989:263) notes that 'GIS has the potential to dramatically increase both magnitude and importance of errors in spatial data bases', but despite this fatality of spatial analysis there are no tools for measuring such inaccuracies and no methods to measure their significance. As a consequence Barnes's (1998:204) suggestion that 'quantitative and cultural approaches are both necessary, shedding light in different ways on social life' seems more pertinent and essential. It now seems that exploring society requires quantitative and qualitative enquiries that are interdependent, especially when exploring spatial variability. This GIS and quantitative error therefore supports the necessity of interdisciplinary research.

According to MacEachen (1992) and MacEachen *et al.* (2005) it is possible to simply visualise uncertainty within data by various methods such as reducing resolution, buffering, 'fuzzing' lines and reducing fill clarity. These methods are purely visual and allow the user to realise that the data has uncertainties and therefore the map ought to be used with due caution. Yet, these methods do not provide calculation of uncertainties. The reliability of the maps depends on the accuracy of the original qualitative data, the interpretation and the truth of data?

It is possible to map the uncertainty with the interpolation process although only by through another interpolation technique called Kriging. Kriging uses a geostatistical process based on the distance from the predicted point and/ or on the number of 'real' data points around that predicted point (Burrough and McDonnell 1998). This process is based on Tobler's first law of geography that suggests, 'everything is related to everything else, but near things are more related than distant things' (Tobler 1970, contested by Miller 2004). Using Kriging, the interpolation provides a local representation of the spatial data, giving a potentially more accurate map. The accuracy of the map can also be displayed through a map displaying variance within the data. Figures 7.19 and 7.20 display the scored data as a Kriging calculated visualisation, whilst Figures 7.21 and 7.22 are the corresponding variant maps.

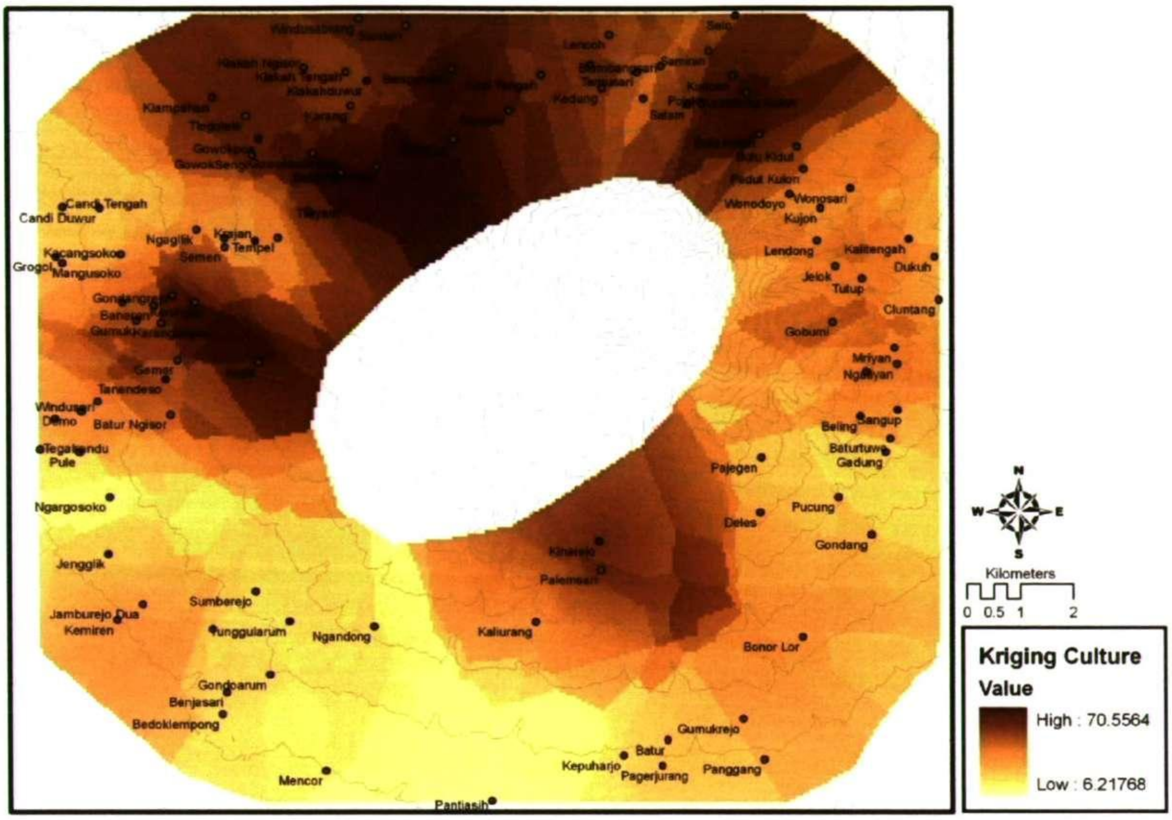


Figure 7.19: Cultural Intensity displayed using a Kriging Interpolation.

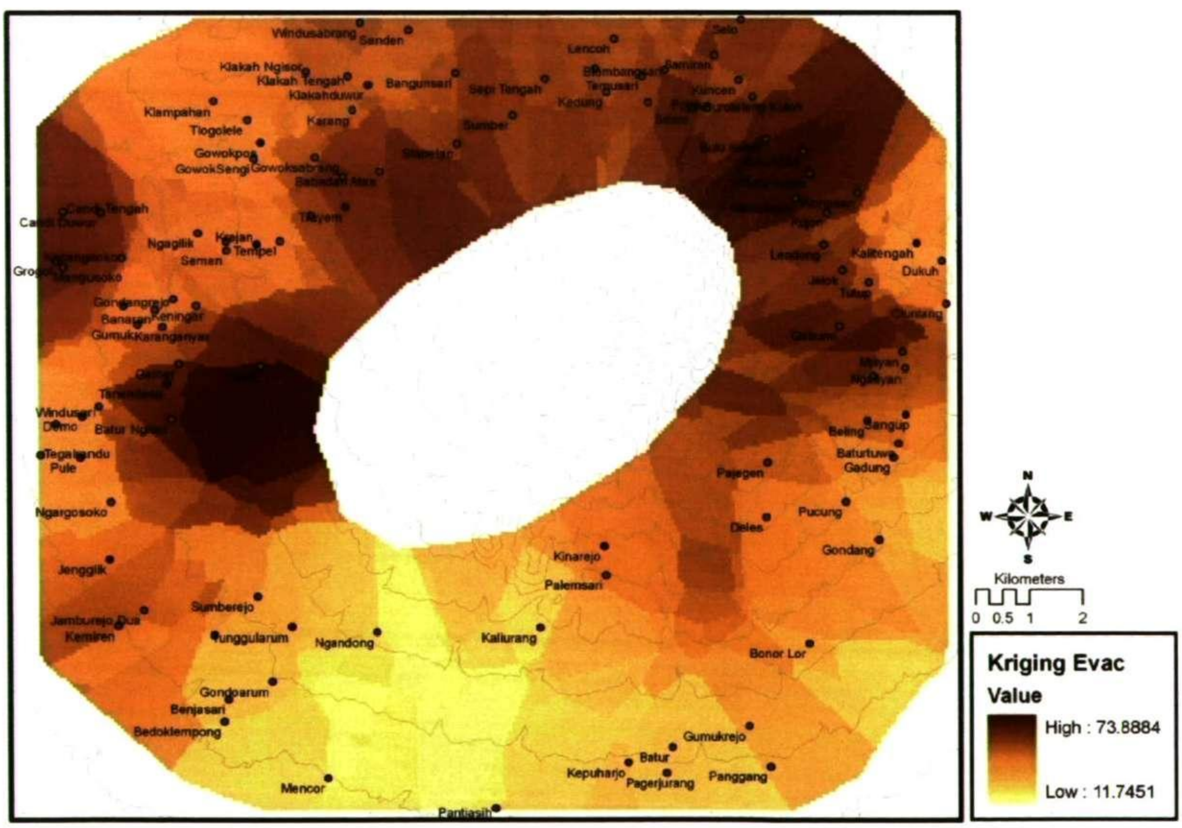


Figure 7.20: Evacuation data displayed using Kriging Interpolation.

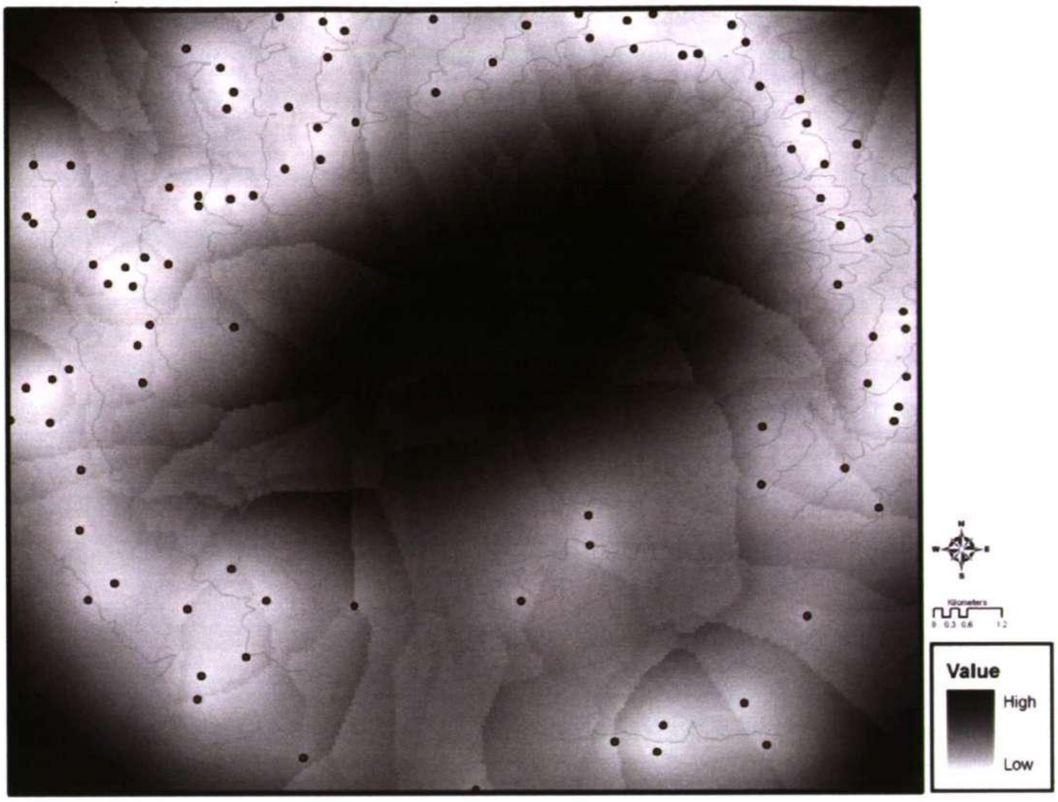


Figure 7.21: A variant map for cultural intensity, displays uncertainty of Kriging interpolation. As the prediction gets further from the actual data set uncertainty increases.

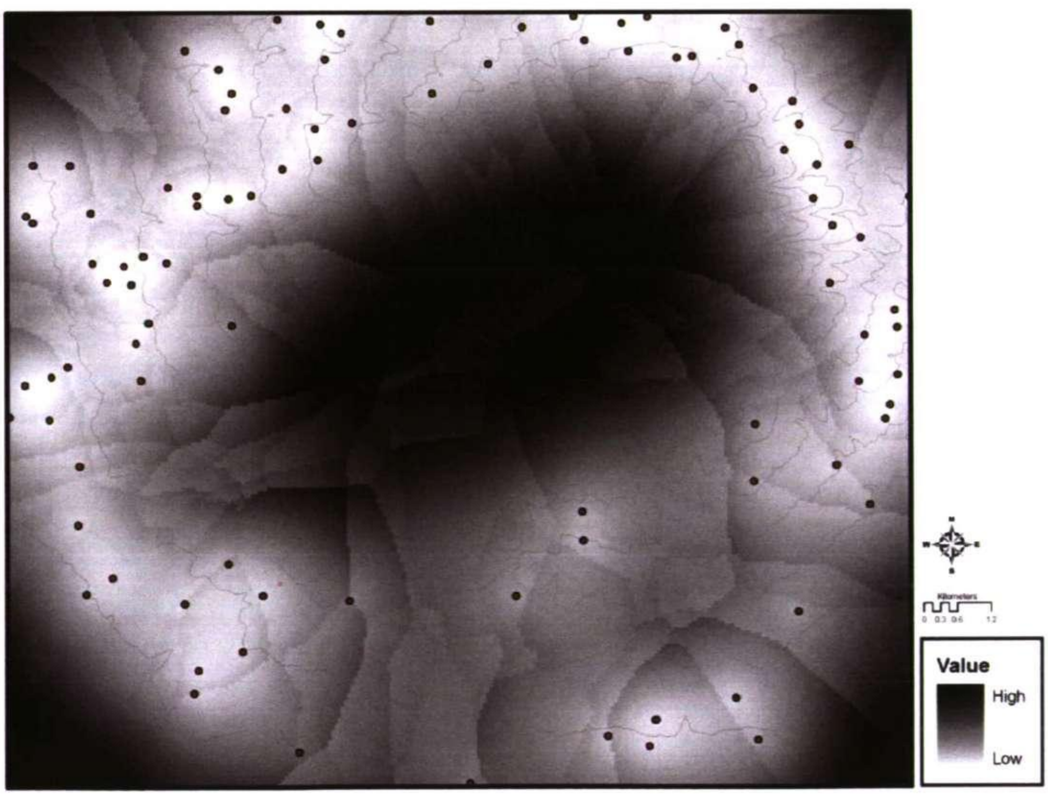


Figure 7.22: A variant map for refusal to evacuate data.

Variant maps represent the uncertainty of the interpolation. Areas of low score (white) are regions of low uncertainty and areas of high score are regions where the predicted data is less likely to replicate actual data. This is one way of showing uncertainty within an interpolation and within a spatially influenced random data set, where certain areas are less sampled than others. What this does not show is whether, compared to other interpolation techniques, this is the best fit for our data. There are other types of interpolation such as Inverse Distance Weighted (IDW) that assumes the predicted data is a 'distance-weighted average of data points occurring within a neighbourhood' around that point (Burrough and Mc Donnell 1998:117).

So far the final scores have been displayed using both Natural Neighbour and Kriging interpolation processes, yet it is possible to decide which method is most appropriate for the data by calculating the Route Mean Square Error (RMSE) (Pitt and Myung 2002). RMSE is calculated by comparing the difference between actual data and predicted data in the same location and imputing these results into the following equation:

$$\mathrm{RMSE} = \sqrt{((\sum \Delta^2)/n)}$$

Equation 7.2: Route Mean Square Error (RMSE).

The square route of the sum of the differences squared between predicted data and actual data at one location ($\sum \Delta^2$) divided by the number of locations sampled (*n*).

This process has been applied to each actual sample using Kriging, IDW, and Natural Neighbour interpolations, the results are displayed in Table 7.8. High results indicate a high error and the lower the result the better the fit of the data to the interpolated data. From Table 7.8 it is clear that the interpolation process that provides the best fit for this data is actually neither Kriging nor Natural Neighbour, but instead IDW.

In conclusion although the Kriging method is recommended because it allows the viewer to observe the uncertainty within the interpolation and it allows a certain amount of user preferences (such as size of influencing plots or distance) it seems for this data series IDW provides the best fit. Figures 7.23 and 7.24 provide the final interpolated data in IDW and Figure 7.25 and 7.26 show the potential to overlay the interpolation on a three-dimensional image of the volcano, allowing a visually easier process of interpretation.

Data	Kriging	IDW	Natural Neighbour
Cultural Intensity	13.39	0.13	3.73
Refusal to evacuate	13.71	0.14	8.48

Table 7.8: RMSE results for three interpolation processes.

Figures 7.23 shows that cultural intensity appears focused predominantly on the north-western region, as well as the area around Pelemsari in the south, corresponding with previous findings. Figure 7.24 provides a more interactive examination of the data and shows that cultural intensity also seems to correspond to altitude. For example, regions high on the volcano, such as Pelemsari and Stabilan in the north, appear to have a more cultural intensity. Their remote location and higher volcanic threat has led to an increased and maintained cultural belief system. The three dimensional model highlights this relationship showing how different visualizations can emphasize or absorb certain patterns. Comparing Figure 7.23 with Figures 7.24 confirms that there is a correlation between areas of high cultural intensity and a high failure to evacuate. Figure 7.25 also emphasises an area of high evacuation failure centered on Batur Ngisor and Kepit, regions that have experienced traumatic past evacuations in the past. Other areas that have been emphasised as having a high evacuation failure are on the western outer reaches of the survey. These areas, focused on Grogol and Jamburejo are regions that do not have a particularly high cultural intensity; the residents of Grogol and the surrounding area do not believe the hazards could reach their homes and therefore will wait and watch the eruption and make their own decision whether to evacuate or not. Jamurejo in the southwest is located in a region that has a strong Islamic influence and the residents repeatedly discuss the negative impacts of the transmigration policy of the 1960s.

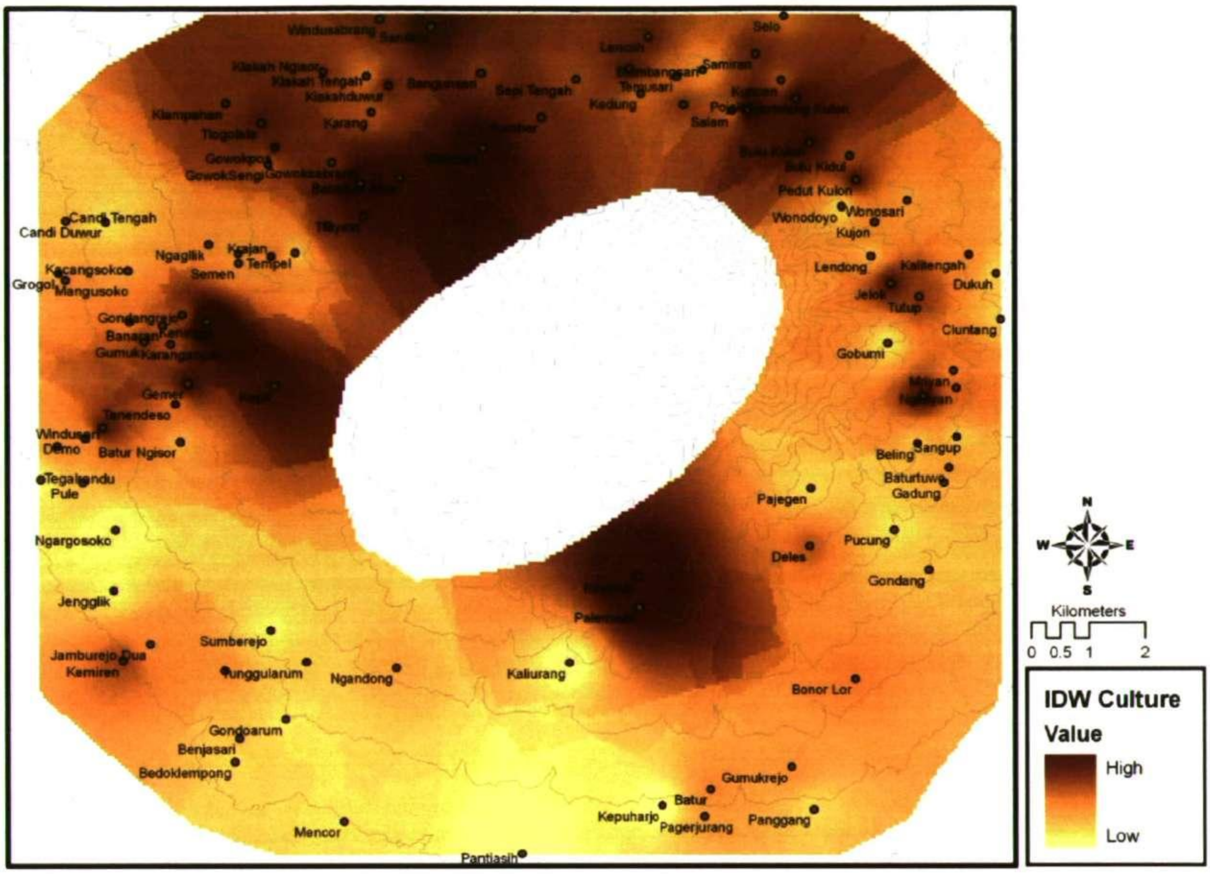


Figure 7.23: Cultural Intensity scores mapped using an IDW interpolation technique.

