Geographical Research

Agroforestry on an Active Volcanic Small Island in Indonesia: Prospering with Adversity

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Abstract
This paper draws on the literature on agroforestry, disaster risk reduction, and livelihoods of people on small islands as it applies to a community prospering in conditions of adversity in Kinali village on Siau Island, Indonesia. Siau Island produces between one-third and one-half of all nutmeg and mace exported from Indonesia. The Kinali community has adopted strategies that enable it to prosper in spite of the risks of living on a small island with an active volcano. The paper charts the sociocultural dynamics of the village and examines how local coping mechanisms based on an agroforestry economy have assisted villagers in dealing with the multiple hazards and constraints arising from the biophysical characteristics of their island. The paper thus contributes to more informed responses to managing volcanic risk.

KEY WORDS *agroforestry; disaster risk reduction; livelihoods; small islands; hazards; volcanic risks*

Introduction

Limited natural resources and vulnerability to multiple hazards are common characteristics of small islands (McCall, 1994; Briguglio, 1995; Arnberger and Arnberger, 2001). Communities living on small tropical islands are geographically isolated from the mainland and can be prone to volcanic eruptions, earthquakes, tsunamis, landslides, and their attendant environmental impacts (Campbell, 2009; Nunn, 2009; Wisner and Gaillard, 2009; Terry and Goff, 2012). Small islands share many challenges with continental landscapes but experience additional constraints such as limited land area, scarce freshwater resources, and fragile ecosystems. However, small island communities manage to survive and often flourish in these risky environments (Reenberg *et al*., 2008; Thaman, 2008; Campbell, 2009; Mercer and Kelman, 2010).

On small tropical islands, many villagers sell food crops and agroforestry products (Barbier, 1989; Arnberger and Arnberger, 2001). The revenues from these sales enable them to purchase their staple foods and other necessities, which may otherwise be unavailable or of limited availability (Thaman and Clarke, 1993). Cash crop farming especially from tree crops enables islanders to enjoy livelihoods beyond simple

subsistence. Land scarcity, encroachment of settlements on arable land, and threats from natural hazards provide additional incentives for investment in tree crops (Thaman, 1993; Noordwijk *et al*., 2012; Pachauri, 2012).

The ecological and social aspects of natural resource management cannot be de-coupled in any landscape but on small islands this is brought into sharp focus (McCall, 1994; Christensen and Mertz, 2010). Here we analyse the strategies that the people of Kinali village on Siau Island (2°45′N 125°25′E) (Arnberger and Arnberger, 2001) have adopted that enable them to prosper in spite of the risks of living on a small, isolated island with a very active volcano. Traditional natural resource management based upon strong social networks and a strong culture are the factors that have enabled them to do so. These strategies treat the volcano as a source of opportunities and not just a threat. We highlight the role of agroforestry as the basis of a livelihood strategy and ask how successful this has been and if there are lessons that might apply more widely. The first section of the paper characterises the approach to living with risks on small active volcanic islands and describes the agroforestry system employed by the people. The second section describes the research location in more detail and outlines the methodology for the research. We then explore agroforestry in Kinali village and describe the community's way of coping with hazards through adoption of environmentally sound and sustainable management practices for their agroforestry. We conclude by describing the importance of local natural resources management practices and culture in disaster risk reduction.

Living with risks on volcanic islands

Living with volcanic risks

The risks of volcanic eruptions to people and their environment have been widely documented (i.e. Dibben and Chester, 1999; Johnston *et al*., 1999; Ward and Day, 2001; Cronin *et al*., 2004; Dominey-Howes and Minos-Minopoulos, 2004). However, less is known about the potential benefits of living in volcanic regions when the rich volcanic soils can support highly productive agriculture. An example of the contribution of a volcano to local livelihoods is described by Duncan *et al*. (1981) who studied the positive contribution of Mount Etna, the largest continental volcano in the world, to the wealth and status of people living nearby when compared with those living in other regions of Sicily. Mount Etna provides fresh water and fertile volcanic soils, which account for the intensive agricultural activities and expanding settlements on the lower slopes of the volcano. On many active volcanic islands, the periodic addition of volcanic ash to the soil contributes essential nutrients that increase soil fertility (Arnberger and Arnberger, 2001).