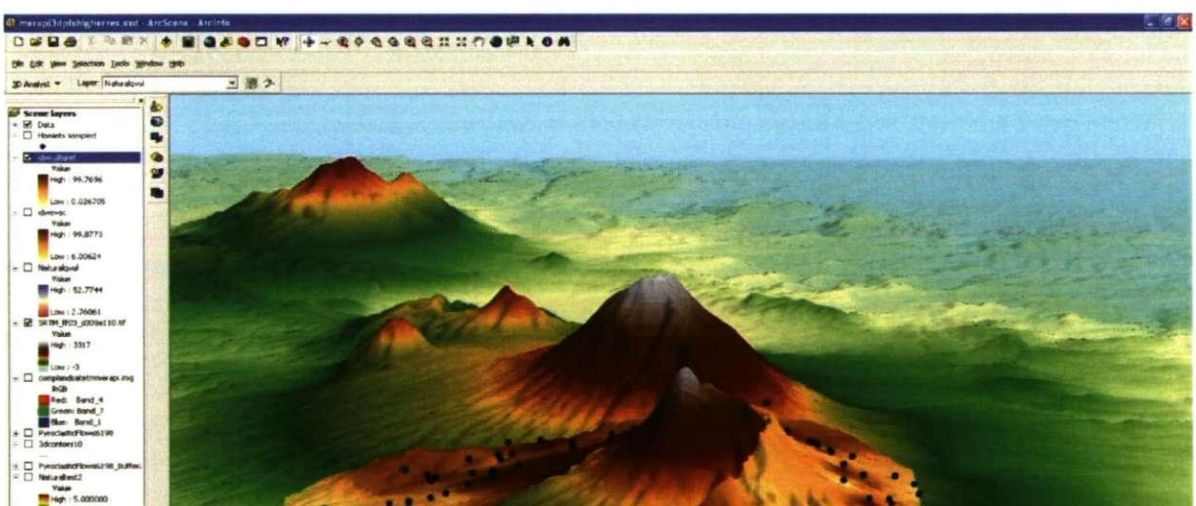


Figure 7.24: Screen view of Mt Merapi in three dimensions with IDW interpolation of cultural intensity and sampled settlements overlain.

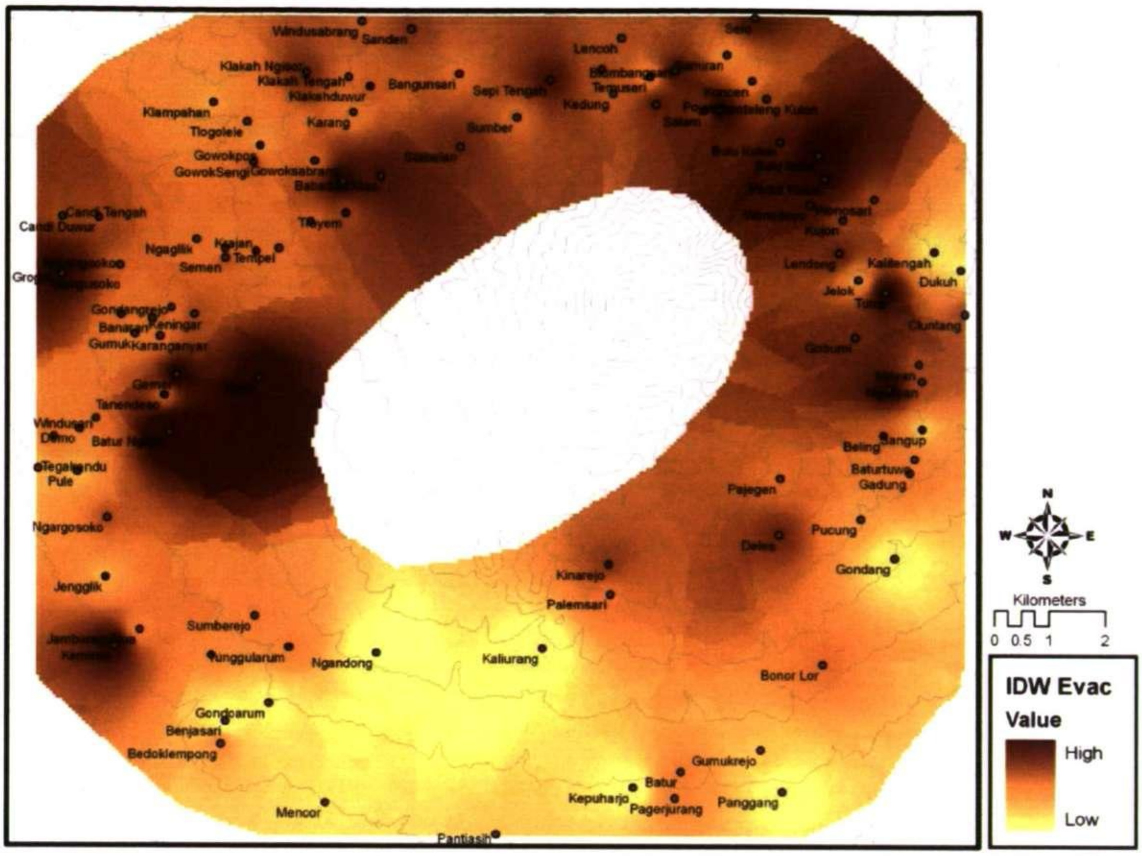


Figure 7.25: Refusal to evacuate scores map using an IDW interpolation technique.

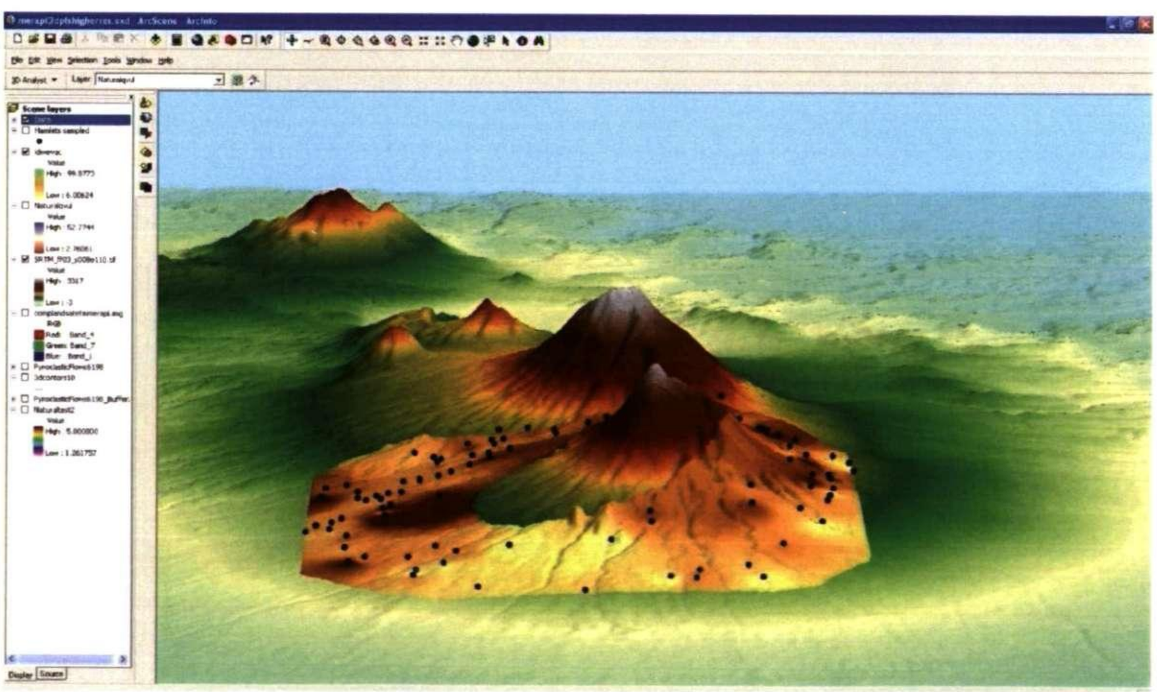


Figure 7.26: Screen view of Mt Merapi in three dimensions with IDW interpolation of the refusal to evacuate data and sampled settlements overlain.

7.7. Summary.

By discussing just a selection of the patterns and relationships in this data it is clear that the people living on Mt Merapi are influenced by a complex range of social, economic and political factors. Yet by viewing the data through an interpolated map the relationship between cultural intensity and evacuation failure is emphasised. These patterns correspond with, and reinforce, the idea that intense cultural beliefs at Mt Merapi correlate with regions of evacuation failure. Cultural beliefs are therefore an important element making people at this volcano more vulnerable. These interpolated raster maps can now be added to other valuable raster maps, for example, social vulnerability maps in order to produce holistically visualised vulnerability.

Interpolation, visualisation and mathematical manipulation of data within GIS are all important issues that influence the interpretation of results. Yet it is the original 'truth' of the data series that determines the ultimate uncertainties within this kind of survey. This can be influenced by researcher bias, subjectivity, reflexivity, acceptance, and access (all discussed in chapter 4) and in addition, interviewing procedures such as data sampling, question design, and translation; and by the conversion process from qualitative to quantitative data. The following discussion chapter will explore these fundamental influences that have shaped this project and how this information can be compared with and combined with existing vulnerability data to provide a holistic risk assessment.

Chapter 8: Directions for social volcanology: limits, communication, contributions and applications.

> ...what we call our data are really our own constructions of other people's constructions. (Geertz 1973:9).

8.1. Introduction.

The aim of this PhD research was to examine the influence of culture with regard to local people's reactions during a volcanic crisis. Other ideas have branched from this key enquiry and have helped to guide, frame and develop this project from theory to a practical application of methodology and results. Using Mt Merapi as a case study provided an ideal testing ground for these queries and the results have provided a foundation on which to build further research. The potential practical application of mapping culture and incorporating these elements within local and global risk assessments will now be considered. Over the last three years I have discovered the potential for using social science methods in order to improve understanding of risk at volcanic regions, but I have also come across unanticipated problems and unexpected merits. This chapter therefore sets out some key guidance for natural scientists wishing to undertake social volcanology research.

8.2. Merits and shortfalls of mapping cultural vulnerability.

The distinctive and exploratory nature of this research has produced challenges relating to the use of social methods and assimilating the resulting information for risk mapping. These challenges have been partially overcome through the use of mixed methods, trial and error, and drawing on experiences from both natural and social sciences. The following sections highlight some of the key points of uncertainty with the methods and visualizations. By reviewing the methods used here, further explorations into social volcanology be carried out with greater rigour and validity, building upon this research design to improve studies in disaster management.

8.2.1. Positionality and reflexivity.

Throughout any undertaking of social enquiry the researcher needs to be reflexive and consider their position within the project and the subject's environment (section 4.1.2). Simply by entering into the field the researcher changes the social world under study (Mauthner and Doucet 2003, Cloke *et al.*2004). Within this study my positionality has moulded the thesis and driven this project into new practical directions. Yet as a white, western, female researcher entering into a male dominated landscape I was very aware of my influence during interviews and participatory workshops. This influence was ameliorated by the presence of my local Javanese male research assistant who enabled me access to the communities under study and who effortlessly moved between female and male social groups (section 4.4.1). The unanticipated efficiency and sensitivity of my research assistant was indispensible to the project and his general likeable but thoughtful character was perfectly suited for this type of research. The choice of research assistant is therefore absolutely vital to the success of such research and fortunately Aris was both enthusiastic and capable, the vital key stone in this project.

It is the researcher who interprets the subjects' view of the world and although participatory bottom-up methods go in some way to reduce the subjective nature of ethnography and social interpretation, the results and conclusions are still the researchers interpretations of the subjects perspectives (Miles and Huberman 1994). The findings from both field seasons are primarily based on interpretations. To counter this potential bias the subjects interviewed in the final field season were encouraged to analyse their cultural and hazard setting. The interviewees where asked to identify the most culturally intense regions, and areas where people refused to evacuate in 2006 (Figures 8.1 and 8.2).

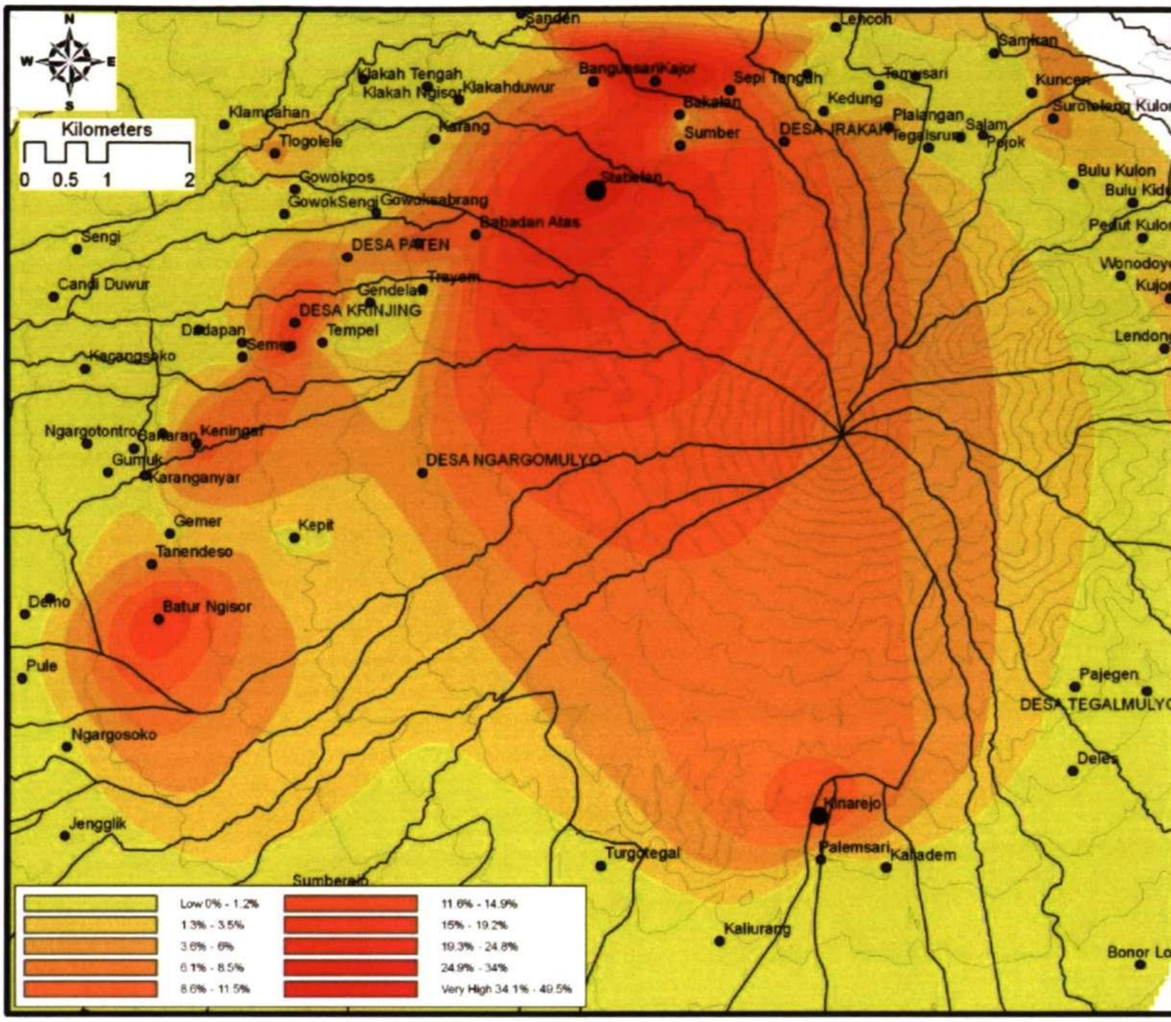


Figure 8.1: Areas identified by interviewees as areas that may refuse to evacuate in future and/ or did fail to evacuate in 2006. A score was allocated to certain locations depending on informant's opinion and how often each location was mentioned in relation to evacuation failure or success. Point data has then been interpolated to predict any missing data. This distribution corresponds with the evacuation failure map created from the scoring method and highlights the north and north-western regions as more likely to refuse an evacuation. Stabilan (highlighted with a larger black point) is a well-known for its very spiritual relationship with Mt Merapi having its own supernatural creatures that apparently refuses to let the residents leave during an eruption. They believe that if they leave Mt Merapi will destroy their homes. It is also extremely isolated with poor access roads, I believe its isolation and strong cultural beliefs has led to a reputation for being independent and determined. Informants believe that the people of Stabilan are brave enough to remain at home during an eruption because of their beliefs, Stabilan also scores high in the cultural intensity map, Figure 8.2.

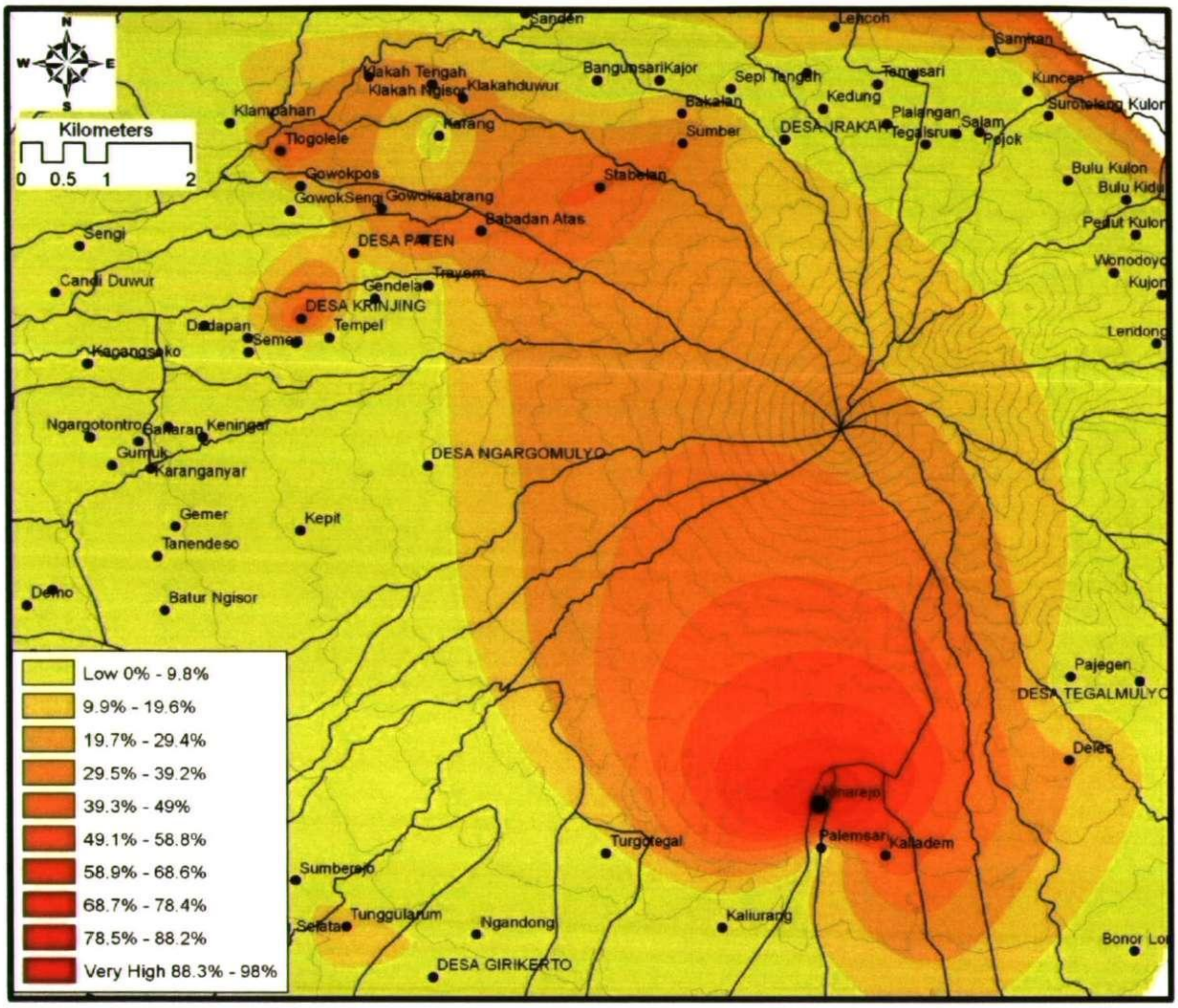


Figure 8.2: Areas identified by interviews as having a high cultural intensity. A score was allocated to certain locations depending on how often (hit rate) they were referred to by the informants in relation to being culturally intense. The point data was then interpolated in order to predict missing data. The map shows that the interviewees highlighted Kinerajo (highlighted with a larger black point) as an area of high cultural intensity, this could be because of the media's exploitation of Mbah Marijan through television advertisements following the 2006 eruption and demonstrates that although this method is helpful it could be skewed by local rumours, speculation and the media. Although Stabilan is not the most culturally intense as I expected it is still scores relatively high.

Carrying out this kind of 'participatory' survey could help to reduce researcher bias and subjectivity, although this type of survey is also potentially influenced by local rumour, speculation and prejudice (demonstrated by Figure 8.2). The reduction of researcher bias and improvement in the validity and rigour of interpretations is aided by allowing the participants to openly converse through semi-structured interviews, discuss and design through participatory workshops and include their perceptions within a comparison survey.

In order to further overcome researcher bias during the data collection it would have been necessary to train local researchers to carry out all aspects of data collection, yet in reality this is fraught with issues relating to local prejudice, flexibility and creativity of interviews, data consistency, time and resources available. As a lone PhD researcher it was not possible to employ, train and act as mentor to many local facilitators. Interdisciplinary research is ideally a team based endeavour, bringing together people with different specialisms and is therefore a challenge for an individual. An individual with a background in one discipline has to learn another (in this case social research methods) whilst simultaneously moving the project forwards by collecting information, organising logistics, learning a new language, training a research assistant and finally writing conclusions in a 'foreign' academic style.

8.2.2. Sampling, analysing and scoring.

A multi-modal qualitative data collection method was chosen because, as discussed in chapter 4 (section 4.2), it can provide 'a portrait of people...a written description of a particular culture, the customs, the beliefs and behaviour' (Harris and Johnson 2000:12). I found qualitative data collection to be creative, refreshing, and flexible, yet as Tesch (1990) suggests, it is also unstructured and less formal than conventional quantitative methods. These methods were all effective, given the brief amount of time in the field, but the interviews were most effective. These conversations with purpose allowed a flexibility and depth to the enquiry and were less disruptive to the subject's daily activities than the workshops.

It is vital to design a method of data collection that is not only effective but also culturally acceptable to the subjects. The less formal interviews 'fitted in' with their ideas of hospitality as strangers are welcomed into their homes and provided with refreshments. Focus groups were not used as much because according to Javanese custom it is not appropriate to complain or be negative in any way, and grouping people together to talk about negative aspects of the last eruption was not considered appropriate.

8.2.2.1. Sampling.

Using the snowball sampling method and convenience technique was appropriate within the social setting of Mt Merapi, where participants were often hard to access and my unfamiliar appearance caused initial apprehension. Telling the potential subject that they had been recommended by a fellow well-known community member eased their concerns, and in turn these subjects would recommend people who would be happy to answer our questions (section 7.3). During both field seasons, the snowball sampling technique worked well, especially when initially targeting the head of the village and then the hamlet. Interviewing these subjects first proved useful in gaining general information about their settlement and subsequently they became temporary gatekeepers, introducing us to other members of the community, who in turn recommended others who would be happy to talk with us. Convenience sampling or opportunistic sampling techniques (Burgess 1984, Calveley and Wray 2002) were employed more within the initial field season and as I became increasingly well-known and accepted within the communities it became easier to interview people when the opportunity presented itself. Yet after returning from the field, the sample results showed certain subject characteristics are skewed towards dominant demographics, in particular a male dominance and an uneven age distribution.

Gender: I naively assumed that as a woman I would have less 'trouble' forming a female or evenly mixed workshop than if I had been a male researcher. Unfortunately the workshops were perceived by the community as official meetings and therefore were mainly attended by the men. This goes against the ethos of participatory research and should be discouraged in future endeavours. The researcher ought to be aware that by failing to give an equal voice to women in the field the results from both field seasons are biased. However the society under study is also 'biased', as it is the men who make the decisions whether to evacuate or not and it is the men who attend trainings, meeting and are the village officials. I met only one female head of village, and she had taken over from her husband. Even during an interview with this woman her husband dominated the conversation and she resumed her role as hostess. It could be argued that for this particular research, which has focussed on the actions and motivations controlled by invariably male community leaders, a male dominated sample set has less effect on the outcome than initially assumed. To test this assertion a second comparison survey would be needed with not only an even balance of men and women subjects but careful attention to the overall design, contemplating for example fundamental issues on the use of female and/or male facilitators, the interview environment and cultural setting.

Age: As a result of conducting interviews within the settlements during the day, the ages of the sample has a skew towards the older generation in Pelemsari and the younger generation in Batur. Interviewing during the day in Pelemsari meant that many of the younger generation were 'at work' collecting grass or gravel elsewhere, because of the less diverse livelihoods in this settlement (chapter 4 and 5). The younger generation have moved away from the isolated rural areas seeking occupations in urban regions, therefore because of its more isolated location those of working age from Pelemsari would be away from the settlement for most of the day returning only at night. In Batur, the younger generation have remained within the settlement as there is a diversity of occupation and in addition the majority of younger people worked in the Gendol River from very early morning to mid-day (when it becomes too hot) therefore many of the younger generation were at home in the afternoon resting and happy talk to us during that time. The unexpected age variance during the day in the different settlements poses the question when is the optimum time to carry out interviews? In a team of only myself and one research assistant carrying out intensive data collection meant that by evening we would both be experiencing research fatigue and it would have been detrimental to our professional relationship, health, the quality of data and the ethnographic aspect of the data collection, to start interviewing during the evening into the night. Future projects could gain a less biased sample with a group of facilitators who could interview during the day and the evening. This would also provide the opportunity to contrast age with hazard perception, cultural intensity and failure to evacuate in order to see whether these elements of vulnerability are more prominent in certain age groups and testing the notion that local cultures are dying out with the older generations.

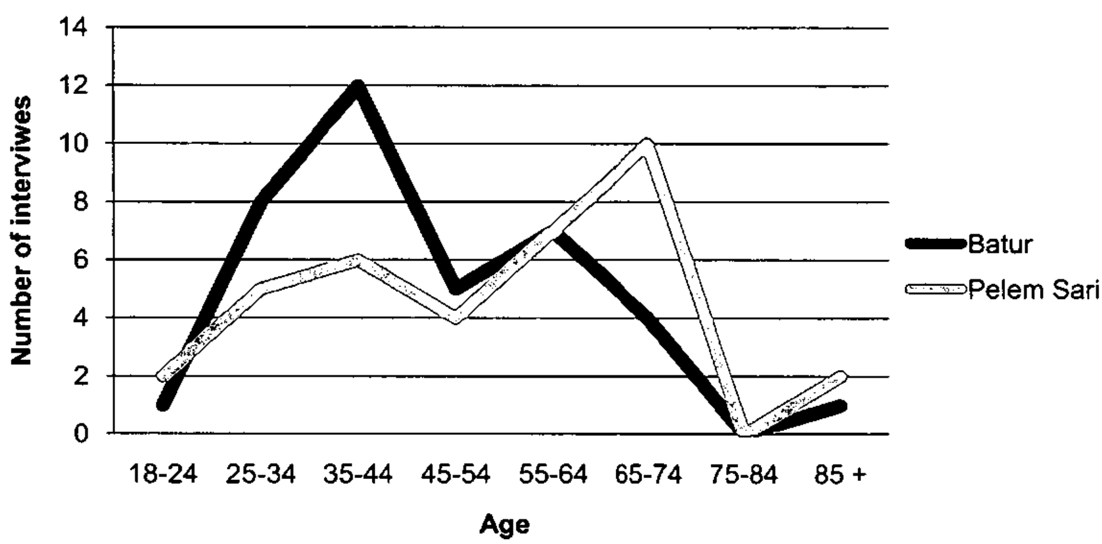


Figure 8.3: Age diversity within sample for the 2007 field season.

Although the snowball sampling was successful in the second field season, applying this to the overall settlement selection was less successful (section 7.3). It led to an uneven number of interviews being taken at each settlement, as in some settlements over five interviews were carried out, whilst others had only one or two. When later scoring the data this meant that some scores were averages providing arguably more valid results and other relied just on one interview. In order to test whether this irregular subject sampling had a significant effect on the resultant maps the settlements with only one interview were removed and the data re-plotted with GIS.

When single interviews are removed it leaves a sample set of 42 settlements that are distributed around the volcano. Figures 8.4 and 8.5 demonstrate that in comparison with the maps in chapter 7, there is no significant change to the pattern of cultural intensity in the north or south, but there is a smoothing effect in the northwest were high cultural intensity has been dampened indicating that this area is less culturally sensitive. The most dramatic change in pattern is in the evacuation map where the area of high failure to evacuate refocuses in the north east flank and seems relatively low elsewhere. Although this process re-visualises the data slightly differently they do not correspond with the general observations made during the field season. Ideally, a set number of interviews would have been carried out at each locality, but should researchers discount convenience or opportunistic sampling altogether? The single interviews represent opportunities for more data collection and have been counted providing crucial information. They have been included because individuals sampled through the snowball technique are usually those that have influence over the community, making decisions or advising the community in times of crisis and this is why they have been recommended. In other words, these single interviews represent the key motivator's voice, representing people's motivations, actions and perceptions in a community and to discount this would be to potentially ignore an entire settlement. In this kind of research it is therefore necessary to examine the social setting before discounting anomalies or single interviews.

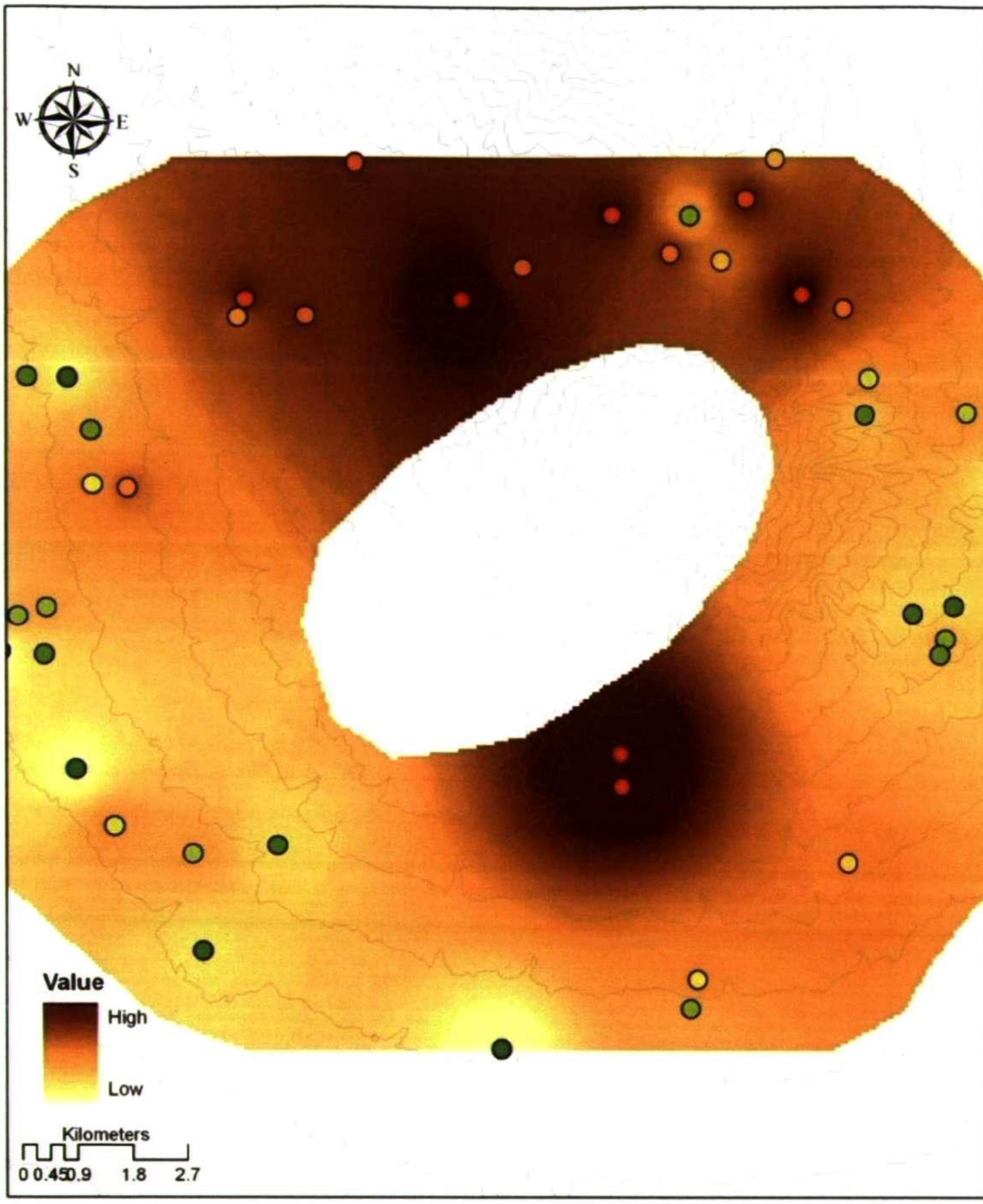


Figure 8.4: Cultural intensity using only data that includes more than one interview. Visualised using IDW interpolation and simple plots dark green indicating low cultural intensity, and red indicates high cultural intensity. This reprocessing creates a smoother image and removes the high cultural intensity score previously found in the North West.

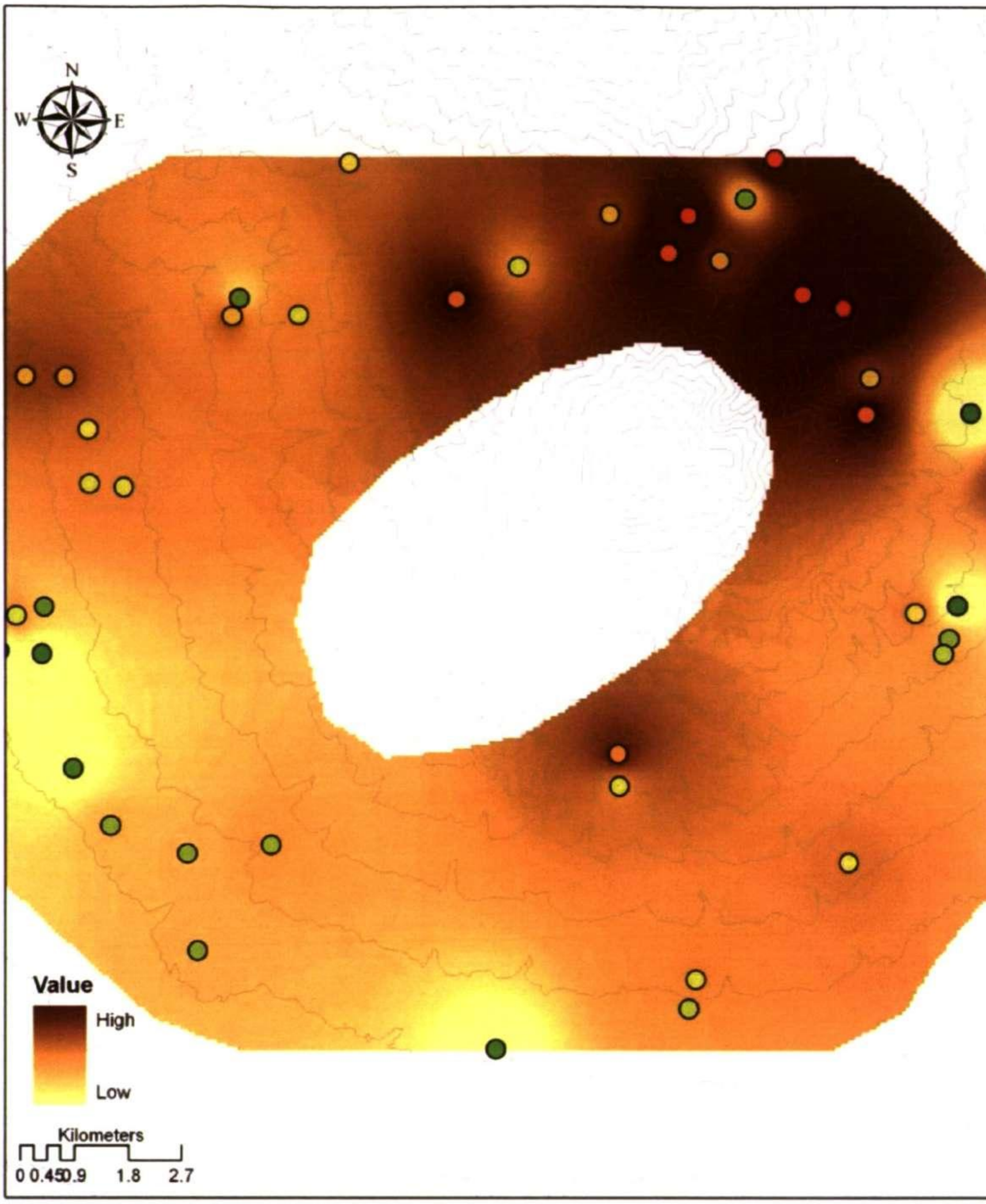


Figure 8.5: Interpolated image illustrating failure to evacuate using only sample settlements where more than one interviews was carried out. Here the reprocessing has shifted the high failure to evacuate to the northeast region a region that has rarely been effected by volcanic hazards. This map does not show the detail required for an effective evaluation of evacuation failure.

Single interviews were also taken due to time constraints - regions that seemed to exhibit a wider variety of perceptions and culture, in a relatively small spatial area, were sampled in more detail, whilst areas, such as the south, where opinions were more uniform, had a lower spatial sampling spread. This concept was repeated within the settlements and if opinions varied greatly more interviews were undertaken in order to provide a broader sample from that region. This change in methodology was necessary and fits with the qualitative data collection philosophy that methods are not fixed, they should 'develop and change in response to changing work contexts' (Strauss 1987: 8).

These sampling issues can influence the overall visualisation of results. Single interviews may produce a speckled visualization yet as discussed in Appendix 7 smooth featured, over analysed and cartographically manicured maps give an 'air of scientific authenticity that may or may not be deserved' (Wright 1942:527). In other words, this classic paper suggests that maps should be used with caution as they are an estimated version of a particular element of the world and should not be taken as representing the world; they are products of the subjective landscape of the cartographer. Therefore I believe that necessary all information ought to be included, however solitary.

8.2.2.2. Analysis.

The main shortfall of using grounded theory analysis is that is relies on the interpretations of the researcher (Strauss 1987). Coding is subjective as it is the researcher who applies and extends them, and it is the researcher who extracts themes from the data that to them seems relevant. There is a possibility that important data is overlooked and not included within the results so in order to partially overcome this subjectivity it is vital that the researcher is open to all possibilities. In this project I had to continually reflect on my expectations from the research and try not to find relationships where there were none. This is why chapter 5 discussed both the cultural aspects of the villagers' daily lives, and the other influences that control their motivation, such as livestock and trust in the government. Additionally, a flexible semi-structured data collection method was chosen so that preconceptions were not intrinsically designed into a survey, as is often the case when using questionnaires. This all links back to the subjective nature of qualitative enquiry and the need to involve participants throughout the entire project in order to test conclusions with them.

8.2.2.3. Scoring.

Qualitative data is creative and subsequently difficult to measure (Srnka and Koeszegi 2007). It is therefore logical to apply a creative method to transform qualitative data into a quantitative format for further statistical measurements and visualisation with GIS.

The principle of the Social Vulnerability Index (SoVI) statistical analysis to produce only influential factors resembles grounded theory. Therefore by coding and categorising the interviews, the most influential elements within this data have already been extracted. Scoring the key indicators according to significance is subjective and influenced by researcher bias, as are the field observations, experiences and the interviews themselves that influence the score allocated to each key theme. Although at present this method of transformation is crude there is no other guiding framework and so comparing the results against the community's maps is a useful way of testing the data scoring process but a more rigorous procedure would be to carry out a detailed qualitative survey of all the areas and use this information in comparison with the transformed data. This stage of the project is experimental and the concepts and methods will be improved and developed so that qualitative elements of vulnerability can be incorporated into risk assessments to provide meaningful information to disaster managers.

8.3. Applications within volcanic risk reduction.

In order for the methodologies used is this research to be practical and useful for the disaster managers and scientists working at Mt Merapi this data needs to be integrated into a conventional risk assessment. At present no such assessment exists for Mt Merapi, although according to the director of the Merapi Volcano Observatory they hope to produce a risk map in 2010. This would be timely as the results from this study may provide additional information that they could incorporate within their risk map design.

The following section explores the process of integrating the cultural element of vulnerability within an existing risk assessment carried out for Mt Merapi in 2008 by Utami (2008). This is an important practical application of social volcanology research.

I used Utami's risk map instead of the basic risk map produced by Thouret and Lavigne (2005) as it is based on more up-to-date information. Thouret and Lavigne (2005) relied on data from 1998, now over 10 years ago and due to high population growth and movement is now potentially meaningless. Additionally, Utami (2008) used the Social Vulnerability Index (SoVI) to quantify and score vulnerability for each village region on Mt Merapi and information has been processed using similar concepts used to design the cultural intensity map. Utami (2008) devised 10 indicators of vulnerability given in table 8.1 to construct a vulnerability score. All the indictors used are based on quantitative statistical information retrieved from national government surveys carried out in throughout Indonesia in 2006 and 2007. Figure 8.6 shows maps the relative vulnerability of each village region, whilst Figure 8.7 displays the continuous interpolated map of vulnerability using the SoVI.

Indicator	Variable
1 Gender	Percent of women
2 Education	Number of illiterate
	Percent of farming households
	Number of home/small-scale industries
	Percent of farmlands
	Number of population working as farm labourers
3. Occupation	Number of population working as farm labourers

4. Property ownership	Number of permanent houses
5. Infrastructure and lifelines	Percent of households with electricity
6. Family structure	Average number of people per household
7. Population growth	Population density
8. Medical services	Number of health facilities per 1000 people
9. Dependant population	Percent of households rated 'poor'
	Percent of poor households receiving social health care services
10. Special need	Percent of population who are disabled.

Table 8.1: Indicators of vulnerability used by Utami (2008) to calculate vulnerability at Mt Merapi using SoVI.

According to figures 8.6 and 8.7 the most socially vulnerable regions are in the north-west and east whilst the southern flanks vulnerability remains low. There is a west to east strip of high vulnerability across map. In comparison with the cultural intensity map (Figure 8.8) the high cultural intensity (vulnerability) around the region of Kinarejo does not correlate with the quantitative maps at all. The quantitative maps therefore do not highlight the region around Mbah Marijan's home as socially vulnerable yet this study indicates that this is a region of high cultural vulnerability.

Without all the influential elements of vulnerability, during a crisis emergency managers would only be able to use statistical vulnerabilities to estimate risk and at Mt Merapi the southern areas could be wrongly considered more resilient. In fact it is these areas that will require pro-active outreach programmes and priority evacuations, especially in light of the recent re-direction of hazards from the west to the southern flanks (as discussed in section 3.1.3 and 3.1.4).

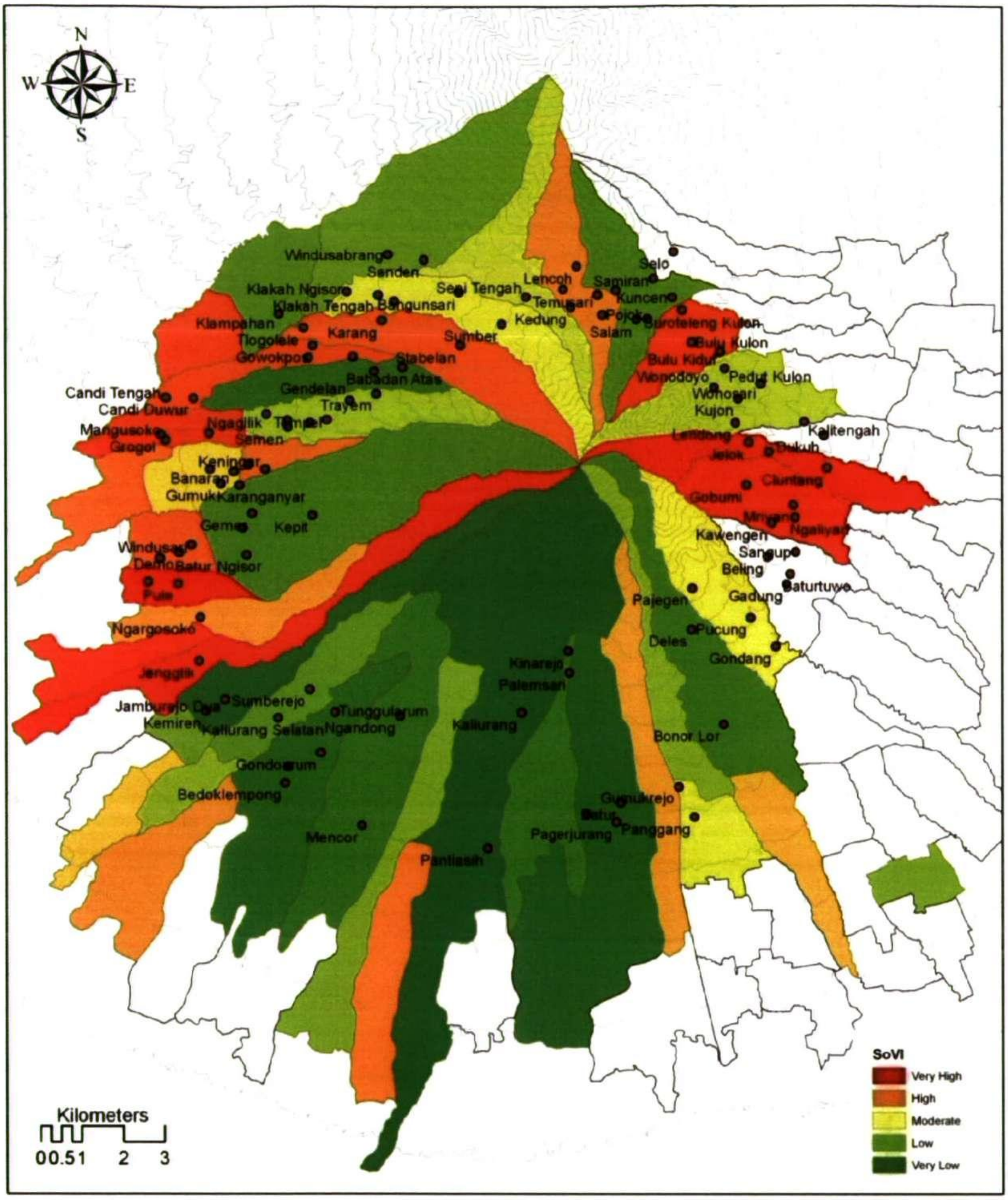


Figure 8.6: Quantitative vulnerability assessment using SoVI. Total vulnerability is calculated for the extent of a village region, using 10 quantitative indicators. Modified with permission from Utami (2008).

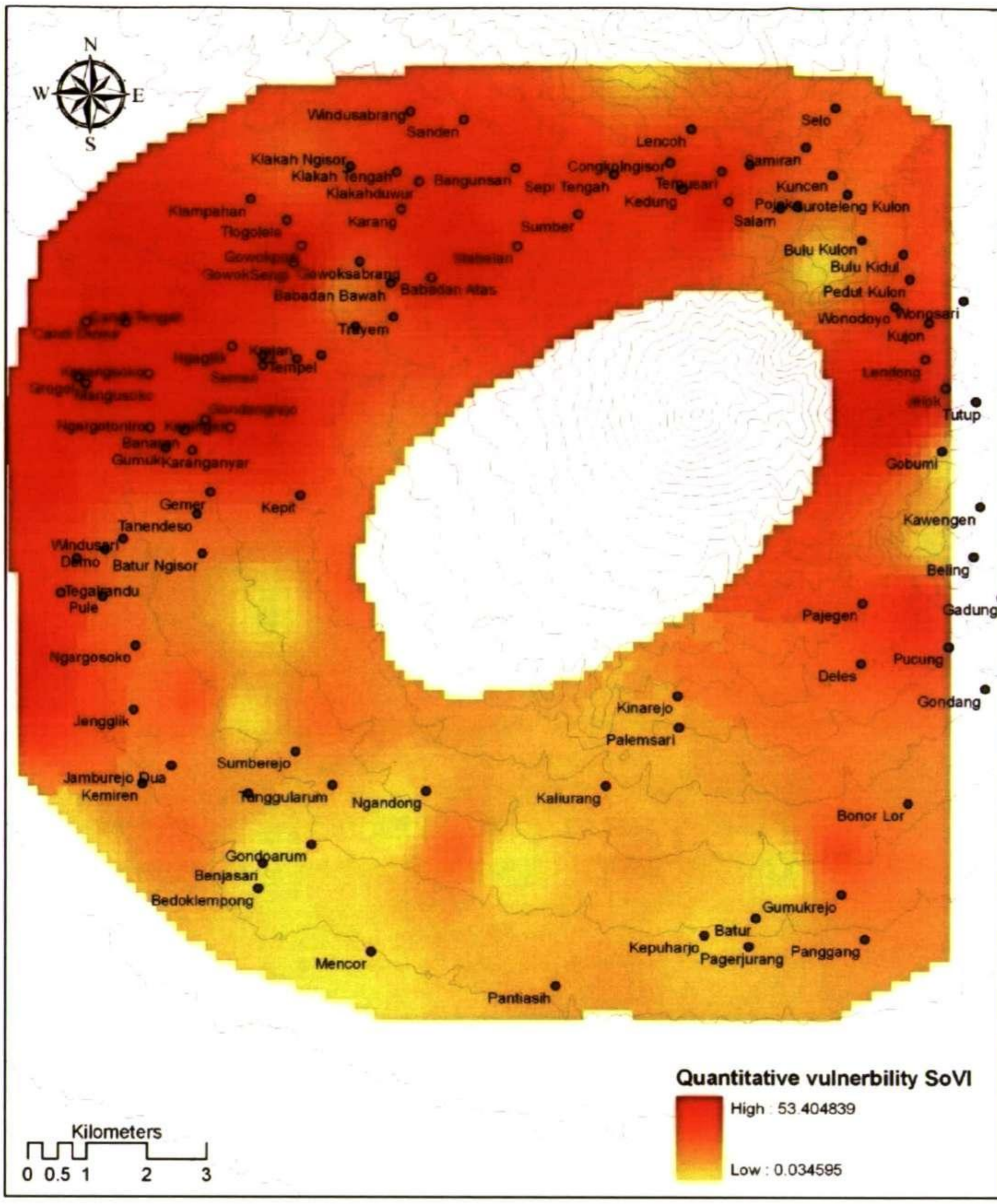


Figure 8.7: An IDW interpolation of villages ranked according to their quantitative vulnerability calculated using SoVI, modified with permission from Utami (2008). These results do not take into consideration the eastern settlements sampled in this study.

Because cultural vulnerability is considered an additional variable within vulnerability, it is reasonable to assume that the cultural intensity scores could be added to the original SoVI scores. Yet, because the data sets do not correspond spatially it is necessary to combine the predicted vulnerability maps (those that have been interpolated). Including the cultural intensity scores with the SoVI scores can be achieved within a GIS package quite simply by adding the two interpolated maps together. Each score of quantitative vulnerability within each raster cell is added to its spatial equivalent within the other cultural vulnerability map.

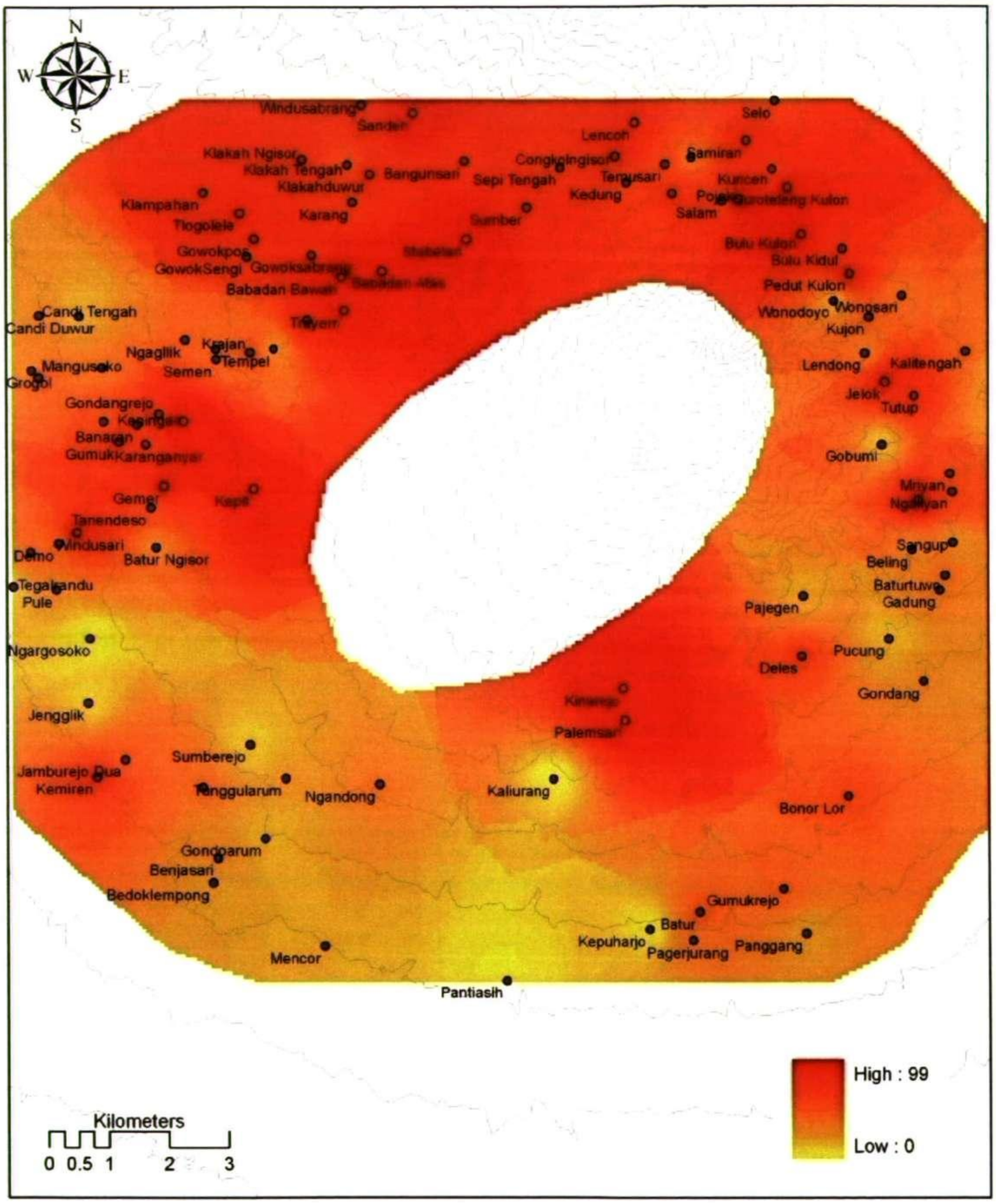


Figure 8.8: Cultural vulnerability map visualised using an IDW interpolation (this map is the same as the cultural intensity map in Chapter 7, Figure 7.12).

The resulting map provides a more holistic vulnerability assessment as it illustrates areas of high social and economic vulnerability in conjunction with cultural vulnerability. Figure 8.9 demonstrates how the data from this research can be combined with other vulnerability data. If other variables such as place attachment, emotional response, hazard perception, risk perception or evacuation failure, can be quantified using a similar process then vulnerability maps can be increasingly representative estimations of the anticipated needs and actions of a community during a crisis.

A further application of vulnerability maps would be to combine these maps with hazard impact information to produce a risk map. Although Mt Merapi has an official hazard map it is argued here that it would be ineffective during an eruption larger than VEI 2 (small dome collapse eruption with minor explosive activity). Despite this limitation, it is instructive to identify areas at increased risk using the more holistic vulnerability map and overlaying the hazard zones created by Hadisantono *et al.* (2002). The hazard zones are therefore allocated a score, e.g. 1, 2, 3 according to degree of hazard impact and frequency (previously calculated during the original hazard map design) and then combined with the vulnerability scores to produce a risk map as shown in Figure 8.10.

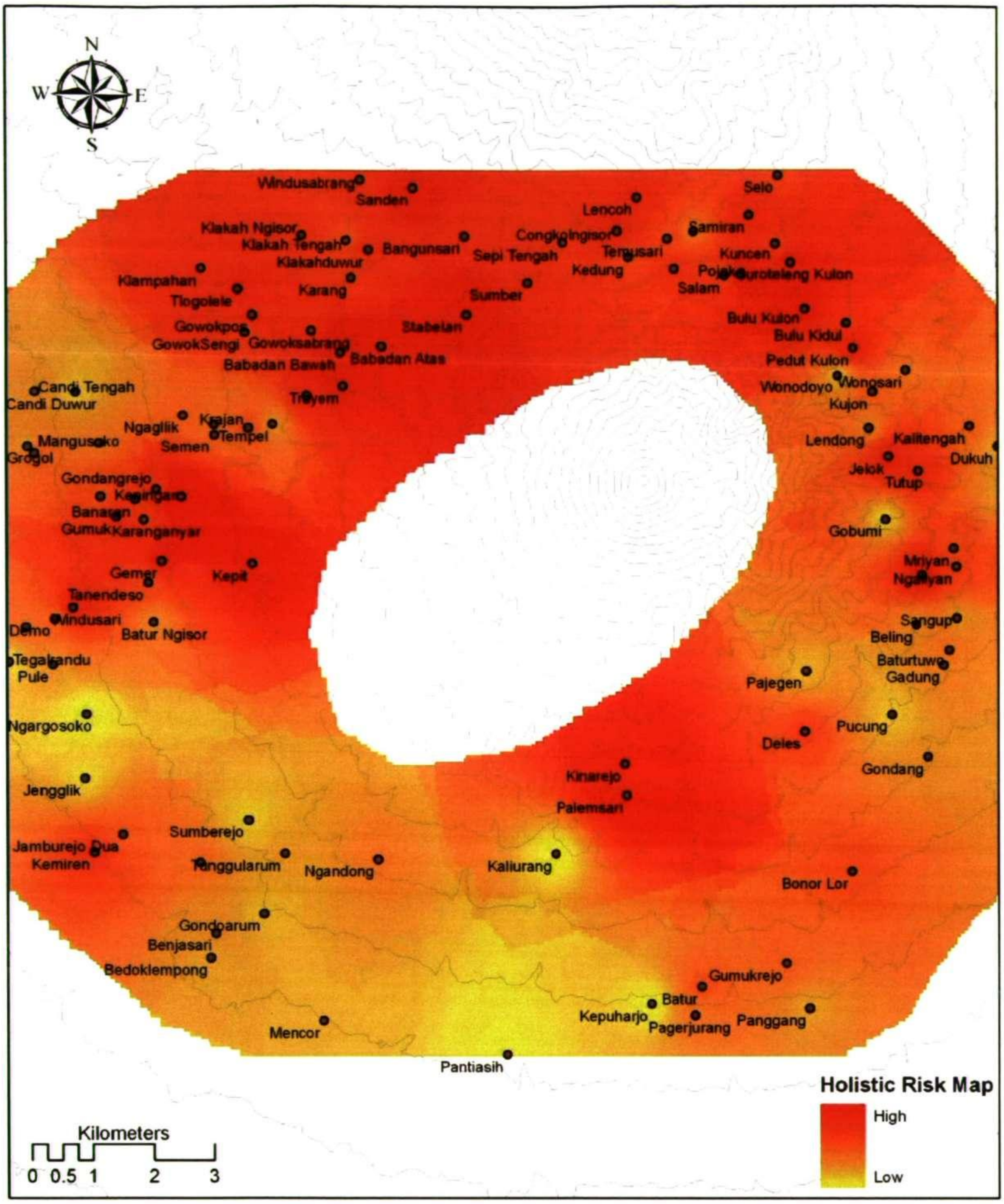


Figure 8.9: By combining the quantitative risk assessment with the cultural vulnerability map produces an integrated risk assessment. Although experimental this map demonstrates the possibility of integrating qualitative vulnerabilities within risk assessments and maps.

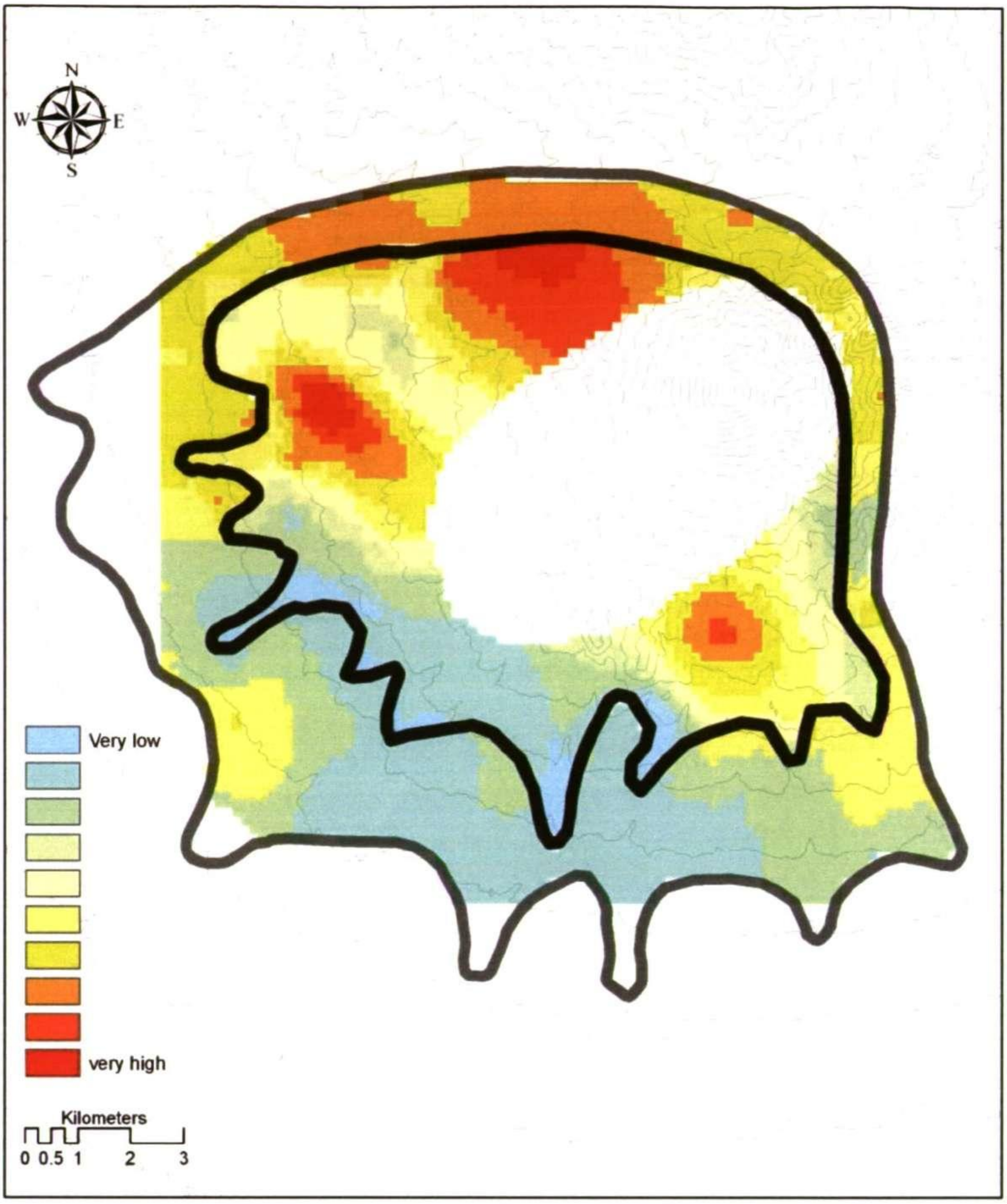


Figure 8.10: Integration of hazard and social elements of risk, to produce a basic risk map for Mt Merapi. Although this map is experimental it demonstrates the potential for producing useful maps for emergency managers at Mt Merapi. This map only corresponds to small eruptions at Mt Merapi. Although the final risk map is not detailed it does demonstrate the potential process and practical applications of social volcanology research.

8. 4. Communicating risk and reducing vulnerability.

Through the development of maps such as Figure 8.10 areas that require pro-active educational programmes, good transport links, efficient prioritised evacuations and increased post-disaster support can be identified. At Mt Merapi it is the more isolated higher regions, in particular, those in the north-west and south that requires prioritised pre and post disaster mitigation. Once these regions have been identified it is vital that action is taken to reduce the impact of future eruptions. As Figure 8.11 shows (and as discussed in chapter 2) pro-active risk reduction measures are vital and this section aims to suggest ways in which the information gathered during this research can be used to add to the risk management cycle at Mt Merapi. Designing adequate education and communication procedures are integral to these measures and assessing their effectiveness post-event is equally important (Smith 2001).

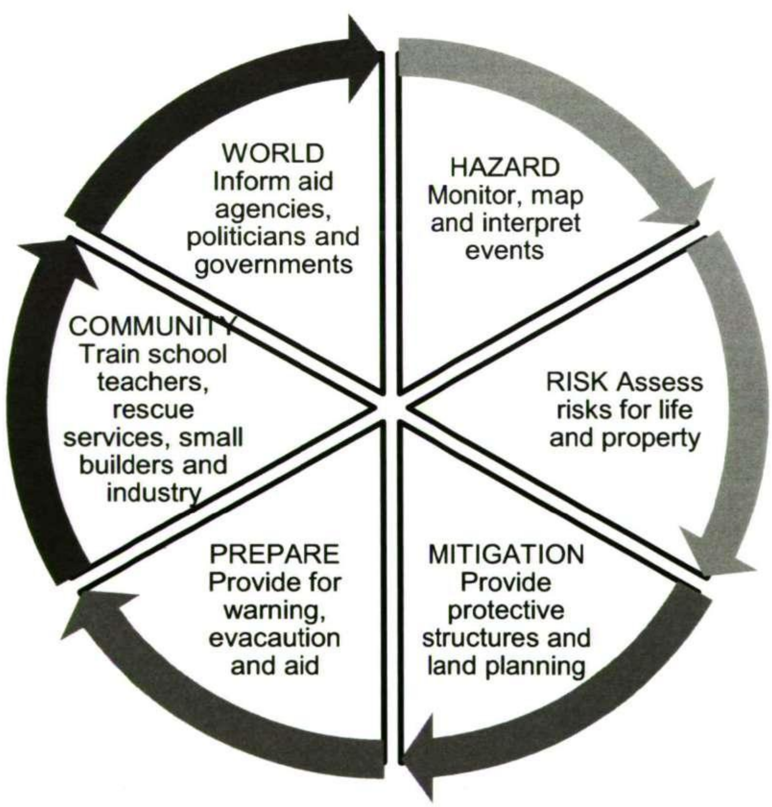


Figure 8.11: The risk management cycle, dark grey arrows correspond to types of education. Source: modified from Smith (2001:76).

So far, cultural reactions to volcanic hazards have been examined qualitatively and transformed into visualisations for incorporation within conventional assessments. If the findings in this project and the maps are to be meaningful the information needs to be communicated to the local scientists and potentially the local communities at risk.

Communicating hazard and risk knowledge to local communities has become popular in volcanic regions (Paton *et al.* 2001, Driedger *et al.* 2005, Dobran 2006, Paton *et al.* 2008). Yet its effectiveness and ethical grounding is often not tested (Leonard *et al.* 2008), especially where they may already have their own local knowledge. There is therefore the danger of imposing western thought in a social setting that already successfully uses local environmental management practices or cannot interpret or replicate the information provided. It is necessary to assess the potential ethical impact of educational outreach programmes and consequently design them specifically for each location. Cardona (2004:50) notes that 'no major advance [has] been achieved given that solutions are often not socially, culturally or economically applicable or adequate'. Therefore, is it necessary at Mt Merapi to provide educational programmes for the local people? Do they already deal with the risks effectively without intervention and would imposing western science erode their rich and unique culture?

The evidence provided by the social surveys not only enables an evaluation of cultural reaction but also provide valuable information to shape educational outreach as a mitigation tool. One of the key themes that emerged from chapter 5 was that the people in both Pelemsari and Batur believed that their 'area' is entirely safe from the volcano, a belief also encountered during the second field season especially in regions that have not experienced the direct impact of hazards in living memory. This sense of immunity reduces the level of local risk perception, putting them in increased danger. As Paton *et al.* (2008: 182) suggest, 'if people perceive their environment as being safer, their level of perceived risk will decline, as will their perceived need to adopt protective measures'. This unrealistic perception of personal risk means that the local people need to fully understand the potential dangers of living on Mt Merapi and that this volcano could produce different types of eruptions and therefore effect different areas.

In addition, because of the volcanic nature of Mt Merapi during the last 100 years the residents were surprised in 2006 when the volcano apparently 'changed direction'. The local people therefore do need educational programmes in order to understand that for this volcano that changes in eruption style and subsequently direction is normal and could happen in the future.

8.4.1. Current educational outreach at Mt Merapi.

Conventional educational outreach programmes globally have concentrated on producing maps, signs, pamphlets and the organisation of meeting with key stakeholders (e.g. Dengler 2003). Although these educational tools are useful in some social environments, they may not be so successful in other regions. Alternative locally specifically designed programmes are required for each region.

During both field seasons I only came across two forms of educational material - a simplified hazard map that referred to a particular section of the volcano and an instruction poster indicating what action is required during a crisis. The hazard map is simplified but still based on the official map used by authorities and therefore is technical. The poster is confusing with no clear steps and no clear understandable symbols. These simplified hazard maps and educational posters and were distributed to various settlements around the volcano, but were widely ineffective as they included written instructions that required a level of literacy lacking in rural regions. Additionally the instructions were in Indonesian, a language that is less widely spoken especially in isolated rural areas where the local language predominates (Javanese at Mt Merapi). Little or no instruction accompanied the distribution of these materials and so some residents, unaware of their significance, simply placed them on their walls as a decorative feature. Paton *et al.* (2008) carried out an evaluation of the effectiveness of an educational outreach programme carried out in Auckland, New Zealand. This is one of very few published studies that have attempted to audit educational measures. They conclude that just simply providing information will not motivate people to take proactive measures of preparedness. Paton *et al.* (2008) demonstrate the importance of evaluating educational efforts and by talking to just a few residents at Mt Merapi it was clear that providing educational material alone is not enough.

Clearly a more effective mitigation scheme is required and in some regions this is occurring. During a visit to Jengglik on the south western flank I observed an evacuation drill organised by the government. This type of exercise can be extremely effective and is a method of educational outreach that is performed in Japan and the USA (Sasaki and Yamakawa 2004; Pinsker 2004). At Mt Merapi this elaborate exercise involved some local residents and government officials recreating various scenarios, each with an educational purpose. This impressive spectacle entertained the community whilst providing important information and reminding them that they do live in a potentially dangerous region. Despite an observer being run over by an over-enthusiastic ambulance driver these exercises appear to be an excellent educational tool. They were designed and implemented after the 2006 eruption and therefore an evaluation of their effectiveness is required after the next eruption.

It is also useful for those services that will be involved in a future evacuation. Rehearsing the event reinforces individual roles and identifies less efficient elements of the evacuation. These exercises need to be regularly organised but they are expensive and are not imposed in all districts around the volcano. The exercise was primarily organised by Magelang local authority that governs the western district of the volcano and to my knowledge nowhere else at Mt Merapi has similar regular activities.

A failure of these exercises is in not providing any information about the types of hazards that could be faced. Misinterpreted use of terminology increases vulnerability at Mt Merapi as they do not fully understand the characteristic of each hazard. For example, those interviewed, during both field seasons, often referred to only two categories of hazard, ashfall and lava. The term lava covered anything from actually lava flows through to pyroclastic flows and lahars.

8.4.2. Ideas for future educational tools: Wayang.

The fear of eroding local culture by using scientific explanations about hazards is a serious issue in culturally diverse countries. At Mt Merapi it is the stories about the supernatural creatures controlling the eruptions that may provide a partial solution to increasing hazard awareness. Building western science into oral traditions could reduce vulnerability through sensitively acceptable and sustainable education (Mercer *et al.* 2007). One way, at Mt Merapi, is to use *Wayang*. The development of a socially acceptable *Wayang* story, concerning the dangers of volcanic hazards, that could be part of a travelling theatre, would not only provide educational entertainment to isolated regions it would also mean that new myth and legends are developed. Cronin and Cashman (2007) suggest that analysing the efficiency of oral traditions to transmit hazard information may improve modern hazard forecasting and mitigation activities. Hazard awareness could be incorporated within their traditional belief systems and become intrinsic in their oral traditions. Developing and encouraging local knowledge through 'new' educational myths provides sustainable information without eroding their culture.

Traditional stories are communicated through out Java through *Wayang* (Plate 8.1). *Wayang* performances involve a travelling shadow puppet show and these are a normal constituent to important ceremonies such as *Merti Bumi* (harvest) or *Labuhan*. They are integral in Indonesian culture and provide entertainment and moral themes (Forshee 2006). *Wayang kulit* are flat puppets made from leather and in the Mt Merapi region these are particularly popular (Plate 8.2). *Wayang* performances are accompanied by a *Gamelan* orchestra and in Yogyakarta style *Wayang* the puppets are symbolic and manipulated to illustrate the ancient accounts leaving the audience to interpret the meaning and moral of the story. The movement of each puppet has a particular meaning; for example, a head held high represents impatience, irritation and aggression (Forshee 2006). The *Wayang* characters include clowns that provide the main moral of the story. Interestingly, the main clown characters are Semar and his son Petruk. Petruk is recognised as one of the supernatural creatures of Mt Merapi and therefore the characters are already in place to communicate hazard through a puppet performance.

Plate 8.1: *Wayang* theatre with *dalang* (puppeteer). Photographs were taken with permission by the author in the *Wayang* museum, Yogyakarta.

Plate 8.2: ***Wayang*** **kulit, leather puppets. Photographs were taken with permission by the author in the** ***Wayang*** **museum, Yogyakarta.**

The other style of shadow puppet in central Java is Solo (representing the other centre of regional power the Kraton of Solo). The Solo puppets are less symbolic and use puppets that bear direct resemblance to certain people, either local or national. Plate 8.3 shows a Solo style puppet in the form of the ex-President Sukarno. The Solo style would provide a less interpretative, more direct structure for hazard communication and this style has been used in the past to communicate political propaganda and health information. The New Order government promoted and financially supported organisations that provided *Wayang* to urban and rural regions, it was used as a way of communicating to all regions even those beyond the direct reach of information officers (Wientraub 2004).

Plate 8.3: This is a *Wayang* puppet in Solo style it is a puppet of the later President Sukarno. Photographs were taken with permission by the author in the *Wayang* museum Yogyakarta.

Although primarily utilised by the government for propaganda this does demonstrate the potential for adapting key stories to provide information for local communities. During the second field season I interviewed the Head of *Wayang* Art studies at the Institute of Arts, Yogyakarta, in order to confirm the possibility of using *Wayang* in this way. He was very confident that it could be done. However, the ex-Head of Indonesia' s *Pusat Vulkanologi dan Mitigasi Bencana Geologi Badan Geologi* (Dept of Volcanology and Mitigation of Geological Hazards) was concerned that communities are spending less time watching *Wayang* and more time watching television. He argues that television is a more appropriate method of communication. Yet according to Hugo (2000a) Indonesia has one of the lowest percent of televisions per 1000 inhabitants in Southeast Asia. *Wayang* is still considered special and the audience numbers for *Wayang* performances are still high, especially in rural isolated regions where television reception is limited to one channel (this is the case in some of the isolated north-western regions on Mt Merapi, those areas identified at high risk in the section 8.2). In other words by identifying areas of cultural intensity will show you were *Wayang* may be most effective.

Wayang is less popular only because it is expensive to hire the *dalam*, his theatre and the gamelan orchestra. It is therefore restricted to special occasions only. If the cost of *Wayang* was eliminated by becoming a government organised performances then it would be openly accepted in all the regions of the volcano.

8.5. Future research developments.

8.5.1. Designing local and national risk database.

This project has focussed on local indicators of cultural vulnerability at Mt Merapi volcano because examining local variations of knowledge, customs and beliefs is vital to efficient and specialist risk reduction. It appears essential, especially in culturally and socially diverse countries such as Indonesia, that scientists explore and integrate local perspectives into risk analysis. National assessments of risk will also aid the prioritization of risk reduction strategies whilst, as suggested above, carrying out qualitative surveys could also indicate the most suitable mitigation scheme that is acceptable and efficient. National risk assessments are extremely important but they need to have a dual purpose, namely multi-hazard and single hazard assessment. In countries such as Indonesia where multiple hazards can impact on one region, it is important to consider multi-hazard impacts (a disaster involving more than one hazard, such as an earthquake causing numerous landslides) so that the worst possible scenarios can be planned for and managed. Areas that have the potential for multi-hazard high risk impact need to be identified and then strategies prioritised (Mosquera-Machado and Dilley 2009).

Although there is a lack of global vulnerability studies (this will be discussed in the following section), there is a growing number of risk perception and risk assessments being carried out locally in volcanic regions (e.g. Gregg *et al.* 2004; Barberi *et al.* 2008; Haynes *et al.* 2008; Gaillard 2008; Paton *et al.* 2008). These projects are vital to the development of vulnerability assessment methods that can be replicated globally. Gregg *et al.*(2004) examined the perception of volcanic risk in Kona communities, Hawaii and concluded that respondents showed an unrealistic optimum bias and have a low level of preparedness influenced by a low perception of threat. Gaillard (2008) used questionnaires to quantify the risk perception of local communities living near Mt Pinatubo in the Philippines and concluded that previous experience influences future actions and strong cultural attachment to their settlements meant that they refused to leave their towns despite seasonal dangers from violent lahars. At Mt Vesuvius, Italy, Barberi *et al.* (2008) noted that despite local people having a high risk perception they lacked volcanic knowledge and trust in authorities and its emergency plan already designed for a future eruption at this extremely dangerous volcano. From this scattering of case studies generic commonalities emerge. Perhaps these common themes could aid the development of a national and global framework for risk assessments? Collating these case studies and future studies within a national and global data base would allow local authorities to examine results for their region and carry out additive surveys.

8.5.2. Designing a global database.

At present there are no global databases for hazard or disasters that fully take into account factors of vulnerability. At best, indicators such as mortality, injury and economic loss are considered representative of vulnerability.

A global database of risk could provide valuable information for all sectors of society. The three main risk databases that exist at present are the Disaster Risk Index (DRI) designed by the United Nations Environmental Program (UNEP) Division of Early Warning and Assessment (DEWA) Global Resource Information Database (GRID) under contract from the United National Development Program (UNEP/DEWA/GRID-Europe 1998-2008), and Global Natural Disaster Risk Hotspots project implemented by Columbia University and The World Bank (Dilley *et al.* 2005). The databases use up to two indicators of vulnerability, mortality and economic loss calculated from Gross National Product (GNP) (Mosquera-Machado and Dilley 2009). The financial impacts of natural hazards are mainly collated by re-insurance companies such as Swiss Re (Sigma) and Much Re (NatCat) (Peduzzi *et al.* 2005), whilst other global databases such as the Smithsonian Institution's Global Volcanism Program and the worldwide Volcano Data base of the National Geophysical Data Centre (NGDC) examines only the physical characteristics of global volcanic eruptions (GVP n.d, NGDC 2009). The EM-DAT: Emergency Events Database, that is updated every 3 months, has occurrence and impact details of over 16000 disasters that have taken place since 1900 (CRED 2009). This database not only examines the physical impact of each disaster but includes the human impacts and financial losses. The human impact is categorised according to number of fatalities, injured, homeless and affected. This interactive and advanced database includes country profiles, maps, disaster trends, disaster lists and profiles, it is an excellent example of how global information can be stored and presented. Despite its impressive data collation and visualizations this database does not include basic elements of vulnerability.

Identified by the Hyogo Framework for Action 2005-2015 risk identification and assessment has become a priority in hazard regions (ISDR 2005). Yet as the databases listed above demonstrate it is only quantitative indicators of vulnerability that are taken into account for a global analysis. The dominant focus still remains on hazard impact and although this is vital and important it does not indicate social variance and global vulnerability.

Logistically collating global data is inevitably extremely difficult. Some regions will not release information for political reasons, for example Burma, where 'the December 2004 Tsunami, so it might appear, never happened ...it seems that in terms of official information at least, the Tsunami stopped at the border' (Grundy-Warr and Sidaway 2006:480). Data that does exist is mainly collated from national surveys using statistical demographic and not qualitative surveys. In addition although demographic characteristics of a vulnerable society are applicable to any hazard type, qualitative information can be developed from past hazard experience, such as cultural vulnerability at Mt Merapi. The local people are culturally vulnerable to volcanic hazards though perhaps not to tsunami or snowstorms of which they have little experience. Therefore is it possible to design a holistic vulnerability framework that can be applied to any hazard?

It is necessary for each region at potential risk to re-evaluate their risk using a holistic method; this data can then be integrated within national and global assessments and databases. But it is finding a common framework for qualitative data that is the problem for developing a comparable database. Social science methods do not have a common design instead encouraging a flexible creative framework (as noted in chapter 4 and 7), how is it going to be possible therefore to design a global framework for qualitative elements of vulnerability?

It would be essential to transform any qualitative data into quantifiable information, and still include descriptions, case studies and explanations to accompany such data. This would be in a similar format as the successful and widely used Volcanic Explosivity Index, designed by Newhall and Self (1982) that integrates quantitative data alongside detailed descriptions. This would be easily designed and implemented through such already advanced physical databases such as EM-DAT (CRED 2009).

One of the future challenges for social volcanology is to design a database that incorporates all elements of vulnerability both quantitative and qualitative that can be compared to physical statistics. The next step is therefore to find a common framework in order to categorize and rank certain vulnerabilities, such as culture. This framework should then be implemented by scientists and authorities in the region at risk for local evaluation and then incorporated within a global interactive database.

8.6. Summary.

The main criticism of this research is that it primarily relies on my interpretation of a local social world, hence my background, and worldview influences the results at nearly every stage. This over riding influence can be made evident through reflexivity, as being aware of one's influence can reduce its impact. Methods for data collection and analysis also need to be continually reappraised using a variety of different designs to ensure rigour. It must be noted that integrating interview data into risk maps is only part of the holistic risk assessment process. It is vital that just as natural and social data are combined so are quantitative demographic statistics and data on qualitative influences.

Although the final survey inevitably has shortcomings, I would argue that the overall concept is valid. This type of social volcanology research is not only necessary in culturally sensitive regions, such as Mt Merapi, but globally and therefore 'a lack of certainty should not be used as an excuse for inaction' Dilley *et al.* (2005: 25).

Communicating the findings to local scientists and communities is essential and will be carried out during future research endeavours, and although this is extremely important it is also important to consider how this information can reduce risk. The development of maps can aid authorities to prioritise mitigation strategies and this project has also indicated that these strategies need to be culturally sensitive. Educational programmes must be tailored to the community and not disturb their daily activities. Using a *Wayang* theatre could be a solution to targeting isolated at risk communities without causing disruption to their economic activities or culture.

This research has wider implications and could aid the development of global vulnerability databases. At present no inclusive vulnerability database exists, yet by collating, comparing and combining information from relevant local interdisciplinary cases studies, over time, a qualitative database could be developed. Designing a framework for qualitative elements of vulnerability will be the continuing challenge set by this project.

As Chester *et al.* (2001:93) states 'it is only a matter of chance that causalities [from volcanic eruptions] have not been higher'. So far throughout the 20^{th} and 21^{st} centuries the global society has been lucky with around 95600 fatalities directly resulting from volcanic eruptions from 1900 to 2009. Yet only a modest eruption from Mt Merapi volcano could endanger over 1 million people (Thouret and Lavigne 2005, CRED 2009). There are many other potential volcanic time-bombs situated in densely populated countries and so the worst may be yet to come.

Chapter 9: Perjalanan: the conclusion.

Perjalanan is a Bahasa Indonesia word that means three things: 1) way or movement; 2) journey or trip; 3) attitude or behaviour. I believe it encapsulates the process of completing this research as it has been an academic journey and a movement from physical geology to social science. It has also been an unexpected personal journey that has changed my previously narrow attitudes towards at risk communities and my perceptions of the world.

The terms cultural intensity, cultural vulnerability and social volcanology are distinctive interdisciplinary terminologies that have been developed during this research. The overarching term that encapsulates the main topic of this research is social volcanology. This interdisciplinary field focuses on the impacts of volcanic hazards on society and aims to reduce the volcanic risk by examining local societies (Donovan In press). A key facet of social volcanology is exploring the cultural reactions to volcanic hazards.

Cultural vulnerability has been used throughout this project to describe the traditional belief systems that influence actions during a crisis. Cultural vulnerability is described in chapter 2 as the lost elements of risk because few risk studies attempt to include this influential and important factor. This research has therefore taken on the challenge to examine cultural vulnerability and has attempted to measure a community's cultural intensity as an indicator of vulnerability. In this research, cultural intensity refers to the powerful relationship a community has with a volcano and its hazards. Its indicators are the stories and actions undertaken to maintain their culture. In other words, it relates to the oral traditions and ceremonies that reinforce their beliefs. Cultural vulnerability and its indicators, for Mt Merapi outlined in section 7.2.1 and detailed for this study in Table 7.5, can be used in combination with other indicators of social vulnerability, such as those used by Cutter (2003) in the Social Vulnerability Index. By combining cultural vulnerability with other indicators of social vulnerability a holistic, more effective risk assessment can be produced.

9.1. Cultural vulnerability at Mt Merapi, Indonesia.

The central aims of this research were to examine the influence of culture with regard to local reactions during a volcanic crisis, to design a methodology to collect cultural information, then to analyse and process this data so that it could have a practical application. These aims were addressed by using a mixed social methodology and fully immersing myself within the communites under study. Because of the intensive nature of social enquiry and the restricted time required, the core of this thesis is focussed on the social methods and findings.

Interviews and participatory workshops provided successful methods of gaining a better understanding of the local volcanic customs and beliefs. At the same time living within the settlements provided a distinctive insight into their lives. The initial field season carried out in 2007 focussed on two settlements, Batur and Pelemsari, and it was found that their cultural beliefs do influence their actions during volcanic unrest and that beliefs vary according to location and hazard experience. Therefore, a second wider survey in 2009 enabled the identification of key indicators of cultural intensity and evacuation failure. The results were mapped within GIS and showed that culturally intense regions correlated with regions of evacuation failure. The research therefore found that the cultural beliefs of those living on Mt Merapi are adding to their social vulnerability putting them at increased risk from the volcano.

Traditional beliefs and customs appear to vary depending on hazard experience and isolation. The more isolated settlements on the north and north-western flanks seem to have a higher cultural intensity. Perhaps this is because they have been 'untouched' by the influence of Islam, unlike in the southwest, or perhaps they rely on their belief in order to cope with the reality of their hazardous situation. Here the roads are poor and cross large rivers draining the volcano, if an eruption was to occur directed towards their settlement they would have little chance of evacuating quickly. There geographic vulnerability combined with their cultural vulnerability suggests that the north-western regions of Mt Merapi should be prioritised in regard to improved evacuation routes, alarms and education.

It was found that not all the motivating facets at Mt Merapi are cultural, one of the key themes that emerged from both field seasons suggested that the residents distrust the government's actions and motivations to evacuate. This lack of trust means that the residents take on responsibilities to help their neighbours, to protect their settlements, homes and belongings during an evacuation and therefore the men usually stay behind. Additionally, some refuse to evacuate because they believe the government will forcefully move them to a different region and sell their land. This distrust originates from the political upheavals and authoritarian rule in Indonesia, from living under colonial powers to the turmoil of the late Suharto's presidency.

Poverty is the largest and underlying factor of vulnerability that influences every action of those living on Mt Merapi. The villagers rely on their land and livestock for a livelihood and would therefore return to their homes during a crisis to take care of livestock, resulting, at best, in a nocturnal evacuation only or at worst a total evacuation failure. The government 'controlled' the part-time diurnal evacuation and provided transportation to and from the settlements within restricted areas. Despite government efforts to work with the local community the legacy of previous forced eruptions and a general lack of trust between locals and government resulted in a lack of co-operation. This perspective corresponds with previous research carried out at Mt Merapi by Laksono (1988) indicating that the lack of trust and difference in hazard perception between government and villager is deep-rooted, long-term and complex.

Certain communities, such as Batur, view the volcano as a 'provider' and the benefit of living in this fertile region outweighs the dangers. Many of the residents of Batur and other riverside communities welcome an eruption as they wish to sell the lahar deposits and supplement their income. As Haynes *et al.* (2008) have suggested for other volcanic regions, at-risk communities decide that the benefits outweigh the hazard threat, and at Batur the hazard provides an income.

Villagers have a localised experience-based hazard perception and this is compounded by an apparently unusually short oral history relating to volcanic eruptions at Mt Merapi. These factors, in conjunction with the widely distributed but miss-leading hazard map, have led to an overestimated sense of safety in certain regions. It was therefore important to review the influential hazard map, in order to recommend some key changes that could reduce this false sense of safety in regions that have been relatively recently impacted upon but are not within the current hazard zones. Chapter 6 discusses how GIS can be used to collate and combine information about the hazards at Mt Merapi. By doing this it was found that the existing hazard map is really only useful during a small dome collapse eruption. An explosive eruption of VEI 3 and above could easily produce lahars and pyroclastic flows that would devastate a large region in all directions from the summit, impacting upon regions outside the current hazard zones. This study therefore recommends that there are at least two hazard maps for Mt Merapi to reflect the two different styles experienced over the last 200 years. The information from both maps needs to be communicated to local scientists, authorities and possibly even target communities, identified from both social demographic and cultural data.

Communication with local scientists and people is essential throughout any social volcanology project. Initial communication is important in order to be fully accepted within their society and to gain information that is most relevant. It is also an important way of reducing researcher bias, as the main concern during this type of interpretative research is that the researchers own view point greatly influences the collection and interpretation of data. Finally at the end of the research it is important to communicate the findings and recommendations back to the communities and local authorities.

Key recommendations for the authorities at Mt Merapi include: an in-depth a wide survey of culture is required expanding on the ideas put forward in chapters 5 and 7. This information can then be mapped, using similar the procedures noted in chapter 7, in order to target vulnerable communities. Additionally, a culturally sensitive mitigation programme is required in combination with evacuation drills that are already held in some regions of the volcano. Educational information could be communicated through culturally acceptable ways such as *Wayang* performances

Overall, the residents of Mt Merapi are extremely vulnerable to the hazards expelled regularly by the volcano. When a large eruption occurs, as predetermined by its eruptive history, it is difficult to imagine how the local population will be saved. Their vulnerability encompasses so many variables and culture is just one additional element that is putting these people at risk. Examples from around the volcano have shown that traditional beliefs are intertwined with social, economic and political influences that create complex scenarios during times of stress.

Because of the challenges set by this type of research it provided an opportunity to improve understanding about the volcanic culture at Mt Merapi and, through this, design ways in which this kind of qualitative information can improve risk assessments. Although this final application of information requires much refinement and further development, the foundation has been set to continue researching aspects of cultural vulnerability as part of the growing discipline of social volcanology. Although the study of cultural vulnerability, and subsequently social volcanology, is at present limited it is a developing subject that requires a distinctive interdisciplinary scientist.

9.2. Social Volcanology.

Conducting solitary interdisciplinary research poses many logistical and philosophical dilemmas, as noted in the first chapter accepting the 'cherished beliefs', of another discipline and people without criticising or dismissing and forcing your ideals highlights the largest issue with conducting interdisciplinary research (Evans and Marvin 2006:1010). Negotiating a space between two disciplines (geology and geography) and, in the case of this research, between two very different cultures (the Javanese at Mt Merapi and my own perspectives) requires an open-mind, patience and flexibility.

The ESRC/NERC studentship, that has funded this research, required an alliance across the contested academic field between geology and geography. Demeritt (2008) describes 'geography as a discipline torn in two' yet the breach between geosciences is not just torn but requires the intrepid interdisciplinary researcher to scramble over deeply entrenched and diverse conventions of method and theory, not to mention intellectual boundary and barbed assumptions. The gap between these sciences is therefore treacherous ground for early-career researchers, who are constantly tempted to run for cover in one direction.

In order to strengthen the bridge between disciplines and address social and environmental problems that are in their nature interdisciplinary, researchers need to share their experiences and knowledge, accept mistakes, and as Chambers (1994a:1255) suggests 'failing forwards'. In light of this Chapter 8 set out the key limitations and contributions of this study's methodology and analysis. During this research there have been certain lessons learnt and unexpected positive events that have been instrumental to the development and completion of the project. Some key guidelines for social researchers can be found in textbooks but others are only experienced in the field, when there is no turning back. Therefore, the following paragraphs highlight some of these factors of research in the form of top tips for future interdisciplinary researchers and the hope is that these can be revised and supplimented as interdisciplinary research takes a reflexive step forward:

Permissions: A largely unexpected logistical challenge was that of gaining official government permissions to carry out fieldwork in Indonesia. Official permissions are not only essential for the legality of research but can also by the key to gaining access to certain authoritarian regions. Considering the legal ramifications of research also relates to gaining correct ethical clearance. Geologists rarely have to submit their research plans to an ethical clearance committee to carry out field work and yet any research involving interactions with people and animals require certain procedures that may be unfamiliar.

Research assistant: As Devereux and Hoddinott (1992) advise that choosing a good research assistant and/or local gatekeeper is essential (section 4.4.1). A research assistant can 'make or break a project' and is instrumental in order to gain access to informants, local officials, and to the field (transportation and logistics). Equally a research assistant can also influence the data collection methods and findings, especially if he or she is also acting as a translator. During this research I have had experience of two very different research assistants and one thing that Devereux and Hoddinott (1992) don't mention is personality clashes, during a pilot survey in Bali my research assistant was not dedicated to the research and did not fully understand the commitment expected from him, this led to an extremely strained relationship and in a small way contributed to the work in Bali being retained for post-doctoral research rather than contributing to this study.

Positionality and reflexivity: Being aware of the research assistant's positionality and influence is only one factor to take in account, the most important is the researchers own influence. Positionality and reflexivity were concepts I had never heard of before embarking on this project but now I realise that they can influence everything and have a place not only in social sciences but also physical sciences. Being aware of researcher bias through reflexive research is essential to producing robust work. Social data interpretation of a situation is generated by the researcher and never the only picture.

Changing your plans: Flexibility during the data collection and analysis is an inevitable. It is important to take into account a communities specific characteristics, for example, they may only be available for interview in the evenings, or a male dominated society may make interviewing women difficult. These are characteristics of a community that may only become apparent once fieldwork has begun and therefore a willingness to be flexible can be very useful. In relation to this I found that it is also important not to rely on just one method data collection. Using a bridging approach is one way to ensure at least some information is gathered, even if one or two methods fail.

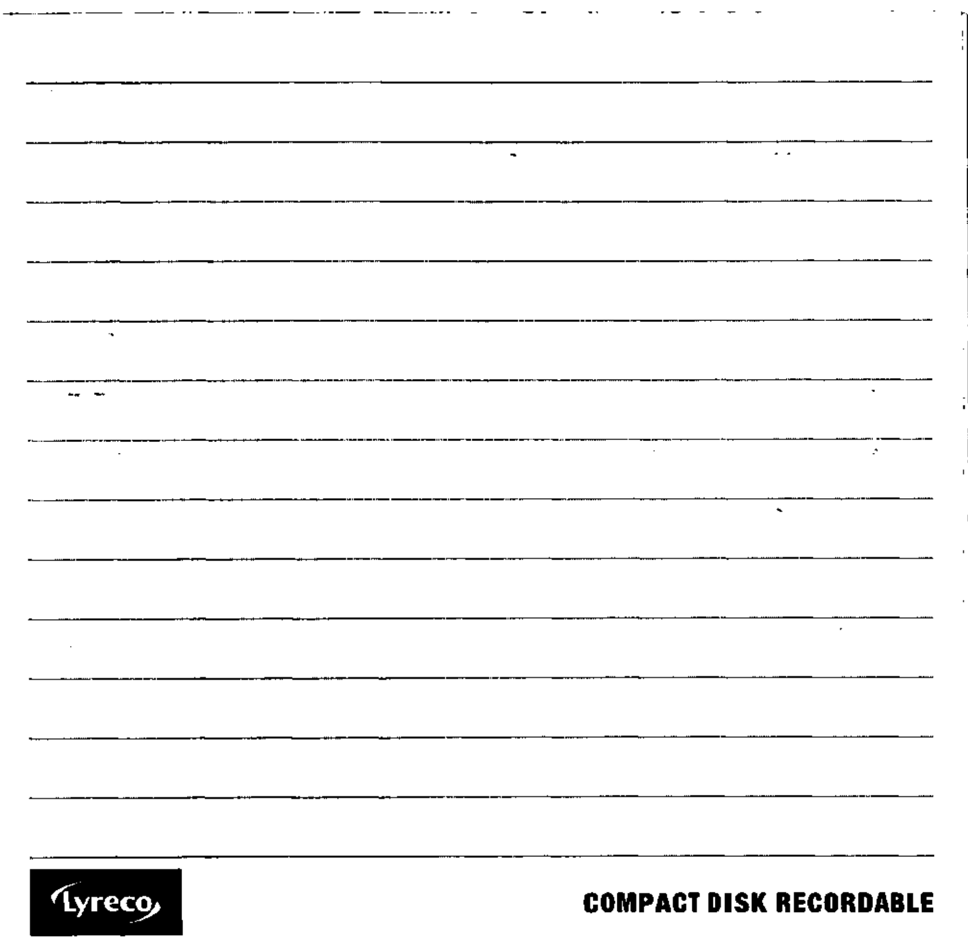
The importance of raw data: Transforming and manipulating data into a range of representations, such as maps or graphs, can highlight key patterns but can also disguise or absorb other important items. Therefore you cannot rely solely on one transformation of data, and as I found I always refer back to the raw data set. For example, the score system, inspired by SoVI, is a representation open to uncertainty, yet used in conjunction with the actual interview transcripts it can provide a useful guide.

Throughout this research I have experienced many unexpected challenges that had both a positive and negative impact of this research but the most important experience has been to live in Indonesia to immerse myself in a different culture. This project started as any other through competition for funding, an office in a university building and a problem to be solved but it has evolved beyond academic boundaries into a personal journey through other worlds and meanings.

The future of social volcanology relies on the identification and monitoring of high hazard regions and therefore only works in collaboration with physical volcanologists and hazard specialists to produce a holistic review of risk. This collaboration and mutual respect is vital to the successful practical application of such social research and during my *perjalanan* I have found support and guidance from scientists within both disciplines. I hope that this partnership will continue.

The thousands of people living on Mt Merapi will continue to try and balance the benefits of living in this fertile region against the danger of an eruption. They will continue to use their beliefs as coping mechanisms in order to explain away the danger and protect themselves in a false sense of safety. And as the memory of larger eruptions fade with the older generations, those who are left face a certain future, Mt Merapi will erupt again. What is uncertain is how large that eruption will be, but what can be recognized is who will be affected.

Appendix 1: Detailed map of Mt Merapi.



Appendix 2: The story of the *Labuhan* ceremony.

The version below primarily comes from this interview but the story was also performed through dance during the ceremony on 14th August 2007.

Sultan Panembahan Senopati was given a gift by a mysterious stranger. The gift was called the Egg of the World (*Endog Jagad*) and the sultan was told by the stranger to eat the egg. The sultan was in his garden at the time and his loyal assistant advised him to test the egg on someone else first. So the gardener, who just so happened to be working close by, was told to take a bit of the egg of the world and so, did the assistant. They both turned into giants/creatures (*Puto*). The sultan told them to go and live on Mt Merapi and that every year he and the Kraton would provide food and clothing. Plate F1 shows the Sultan instructing the creature to go live on Mt Merapi. The village people were very happy about this and the ceremony of providing food and clothing to the creatures that live on Mt Merapi carries on to this day. Over the years the story has been embellished and more creatures now live on Mt Merapi. A *Labuhan* ceremony is carried out in four locations relating to the four compass points and with the Kraton in the center. Mt Merapi is the northern point and is regarded as the most important ceremony of the four.

After the *Labuhan* ceremony has taken place the story is reenacted through dance. Here the sultan banishes one of creatures to Mt Merapi. In the back ground a gamelan band provide the narrative and accompanying music. This performance was accompanied by other ritual dances and yet produced the largest crowd of observers during the ceremony, including many of the villagers who had come to observe the elaborate and entertaining performances.

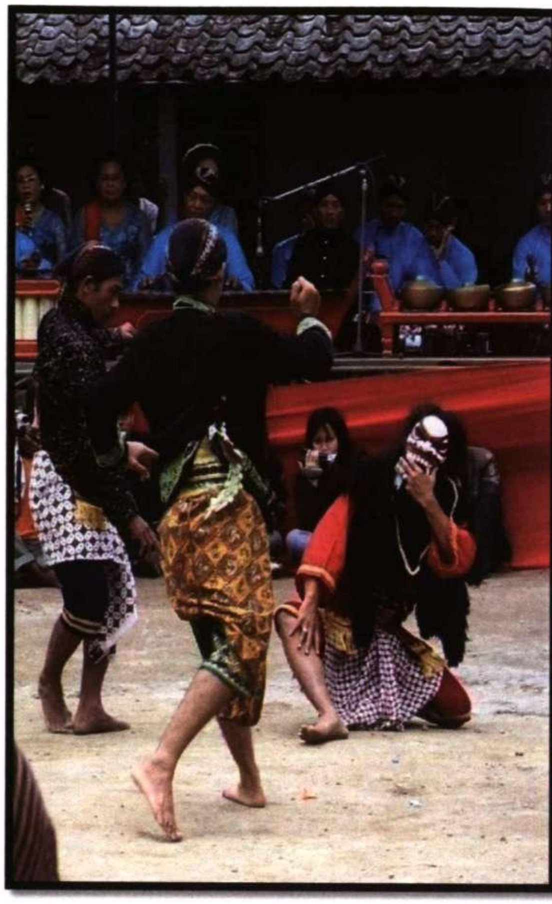


Plate F1: The banishment of *Puto* to Mt Merapi recreated through dance performed at the 2007 *Labuhan* ceremony. This photograph was taken by the researcher on 14th August 2007.

Appendix 3: Copy of Ethical clearance.

UNIVERSITY OF PLYMOUTH

FACULTY OF SCIENCE

Human Ethics Committee

APPLICATION FOR ETHICAL APPROVAL OF RESEARCH INVOLVING

HUMAN PARTICIPANTS

All applicants should read the guidelines at the end of this application

This is a WORD document. Please complete in WORD and extend space where necessary.

*All applications must be word processed. Handwritten applications **will** be returned.*

One signed hard-copy must be sent to Christine Brown. You may also send an unsigned electronic copy of your application to c5brown@plymouth.ac.uk *as this will speed up the review process*

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1. TYPE OF PROJECT

1.1 What is the type of project? (Tick 1 only)

STAFF should tick one of the three options below: ☐

Specific project

Tick this box if you are seeking approval for a specific study, or set of studies, with methods that are explained fully in the following sections. This form of approval is appropriate for funded projects with a clear plan of work and limited duration. ☐

Thematic programme of research

Tick this box if you are seeking approval for a programme of work using a single paradigm. This form

Of approval is appropriate for pilot work, or routine work that is ethically straightforward. Note, the

maximum period of approval for thematic ethical clearance is 3 years. ☐

Practical / Laboratory Class

Tick this box if you are seeking approval for a teaching activity which involves student involvement in the role of an experimental participant.

1.2 Tick 1 only

POSTGRADUATE STUDENTS should tick one of the options below: ☐

Taught Masters Project

M.Phil / PhD by research ☐

UNDERGRADUATE STUDENTS should tick one of the two options below: ☐

Student research project ☐

Practical / Laboratory class where you are acting as the experimenter

2. APPLICATION

2.1 TITLE of Research project
Cultural Responses to Geophysical Hazards in Indonesia

2.2 General summary of the proposed research for which ethical clearance is sought, briefly outlining the aims and objectives and providing details of interventions/procedures involving participants (no jargon)

Recent natural disasters in Indonesia have highlighted the need for improved, proactive, and socially sensitive emergency management. The aims of the project are to build indigenous hazard knowledge into improved disaster management scenarios and to provide a community based risk awareness amongst at risk populations. By adapting participatory social science research methods such as community based hazard mapping and focus groups, this bottom-up research approach fosters an educative change without eroding the cultural values of the community at risk.

The two field areas, Mt Merapi, Java and Mt Agung, Bali, were chosen as they are volcanically and culturally diverse. Both volcanoes are active and have erupted within living memory. In addition the residents living on the flanks of the volcanoes have recently refused to evacuate in times of heightened volcanic activity due to their indigenous beliefs.

The religious, cultural and geophysical differences of these field sites is diverse, epitomizing Indonesia and the need to investigate the indigenous beliefs controlling people's reactions to volcanic hazards and other geophysical hazards.

Adapted Participatory Rural Appraisal (PRA) methods (Chambers 1994a, 1994b, 1994c, 2002, Cronin et al 2004, McNeil and Chapman 2005) will form the basis for data collection. Below are some of the PRA activities that can be used for data collection;

- Community timelines
- Changing village situation
- Story telling
- Seasonal calendar timeline
- Daily activity timeline
- Transect
- Community mapping exercises – focussed on the hazard zones
- Community mapping exercises – focussed on safe evacuation zones
- Diagrams of community organisation structure – emergency management hierarchy
- Diagrams showing relationships between the community and outside agencies
- Descriptions of local traditional disaster management practices
- Community emergency planning chart/diagram outlining the main steps of a volcano emergency plan, including roles and responsibilities.

In addition semi-structured interviews, focus groups and ethnographic methods will be employed; the researcher will live in the two communities during two phases of fieldwork in 2007 (6 months) and 2008 (4 months).

The community based hazard maps will be integrated with more conventional remotely sensed and field-based geo-hazard maps. The resulting resources will form the basis of more readily-understood hazard maps and the development of a culturally acceptable and more effective emergency management for ethnically diverse volcanic regions.

The data will also provide a foundation for the design of an educational outreach programme for Indonesian volcanoes which is both successful without altering the indigenous beliefs of the local at risk populations.

References:

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Chambers, R., (1994c), Origins and Practice of Participatory Rural Appraisal (PRA), World Development, Vol.22, No.7, pp 953 – 969.

Chamber, R., (2002), Participatory workshops a source book of 21 sets of ideas and activities, London: Earthscan.

Cronin et al (2004) Participatory method of incorporating scientific with traditional knowledge for volcanic hazard management on Ambae Island, Vanuatu, Bulletin of volcanology, Vol 66, pp 652-668

McNeil, P., Chapman, S., (2005), Research Methods Third Edition, Routledge.

2.3 Physical site(s) where research will be carried out

Kab Sleman and Kab Magalang, Yogyakarta Special Territory, Java.
Karangasem, Agung, East Bali, Indonesia.

2.4 External Institutions involved in the research (e.g. other university, hospital, prison etc.)

None

2.5 Name(s), position(s) and affiliation(s) of investigator(s) seeking approval, including any external investigators

Miss Katherine Donovan, Post Graduate Researcher, University of Plymouth.

2.6 Name, telephone number, e-mail address and position of lead person for this project:

Dr Iain Stewart, 01752 232457, iain.stewart@plymouth.ac.uk, Director of Studies for project.

2.7 You may include relevant experience of lead researcher (optional)
2.8 Start and end date for research for which ethical clearance is sought (NB maximum period is 3 years)
Start date: 05/2007 **End date: 05/2010**
2.9 Name(s) of funding source(s) if any
ESRC/NERC joint interdisciplinary studentship.
2.10 Has funding already been received?
No ☐ **In-part** ☐ **Yes** X
2.11 Has this same project received ethical approval from another Ethics Committee?
No X **Yes** ☐
2.12 If yes, do you want Chairman's action?
No ☐ **Yes** ☐
If yes, please include other application and approval letter and STOP HERE. If no, please continue

3. BREAKDOWN OF PARTICIPANTS

3.1 Summary of participants

Type of participant	*Number of participants*
Non-vulnerable Adults	*Approximately. 90 for community participant and interview methods. Approximately 50 for stakeholder interviews*
Minors (< 16 years)	
Minors (16-18 years)	
Vulnerable Participants (other than by virtue of being a minor)	
Other (please specify)	

TOTAL	Approximately 140

3.2 How were the sample sizes determined?
• *Participant activities should be conducted with groups of 8 – 12 people, over two sites this will be approximately four groups = approximately 90 people. Some key participants will be interviewed such as community leaders and a representative quota sample of the community.*   • *Key stakeholders in the topic will be chosen due to snowball sampling techniques and convenience sampling, key stack holders will include NGO representatives, members of the evacuation teams, government representatives.*
3.3 How will subjects be recruited?
Through key informants and gate keepers, these are members of The Inter-Cultural Institute based in Yogyakarta, and members of the Indonesian Red Cross who live within key communities– combination of convenience sampling and snowball sampling.
3.4 Will subjects be financially rewarded? If yes, please give details.
No.

4. NON-VULNERABLE ADULTS

4.1 Are some or all of the participants non-vulnerable adults?
No ☐ Yes ☒
4.2 How will participants be recruited? Name any other institution(s) involved
Through gate keepers within the communities, the gate keepers will again be members of The Intra-Cultural Institute based in Yogyakarta, in addition to scientists of The Volcanological survey of Indonesia (VSI).
4.3 Inclusion / exclusion criteria
Participants in the participatory methods must be members of the community under investigation and over the age of 18.
4.4 How will participants give informed consent?
Verbally - recorded by Dictaphone
4.5 Consent form(s) attached
No ☒ Yes ☐
If no, why not?
Consent forms assume literacy within the participants, it may also intimidate the participants essential in participant methods to empower participants not intimidate them.

4.6 *Information sheet(s) attached*
No [X] **Yes** [ ]
If no, why not?
The outline and purpose of the project will be given to the participants during an initial oral presentation to reduce logistical difficulties of transporting paperwork and so the project can be fully explained and understood by those members of the community who are illiterate.
4.7 How will participants be made aware of their right to withdraw at any time?
During the oral presentation as noted in section 4.6. The participants will carry out the activities in their own environment and all participants will be informed that they have the right to withdraw at any time.

4.8 How will confidentiality be maintained, including archiving / destruction of primary data where appropriate, and how will the security of the data be maintained?
Information will be kept confidentially ***Focus groups and interviews will be tape-recorded (where permission is granted) and transcribed, but all responses will be made anonymous.*** ***Interview and focus group transcripts will be encoded so that no written record of the participant's name and data exist side-by-side.*** ***Data will not identify participants unless explicit permission is granted.*** ***Any confidential interviews conducted will be destroyed after the project is complete.***

5. MINORS <16 YEARS

5.1 Are some or all of the participants under the age of 16?
No [X] **Yes** [ ]
If yes, please consult special guidelines for working with minors. If no, please continue.

6. MINORS 16-18 YEARS OLD

6.1 Are some or all of the participants between the ages of 16 and 18?
No [X] **Yes** [ ]
If yes, please consult special guidelines for working with minors. If no, please continue.

7. VULNERABLE GROUPS

7.1 Are some or all of the participants vulnerable? (See guidelines)
No [X] **Yes** [ ]
If yes, please consult special guidelines for working with vulnerable groups. If no, please continue.

8. EXTERNAL CLEARANCES

Investigators working with children and vulnerable adults legally require clearance from the Criminal Records Bureau (CRB)

8.1 Do ALL experimenters in contact with children and vulnerable adults have current CRB clearance? Please include photocopies.
No [ ] **Yes** [ ] **N/A** [X]
8.2 If no, explain
8.3 If your research involves external institutions (school, social service, prison, hospital etc) please provide cover letter(s) from institutional heads permitting you to carry out research on their clients, and where applicable, on their site(s). Are these included?
No [ ] **Yes** [ ] **N/A** [X]
If not, why not?
8.4 If research is being carried out off-campus, please provide evidence of, or explain how you are covered for indemnity

9. PROCEDURE

9.1 Describe procedures that participants will engage in, Please do not use jargon
Participants will take part in a series of activities based on Participatory Rural Appraisal methods, such as: • Community timelines • Changing village situation • Story telling • Seasonal calendar timeline • Daily activity timeline • Transect through villages • Community mapping exercises – focussed on the hazard zones • Community mapping exercises – focussed on safe evacuation zones

- Diagrams of community organisation structure – emergency management hierarchy
- Diagrams showing relationships between the community and outside agencies
- Descriptions of local traditional disaster management practices
- Community emergency planning chart/diagram outlining the main steps of a volcano emergency plan, including roles and responsibilities.

(also see Cronin et al 2004).

Semi-structured interviews and focus groups will also be conducted with relevant community members and stakeholders.

9.2 How long will the procedures take? Give details

Each interview with a community member will last no longer than 1 hour.
Each interview with stakeholders will last approximately 1 hour 30 minutes.

The nature of PRA methods means an exact time table cannot be predetermined, but each activity should take a minimum of 1 hour to complete. Usually these activities make-up a workshop fitting in with the participant daily schedule.

9.3 Does your research involve deception?

No ☒ **Yes** ☐

9.4 If yes, please explain why the following conditions apply to your research:

a) Deception is completely unavoidable if the purpose of the research is to be met

b) The research objective has strong scientific merit

c) Any potential harm arising from the proposed deception can be effectively neutralised or reversed by the proposed debriefing procedures (see section below)

9.5 Describe how you will debrief your participants

A debrief will take place in the form of an oral presentation of the work they have completed. A follow up visit to the participant community will present the researcher's results.

9.6 Are there any ethical issues (e.g. sensitive material)?

No ☒ **Yes** ☐

9.7 If yes, please explain. You may be asked to provide ethically sensitive material. See also section 11

10. PHYSICAL RISK ASSESSMENT

10.1 Will participants be at risk of physical harm (e.g. from electrodes, other equipment)? (See guidelines)

No [x] Yes [ ]
10.2 If yes, please describe
10.3 What measures have been taken to minimise risk? Include risk assessment proformas.
The research does not involve children, sensitive topics, intrusive interventions or harmful interventions. Activities will not require participants to undertake physical activities. Participants will be taking part in social activities in their own environments
10.4 How will you handle participants who appear to have been harmed?
N/A

11. PSYCHOLOGICAL RISK ASSESSMENT

11.1 Will participants be at risk of psychological harm (e.g. viewing explicit or emotionally sensitive material, being stressed, recounting traumatic events)? (See guidelines)
No [X] Yes [ ]
11.2 If yes, please describe
11.3 What measures have been taken to minimise risk?
N/A
11.4 How will you handle participants who appear to have been harmed?
N/A

12. RESEARCH OVERTHE INTERNET

12.1 Will research be carried out over the internet?
No [X] Yes [ ]
12.2 If yes, please explain protocol in detail, explaining how informed consent will be given, right to withdraw maintained, and confidentiality maintained. Give details of how you will guard against abuse by participants or others (see guidelines)

13. CONFLICTS OF INTEREST & THIRD PARTY INTERESTS

13.1 Do any of the experimenters have a conflict of interest? (See guidelines)
No [X] Yes [ ]
13.2 If yes, please describe
13.3 Are there any third parties involved? (See guidelines)

No [X] Yes [ ]
13.4 If yes, please describe
13.5 Do any of the third parties have a conflict of interest?
No [X] Yes [ ]
13.6 If yes, please describe

14. ADDITIONAL INFORMATION

14.1 [Optional] Give details of any professional bodies whose ethical policies apply to this research
British Sociological Association- policy for human social research
14.2 [Optional] Please give any additional information that you wish to be considered in this application

13. ETHICAL PROTOCOL & DECLARATION

To the best of our knowledge and belief, this research conforms to the ethical principles laid down by the University of Plymouth and by any professional body specified in section 14 above.

This research conforms to the University's Ethical Principles for Research Involving Human Participants with regard to openness and honesty, protection from harm, right to withdraw, debriefing, confidentiality, and informed consent

Sign below where appropriate:

STAFF / RESEARCH POSTGRADUATES

	Signature	**Date**
Principal Investigator:		
Other researchers:		

Staff and Research Postgraduates should send the completed and signed copy of this form to Christine Brown, Secretary to the Science Human Research Ethics Committee, A106 Portland Square.

UG / TAUGHT POSTGRADUATES

	Signature	**Date**

Student:

Supervisor / Advisor:

Undergraduate and Taught Postgraduate students should pass on the completed and signed copy of this form to their School Representative on the Science Human Ethics Committee.

	Signature	**Date**

School Representative on Science Faculty

Human Ethics Committee

Faculty of Science Human Research Ethics Committee List of School Representatives

Centre for Theoretical and Computational Neuroscience	Professor Chris Harris (Chair')
School of Psychology	Professor Simon Handley
	Dr Paul Broks
	Dr Matt Roser
School of Earth, Ocean and Environmental Sciences	Mr Matthew Barlow
School of Biological Sciences Representative	Dr David J. Pricenal Dr Oonagh Corrigan
	Social Science and Business
Lay Member	Rev. David Evans

Committee Secretary: Ms Christine Brown

email: c5brown@plymouth.ac.uk

tel: 01752 23276

Appendix 4: Informants demographics for 2007 field season

Data Analysis, Participant attributes and some results from Pelemsari, Batur and Selo.

Batur							
Name	**Age**	**Interview Date and Time**	**At home during big eruption**	**Evacuation**	**Follow the *Labuhan***	**Gender**	**Village is safe**
Adi	55-64	25/07/07, 15:30	Yes	Part-time	No	Male	N/A
Aris	25-34	25/07/07, 09:45	Yes	Full time	N/A	Male	No
Baryanto	35-44	23/07/07, 11:18	No	Part Time	N/A	Male	No
Bingat	55-64	22/07/07, 10:24	Yes	Part Time	No	Male	Yes
Darso	55-64	27/07/07. 08:55	Yes	Never	No	Male	Yes
Endang	35-44	02/08/07, 13:50	Yes	Part Time	N/A	Female	Yes
Henri	25-34	25/07/08, 16:00	N/A	Part Time	N/A	Male	Yes
Ida	25-34	27/07/07, 09:27	Yes	one day	No	Female	No
Kasiran	45-54	02/08/07, 19:00	Yes	Part Time	N/A	Male	Yes
Kenik	35-44	24/07/07, 17:00	Yes	Part Time	Yes	Female	No
Kuatasih	25-34	27/07/07, 16:30	Yes	aprox one month	No	Female	Yes
Little warung owner	55-64	21/07/07, 11:40	Yes	Part Time	No	Female	Yes
Martami	45-54	21/07/07, 12:30	Yes	Part Time	Sometimes	Female	N/A
Mbah Marijan	65-74	13/09/07, 10:30	Yes	Never	Yes	Male	Yes
Mitrorejo	55-64	26/07/07, 09:00	No	Part Time	No	Female	Yes
Mr Narto	35-44	25/07/07, 17:00	N/A	Full time	No	Male	No
Mrs Sujarmi	35-44	25/07/07, 16:40	N/A	Part Time	N/A	Female	N/A
Mukirah	45-54	26/07/07, 11:00	Yes	Part Time	N/A	Female	N/A
Mulyorejo	85 and	19/07/07, 14:30	Yes	Part Time	N/A	Male	N/A

	over						
Ngariyem	18-24	20/07/07, 08:00	N/A	Part Time	Yes	Female	N/A
Ngatiyem	45-54	23/07/07, 11:00	Yes	Part Time	No	Female	Yes
Niti	65-74	23/07/07, 10:11	No	Full time	No	Male	Yes
Pudiwiyon	65-74	27/07/07, 10:44	Yes	Part Time	No	Female	N/A
Puji	25-34	19/07/07, 18:30	Yes	N/A	No	Female	N/A
Riyanto	25-34	19/07/07, 09:00	Yes	Part Time	No	Male	N/A
Sarto	55-64	23/07/07, 08:10	Unassigned	Full time	No	Female	Yes
Sihono	55-64	18/07/07, 09:00	Yes	Never	Sometimes	Male	Yes
Sriyanto	35-44	27/07/07, 16:00	Yes	Never	N/A	Male	Yes
Sriyanto Tiwul	35-44	26/07/07, 19:00	Yes	N/A	N/A	Male	N/A
Sumadi	65-74	26/07/07, 16:00	Yes	Part Time	No	Male	Yes
Sumilah	35-44	19/07/07, 15:30	Yes	Never	N/A	Female	Yes
Sumlih	35-44	22/07/07, 10:00	Yes	Part Time	No	Female	No
Suto	65-74	20/07/07, 08:00	N/A	N/A	N/A	Female	N/A
Tamyo	35-44	19/07/07, 14:00	Yes	aprox one month	N/A	Male	N/A
Tartini	35-44	21/07/07, 10:14	N/A	N/A	N/A	Female	N/A
Tri Kuswantoro	25-34	02/08/07, 12:30	Yes	Never	N/A	Male	N/A
Wagimin	45-54	26/07/07, 11:34	No	Part Time	N/A	Male	N/A
Wento	25-34	22/07/07, 10:00	Yes	Never	Yes	Male	Yes

Table A4.1: Informants from Batur village. N/A means that the answer was not obvious from the reply. The short answer questions and replies give a quick overview of how many people evacuated during the 2006 eruption and whether the participants feel safe in the village.

Pelemsari							
Name	**Age**	**Interview date and time**	**At home during big eruption**	**Evacuation**	**Follow the *Labuhan***	**Gender**	**Village is safe**
Adi	65-74	30/06/07, 14:30	N/A	Part Time	N/A	Male	Yes
Asih	35-44	12/08/07, 19:30	Yes	Never	Yes	Male	N/A
Darto	45-54	04/07/07, 07:00	Yes	Part Time	Yes	Male	Yes
Pudi	65-74	27/06/07, 08:30	Yes	one day	No	Male	No
Cipto	55-64	09/08/07, 07:33	Yes	Never	Yes	Male	Yes
Giono	25-34	09/08/07, 10:50	Yes	Never	N/A	Male	Yes
Simba	65-74	26/06/07, 06:30	Yes	Part Time	No	Female	N/A
Ibu Arjo	55-64	03/07/07, 14:30	Yes	Part Time	N/A	Female	N/A
Ibu Cipto	55-64	03/07/07, 15:30	Yes	one day	No	Female	N/A
Karyo	85 and over	28/06/07, 07:30	No	Full time	No	Male	Yes
Marmi	35-44	12/08/07, 14:00	No	Full time	No	Male	No
Mbah Marijan's daughter	45-54	29/06/07, 10:30	Yes	Never	Yes	Female	Yes
Margo	55-64	07/07/07, 11:00	Yes	one day	N/A	Male	N/A
Darto	35-44	04/07/07, 08:30	Yes	one day	Sometimes	Female	N/A
Marso	55-64	07/07/07, 15:00	No	aprox one month	Yes	Female	N/A
Narti	45-54	06/07/07, 19:00	Yes	Part Time	Yes	Female	Yes

Pujo's mother formatted	85 and over	26/06/07 , 14:30	No	Full time	N/A	Female	N/A
Mrs Pudi	Unassigned	10/08/07 , 07:00	Unassigned	Unassigned	Unassigned	Unassigned	Unassigned
Mrs Pujo	65-74	13/08/07 , 19:00	N/A	N/A	Yes	Female	N/A
Suparjo	55-64	07/07/07 , 13:00	N/A	Part Time	N/A	Female	Yes
Pringgo	45-54	10/08/07 , 07:30	Yes	Never	Sometimes	Male	N/A
Pudi	65-74	12/08/07 , 19:00	Yes	Never	No	Male	No
Purwanto	65-74	10/08/07 , 12:30	Yes	Part Time	Yes	Male	Yes
Samijo	25-34	09/08/07 , 10:00	Yes	Never	Yes	Male	N/A
Samud	25-34	12/08/07 , 15:00	Yes	Part Time	N/A	Male	N/A
Siti	25-34	11/08/07 , 11:00	Yes	aprox one week	Sometimes	Female	Yes
Sri haryanti	18-24	11/08/07 , 15:00	no	aprox one week	Yes	Female	Yes
Surat	35-44	11/08/07 , 11:30	N/A	Part Time	No	Female	N/A
Udi	45-54	06/07/07 , 17:30	Yes	Never	Yes	Female	N/A
Wahono	25-34	09/08/07 , 15:00	Yes	Never	N/A	Male	N/A
Wardi	65-74	13/08/07 , 07:30	Yes	Never	No	Male	N/A
Warjo	35-44	11.08.07 , 09:00	N/A	aprox one week	No	Female	N/A
Warung owner	35-44	09/08/07 , 08:16	Yes	one day	No	Female	N/A
Wigno	65-74	11/08/07 , 09:54	Yes	aprox one week	No	Male	N/A
Yono male	18-24	09/08/07	Yes	Never	N/A	Male	Yes

		, 08:40					

Table A4.2: Interviewees and their details from Pelemsari.

Selo			
Name	**Age**	**Interview Date and Time**	**Gender**
Ahmad	25-34	04/09/07, 13:30	Male
Alef	35-44	20/06/07, 16:00	Male
Atmo	65-74	05/09/07, 10:55	Male
Cipto Samsu	45-54	06/09/07, 13:45	Male
Citro Kamli	45-54	03/09/07, 12:00	Male
Harjo Pangad	65-74	03/09/07, 14:00	Male
Ismail	35-44	03/09/07, 10:00	Male
Muji	45-54	06/09/07, 08:00	Male
Older sister of RW from Sepi	65-74	05/09/07, 15:00	Female
Auto	85+	02/09/07, 16:30	Male
Parli	55-64	04/09/07, 19:00	Unassigned
Reso	75-84	06/09/07, 10:00	Male
Sarju	25-34	03/09/07, 08:00	Female
Somo	65-74	03/09/07, 15:30	Female
Sukadai	45-54	07/09/07, 11:00	Male
Sumirah	45-54	06/09/07, 09:00	Female
Suyitgito	45-54	05/09/07, 13:00	Male

Table A4.3: Information on the Selo informants.

Name	**Interview date and time**	**Occupation**	**Sector**
Dr Hartono	05/06/07, 08:00	Dean of Geography at UGM	Academic
Dr Pramono	06/06/07, 08:00	Vice Dean for Academic affairs, UGM	Academic
Dr Junun Sartohadi	05/06/07, 10:00	Head of Environmental Geography Department, UGM	Academic
Kharisma Priyo Nugroho	04/06/07, 11:00	County representative for Cordaid	NGO

Prof Sarwidi	08/06/07, 15:30	Director of CEEDEDS and vice rector for academic affairs, Islamic University of Indonesia, Yogyakarta	NGO and academic
Representative for Slemen district Water, Mining and Disaster Management Department	09/06/07, 08:00	N/A	Government
Dr Soetoto	10/06/07,17:00	Remote sensing Geologist, Faculty of Engineering, UGM	Academic
Dr Sadwandharu	11/06/07,10:00	Representative from Balai Sabo, Department of water management and research.	Government
Ridwan Saptoto	12/06/07, 11:00	Crisis Recovery Centre, Psychology Department, UGM	Academic and NGO
Subandrio	12/06/07, 14:00 and 10/07/07, 15:00	Volcanologist, Merapi Volcano Observatory/ BPPTIC office	Government
Eko Tenguh Paripurno	18/06/07, 08:30	Lecturer Geology Department, UPN and Director of NGO, DREAM.	Academic and NGO
Dr Kirbani Sri Brotopuspito	19/06/07, 08:00	Geophysics laboratory, and disaster management centre at UGM	Academic
Lasiman	19/06/07, 13:00	MVO staff based at Kaliurang	Government
Representative of Merapi Project	21/06/07, 12:00	Japanese Consultancy Firm	Private
Barandi Spata Widartono	11/007/07, 10:30	Cartography and remote sensing department, Geography, UGM	Academic
Iranda Yodhatama	12/07/07, 10:30	Jangkep	NGO
Dave Hodgkins	12/07/07, 13:00	Ex-Oxfam	NGO
Sugeng	13/07/07, 09:30	Search and Rescue, Yogyakarta	Government
Dr Totok	13/07/07, 15:30	Remote sensing,	Academic

		Geography, UGM	
Haris Eko	14/07/07, 11:00	PMI – Indonesian Red Cross	NGO
Sukirman	24/07/07,09:00	Manager of Merapi Golf	Private
Graeme McRea	06/08/07, 15:00	Anthropologist	Academic
Sapto Winarno	07/08/07, 07:00	Head of Transportation Division, Slemen District.	Government
Rahmi Fauziah	07/08/07, 10:00	Volunteer aid worker Bantul	
Head of Police Slemen	12/09/07, 09:00	Police department slemen	Government
Banu Subagyo	14/09/07, 12:00	UNDP	NGO

Table A4.4: Non-villager informants, their profession and sector.

Appendix 5: Informants demographics for 2009 field season.

Hamlet	**Name**	**Age**	**Position**	**F/ M**	**Date and time**	**Village**	**Region**	**S e g**
Bangunsari	Citro Kamli	44	RW	M	3/09/07, 12:00 AND 23/02/09, 13:45	Klakah	Boyolali	N N W
	Tumar	27	H o H	M	23/02.09, 14:40			
	Jumali	52	Rc	M	23/02/09,14 :00			
	Sardiyuanto	34	RW	M	23/02/09, N/A			
Banoran	Sukandar	40		M	06/03/09, 14:30	Kening ar	Magalang	N W
Batur D	Anon	55	RT	M	16/03/09, 10:00	Sangup	Boyolali	S E E
	Triyono	37	HoH	M	16/03/09, 10:25			
Batur Ngisor	Gimar	n/a	Rc	M	07/03/09, 13:00	Ngaro mulyo	Magalang	S W W
Bebedan D	Muji	43		M	04/03/09, 10:50	Paten	Magalang	N W W
Bebedan A	Sulasi		RT	M	04/03/09, 12:00			
Beling	Tarjpo	50		M	15/03/09, 15:15	Sangup	Boyolali	S E E
	Wijnyo	39	RT	M	15/03/09, 14:45			
Benjasari	Aris	53	RT	M	08/02/09, 18:15	Ledokle meng	Sleman	S S W
Blumbangsar i	Muji	55		M	06/09/07, - 08:00	Samira n	Boyolali	N N E
	Sumirah	45		F	06/09/07, 09:00			
Bojong	Darjo	60		M	07/03/09,11 :15	Ngarom ulyo	Magalang	S W W
Bono Lor	Arjo	72	Rc	M	06/02/09, 10:00	Sidorej o	Klaten	S S E
	Young men							

	Padmo	50	Rc	M	06/02/09, 11:00			
	Listyo	35	H o H	M	06/02/09, 09:00			
Bulu Kidul	Citro	85		M	20/02/09, 11:15	Surotelong	Boyolali	NNE
	Harno	49		M	20/02/09, 10:40			
Candi duwar	Siswoyo	55	HoH	M	03/03/09, 15:15	Sengi	Magelang	NWW
Candi Pos	Yudihaninggar	60		F	03/03/09, 14:30	Sengi	Magelang	NWW
Candi Tengah	Suprih	40		M	03/03/09,14:45	Sengi	Magelang	NWW
Cangkol	Mursadi	54	HoH	M	10/02/09, 13:00	Lencoh	Boyolalli	N
	Rejo Eko Prasetyo	28		M	18/02/09, 13:45			
Cluntang	Bisono	45	HoH	M	17/03/09, 16:00	Cluntang	Boyolali	E
	Marjo	35	HoH	M	17/03/09, 18:45			
Dadapan	Henry	24		M	04/03/09, 15:00	Krinjing	Magelang	W
Delus	Sukiman	38	PASAG	M	10/02/09, 12:00	Sidorejo	Klaten	SE
Demo	Anon		H oH	M	09/03/09, 12:30	Kalibening	Magelang	SWW
	Siswo	50	Rc	M	09/02/09, 11:15			
Dukuh	Sugeng Rujito				05/03/09, 12:30	Jambon	Boyolali	E
Gadung	Mitro Dimejo	69		M	16/03/09, 08:30	Sangup	Boyolali	SEE
	Narno	47		M	16/03/09, 07:30			
	Wanto Puji	45	RT	M	15/06/09, 13:00			
Gemer	Naru	44	HoH	M	07/03/09, 10:45	Ngargomulyo	Magelang	SWW
Gendelan	Tokojrat	51	HoH	M	04/03/09, 12:40	Krinjing	Magelang	W
Cluntang	Sumarjo	41		M	15/03/09, 18:00	Cluntang	Boyolali	E
Gobumi	Darjo Sudiro	44		M	17/03/09, 11:40	Mriyan	Boyolali	E
Godang	Gunar	58	SoV	M	08/02/09, 09:15	Tegalmulyo	Klaten	SE

Gondangrejo	Wiro	82		M	06/03/09, 11:00	Keningar	Magelang	W
Gondo Arum	Mustigai		HoH	M	09/02/09, 13:30	Wonokerto	Sleman	S W
Gowoksengi	Mangu Oawiro	84		M	03/03/09, 11:10	Sengi	Magelang	N W W
Gowopos	Ngati	70	(HoH house)	F	03/03/09, 09:00	Sengi	Magelang	N W W
	Barto Suwinyo			M	03/03/09, 10:30			
	Martono	43		M	03/03/09, 09:20			
Gokosabrang	Cokro Reju	54		M	02/03/09, 13:00	Sengi	Magalang	N W W
	Giyono	64	RT	M	02/03/09, 18:00			
	Karsosandi	45	RT	M	02/03/09, 16:15			
	Minarso		HoH	M	03/03/09, 16:00			
	Remi	85	RT-mother	F	02/03/09, 15:00			
	Tumini	50	F	F	02/03/09, 16:00			
	Cokroinangun	70	RT	M	02/03/09, 17:00			
	Sumar	67	Rc	M	03/03/09, 07:00			
Grogol	Suhadi	45		M	08/03/09, 11:00	Mangunsoko	Magelang	W
Gumuk	Edi Sunarto	57		M	17/03/09, 10:00	Sumber	Magelang	W
	Miharjo	51		M	06/03/09, 13:30			
Gumukrejo	Widjo	71		M	07/02/09, 13:30	Panggang	Klaten	S S E
Jamburejo	Harno	56	HoH	M	10/03/09, 17:50	Kamiren	Mageland	S W
	Surasa	31		M	10/03/09, 15:00			
Jelok	Cokro	76	RT	M	17/03/09, 15:15	Cluntang	Boyolali	E
Jengglik	Nurcholis	32	RT	M	10/03/09, 14:30	Ngblak	Magelang	S W W
	Faad Muslin	28		M	10/03/09, 11:40			
	Pawiro	65	RW	M	10/03/09, 13:15			
Sepi	Atmo	69	RW	M	05/09/07, 10:55	Jrakah	Boyolali	N W W
Kedung	Anon				18/02/09,	Lencoh	Boyolali	N

					15:30			
	Kamin	40	RT	M	18/02/09, 14:30			
Kajangkoso (Kacengsoko)	Suwoto	41		M	05/03/09, 14:30	Mangu ngsoko	Magelang	W
	Giyanto	22		M	05/03/09, 13:45			
	Hatuti	22		F	04/03/09, 07:50			
	Sunarto	80		M	05/03/09			
	Suro			F	05/03/09, 10:25			
	Tukijo	44	RT	M	05/03/09, 17:00			
	Nuryosukamt o	47	HoH	M	05/03/09, 07:45			
	Mulyono	50		M	04/03/09, 18:00			
	Cokrorejo	80	Ex-HoH	M	05/03/09, 09:20			
Kalibening	Suyono	34	HoH	M	09/03/09, 11:50	Kaliben ing	Magelang	S W W
	Nurbiyento	40		M	07/03/09, 08:15			
Kalitengah	Syanto	37		M	21/02/09, 14:45	Wonod oyo	Boyolali	N E E
Kaliurang Lor	Ponilan		RT	M	09/02/09, 11:30	Kaliura ng	Magelang	S W
	Subaryanto		Vill rep	M	09/02/09, 08:30			
Kaliurang	Anon	80+	Rc		11/02/09, 11:30	Hargobi nangun	Sleman	S
Kamiran	Yusif	27		M	09/03/09, 18:00	Kamira n	Magelang	S W
Karang	Marto	42	RW	M	24/02/09, 15:00	Tologle le	Boylali	N W
Karangayar	Kamis	45		M	07/03/09, 10:00	Ngargo mulyo	Magelang	W
Kawengan	Giyono	33		M	16/03/09, 13:30	Mriyan	Boyolali	S E E
Kedung	Sumarno	51	EX-RT	M	19/02/09, 08:45	Lencoh	Boyolali	N
	Ginah	60	F	F	18/02/09, 11:00			
Keningar	HoHs				06/03/09, 10:00	Kening ar	Magelang	W
Kepit (nr Dadapan)	Suyono	45	HoH	M	04/03/09, 13:20	Krinjin g	Magelang	W
Kepuharjo	Anon		HoV	M	05/02/09, 08:30	Kepu Harjo	Sleman	S
Klakah Duwur	Slamet		HoH	M	23/02/09, 10:40	Klakah	Boyolali	N N

								W
Klakah Ngisor	Mulyorejo	100		M	23/03/09, 08:30	Klakah	Boyolali	N N W
	Menang	45	F HoH w	F	23/02/09, 07:45			
Klakah Tengah	Mitrorego	65		M	23/02/09, 09:50	Klakah	Boyolali	N N W
	Parli	28		M	23/02/09, 09:15			
Klakah	Slamat		HoV	M	22/02/09, 19:00	Klakah	Boyolali	N N W
Klampahan	Sunarto Buang			M	17/02/09, 11:00	Ketep	Magelang	N W W
	Mustopa		RT	M	17/02/09, 12:30			
	Suwarno	56	VS	M	17/02/09, 10:00			
Krajan	Tarjo	65		M	04/03/09, 08:30	Krinjing	Magelang	N W W
Kujon	Yoto Rojo	57		M	21/02/09, 10:45	Wonodoyo	Boyolali	N E
	Darmo Wiyoto	37		M	21/02/09, 09:45			
Kuncan	Sipar		RW	M	22/09/09, 12:45	Samiran	Boyolali	N N E
Ledoklemeng	Ngadiyono	50		M	09/02/09, 18:45	Wonorejo	Sleman	S W
	Sagiman		RT	M	10/02/09, 13:30			
Lencoh	Anon		H o V	M	19/02/09, 10:00	Lencoh	Boyolali	N
Ledang	Yinarjo	70	Ex HoH Rc	M	21/02/09, 13:05	Wonodoyo	Boyolali	N E E
	Gido	55	RT bro	M	21/02/09			
Mangusoko	Haryadi		HoH	M	05/03/09, 11:30	Mangunsoko	Magelang	W
Mencoor	Sihono		HoH	M	11/02/09, 09:00	Giri kerto	Sleman	S S W
Mriyan	Anon - many		Village office		16/03/09, 12:30	Mriyan	Boyolali	W
Ngaglik	Hadi Durahman		HoH	M	04/03/09, 15:30	Krinjing	Magelang	N W W
Ngaliyan	Jastro Mulyo	58	RT	M	16/03/09, 14:25	Mriyan	Boyolali	S E E
Ngandang Tritis	Ngadimin		HoH	M	11/02/09, 13:30	Giri Kerto	Sleman	S S

								W
Ngandegan	Surowkiaryo	85	Ex-HoV	M	15/03/09, 15:45	Sangup	Boyolali	S E E
Ngargomuly o	Tatin	36	HoV	M	07/03/09, 09:15	Ngargo mulyo	Magelang	S W W
Ngargosoko	Anon		HoV	M	09/03/09, 08:15	Ngargo soko	Magelang	S W W
Ngargotonto,	Karyorejo	81		M	06/03/09, 12:30	Sumber	Magelang	W
	Maryono	53		M	06/03/09, 11:30			
Pagerjurang	Hadi Sartono	80		M	07/02/09, 17:00	Kepuh Harjo	Sleman	S
	Surtardi	38		M	05/02/09, 09:30			
	Wadi	71	Father of Ex-HoV	M	05/02/09, 09:30			
Pajegan	Anon			M	08/02/09, 11:15	Tegalm ulyo	Klaten	S E
Panggang	Wahyudi	48		M	07/02/09, 15:00	Pangga ng	Klaten	S S E
Pantiasih	Anon		HoH	M	04/02/09, 18:00	Hargo Binang un	Sleman	S
	Marto Mohangyo	65		M	04/02/09, 17:00			
Pentongan	Yami	40	F	F	22/02/09, 11:10	Samira n	Boyolali	N N E
Pedut	Nurokhim	39		M	21/02/09, 16:00	Wonod oyo	Boyolali	N E
Plalangan	Ngatinah	40	F	F	16/02/09, 16:00	Lencoh	Boyolali	N
	Samto		RT	M	19/02/09, 19:00			
	Widodo	45	RW	M	16/02/09, 11:00			
	Parto Karlan	78		M	16/02/09, 16:30			
	Separ and Salam	55 and 30		M	19/02/09, 13:30			
Pojok	Satari	61		M	22/02/09, 11:30	Samira n	Boyolali	N N E
Pucang	Proyo	59	Ex-RT	M	08/02/09, 10:15	Tegalm ulyo	Klaten	S E
Pule	Anon		HoH	M	06/02/09, 17:45	Tegalra ndu	Magelang	S W W
	Hadi Sugito	50	RT	M	08/03/09,			

					11:30			
	Jumali	44	RT	M	08/03/09, 13:10			
	Ngadiman	36		M	08/03/09, 09:30			
	Somobrawiro	71	Ex-HoH	M	08/03/09, 08:00			
	Somodimejo	78		M	08/03/09, 12:30			
	Sukandar	50		M	08/03/09, 11:00			
	Sukimin	46	RT	M	08/03/09, 13:10			
	Trimo			M	07/03/09, 18:00			
Puncang	Donardi	23		M	08/02/09, 10:45	Tegalm ulyo	Klaten	S E
Puntang Sari	Slamet Ngamar	35		M	20/02/09, 12:40	Surotel ong	Boyolali	N E
	Harso Suwito	71		M	20/02/09, 13:00			
Salam	Santoso	18	RW son	M	22/02/09, 09:45	Samira n	Boyolali	N N E
	Suhariman	40		M	18/02/09, 09:30			
	Anon		RT	M	22/02/09, 10:30			
	Amir	85		M	21/02/09, 18:00	Samira n	Boyolali	N N E
Pentongan bojok and Kuncan	Slamet		HoHs	M	20/02/09, 17:45	Samira n	Boyolali	N N E
	Topaworio Karno	66		M	22/02/09, 09:00	Samira n	Boyolali	N N E
	Marsuki	38	HoV	M	22/02/09, 08:00			
	Suharso	28		M	21/02/09, 19:30			
Sanden	Wage Irawan			M	17/02/09, 15:15	Wonole lo	Magelang	N N W
Sangup	Jade Mujiyono		HoH	M	16/03/09, 11:00	Sangup	Boyolali	S E E
	Pandun		HoH	M	16/03/09, 11:40			
	Sunar Winarkoyo		HoV	M	15/03/09, 19:00			
Selo	Alef	35		M	20/06/07, 16:00	Selo	Boyolali	N
	Auto	87	Rc	M	02/09/07, 16:30			
	Ismail	40	MVO	M	03/09/07,			

			staff monitoring post Selo		10:00			
	Parli	56		M	04/09/07, 19:00			
	Ahmed	26		M	04/09/07, 13:30			
	Sukadai	42	Staff of Solo kraton	M	07/09/07, 11:00			
	Sarju	34		F	03/09/07, 08:00			
Selo (hamlet)	Harjo Pangad	73		F	3/09/07, 14:00	Selo	Boyolali	N
	Somo	70		F	03/08/07, 15:30			
Seman	Seneng Hatidubriyo	64	Father HoH	M	04/03/09, 14:25	Krinjin g	Magelang	N N W
Candi duwer and pos	Agus and Napri		Village staff	M	03/03/09	Sengi	Magelang	N W W
	Yanso	45	HoV	M	02/03/09, 12:00			
Sepi	Anon	70	Sister RW	F	05/09/07., 15:00	Jrakah	Boyolali	N
Soko	Suradi	45	HoH	M	09/03/09, 08:40	Ngargo soko	Magelang	S W W
Stabilan	Sipon	45		F	23/02/09, 11:00	Tlogole le	Boyolali	N W
	Tukini	40		F	24/02/09, 14:20			
	Atmo Suwar	63			24/02/09, 11:45			
	Barni	45		F	24/02/09, 10:45			
	Mugiruh	40		F	24/02/09, 09:30			
Sumber	Suyitgito	47		M	05/09/07, 13:00	Klakah	Boyolali	N N W
	Hakamto	54	S o V	M	06/03/09, 09:40			
	Salmat	45	RW and HoH	M	23/02/09, 15:15			
	Suladi			M	23/02/09, 16:00			
Sumerejo	Welimin			M	09/02/09, 09:15	Kaliura ng	Magelang	S W
	Dasmi		F RT wife	M	09/02/09, 10:15			
	Pujilah	55	F	F	09/02/09, 10:00			

Suroteleng	Mardiynto	44		M	20/02/09, 09:15	Suroteleng	Boyolali	NE
Tegalrandu	Muhkambali	50	HoH	M	08/03/09, 15:00	Teglarandu	Magelang	SWW
	Siti Kowiyah and Ahmed Modrik	40 and 45	F H of V and Ex-HoV		08/03/09, 14:00			
Tempel	Dekelan	72		M	09/03/09, 14:00	Krinjing	Magelang	NWW
Temusari	Paiman	56		M	18/02/09, 12:30	Lencoh	Boyolali	N
Tenan	Sartono		HoH	M	07/03/09, 13:30	Ngargomulyo	Magelang	SWW
Tenusari	Hasyim	36		M	18/02/09, 11:40	Lencoh	Boyolali	N
Tlogolele	Yustina		F SoV	F	24/02/09, 08:00	Tlogolele	Boyolali	NW
Trayem	Suwandi	48		M	04/03/09, 09:50	Krinjing	Magelang	NWW
Tunggularum	Adi	70		M	10/02/09, 09:30	Wonokerto	Sleman	SW
	Aris		KLM	M	10/02/09, 11:00			
	Krisyanto	45	HoH	M	10/02/09, 08:00			
	Sihono		PASAG	M	10/02/09, 10:30			
	Wiwin and Anas	27 and 30	F and M	F	10/02/09, 08:45			
Tutup	Karto	66	RT	M	17/03/09, 14:00	Cluntang	Boyolali	E
Windusabrang	Siswanto and Sarti F	22 and 45		F	17/02/09, 14:30	Wonolelo	Magelang	NNW
	Sumadi	43	HoV	M	17/02/09, 09:00			
Windusari	Anom Sunirto	75		M	09/03/09, 09:20	Kalibening	Magelang	SWW
Wonodoyo – Kujon hamlet	Widodo	62	HoV	M	21/02/09, 08:50	Wonodoyo	Boyolali	NEE
Wonosari	Tarto	48		M	21/02/09, 12:10	Wonodoyo	Boylali	NEE

Table A5.1: Demographics of all informants interviewed during 2009 field season.

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