Kelman and Mather (2008) suggest four options for balancing the dangers of living in, or near, volcanos with the benefits or potential benefits of volcanic eruptions. These options are: (1) do nothing, (2) protect society from hazards, (3) avoid hazards, and (4) live with the hazards and risks. In the context of small islands, the fourth option is often favoured. As Kelman and Mather (2008) explain, the do-nothing option will lead to disaster, the scale of which will depend on the extent and characteristics of an eruption and the vulnerability of the local communities. If the risk is known and there is a willingness to accept the consequences of taking the risk, this option could be appropriate. The second option, protection by building defensive structures, can increase risk in the long term as people who become reliant on physical protection may become overconfident and not adopt adequate alternative precautions. The third option, to avoid the hazard by relocating, is also not necessarily favoured because it may lead to increased vulnerability to other natural hazards or social challenges associated with moving to a location which is already inhabited. This paper considers a community which has adopted the last option, living with the risks, by organising themselves to find a balance between the environmental hazards and opportunities.

Agroforestry on small volcanic islands

Conflict over forest land throughout the tropics is a major global environmental issue (Thaman and Clarke, 1993; Bass and Dalal-Clayton, 1995). Agroforests contribute to addressing this conflict by providing the environmental benefits of forests together with the production benefits of agriculture. We have used the definition of small islands from the Indonesia Coastal and Small Island Management Act 2007, which defines small islands as being equal to or less than 2000 km^2 in area (Article 1 item 3 Law 27/2007), and having a population size of 500 000 or fewer people (Hess, 1990). Agroforestry is defined as 'a sustainable land management system which increases the overall yield of the land, combines

the production of crops (including tree crops) and forest plants, and animals simultaneously or sequentially, on the same unit of land, and applies management practices that are compatible with the cultural practices of the local population' (Nair, 1989, 13). This definition emphasises the interactions of production and sustainability.

Volcanic small islands have distinctive biophysical conditions compared with continental areas and these dictate the island's capacity to sustain human communities (Hess, 1990). Inhabitants of small islands have distinctive cultures and strong connections to the land (Tuan, 1974; Beller, 1990; Giavelli and Rossi, 1990; Hanson and Lamson, 1990). Therefore, for agroforestry to be practised on small islands it has to be socially acceptable, practical, and contribute significantly to farmers' livelihoods. This point is highlighted by Dove (1992) who stresses that the functionality of agroforestry for farmers has greater significance than classifying land suitability for agroforestry on the basis of purely biophysical criteria.

This study is based on the sociocultural dynamics of people in Kinali village, Siau Island, who depend heavily on the production of nutmeg (*Myristica fragrans*) and to a lesser extent coconut (*Cocos nucifera*) and cloves (*Syzygium aromaticum*) for export while living on the edge of one of the most active volcanoes in Indonesia: Mount Karangetang. Siau Island produces between one-third and one-half of all nutmeg and mace exported from Indonesia (Marks and Pomeroy, 1995). In 2006, Indonesia was the biggest nutmeg producer in the world (75%), and most of it came from smallholder farmers (98%) (Novarianto, 2010). The best quality nutmeg, mace, and nutmeg oil in Indonesia come from three small islands, and is planted on or around active volcanoes, Mount Karangetang on Siau Island, Mount Gamalama on Ternate Island, and Mount Banda on Banda Island (Novarianto, 2010). Nutmeg productivity is highest on Siau. This paper specifically considers how local coping mechanisms based on agroforestry have assisted Kinali villagers to deal with recurring multiple natural hazards and constraints arising from the biophysical characteristics of their island.

Study site and methods

Kinali village is located on Siau Island, part of the archipelagic district of Sitaro, North Sulawesi Province, Indonesia (Figure 1). Sitaro district consists of 47 small islands of which 10 are permanently inhabited (Badan Pusat Statistik Kabupaten Kepulauan Sitaro, 2012a). It has a total area of 3066 km^2 of which 9% (275.96 km^2) is terrestrial. There are three major islands: Siau, Tagulandang, and Biaro (Badan Perencanaan Pembangunan Daerah Kabupaten Kepulauan Sitaro, 2010). Siau is the principal and most populated island with a population of 40 758 people in 2014, 64% of total population of Sitaro district (Badan Pusat Statistik Kabupaten Kepulauan Sitaro, 2012a).

The Sitaro administrative centre is located on Siau. Siau is currently only accessible by sea and is located midway between the Sulawesi mainland and the larger island district of Sangihe. The voyage from Manado, the capital city of North Sulawesi Province (Figure 1), to Siau takes approximately 5 hours by a commercial speed boat or about 8–9 hours by public ferry. Both transportation types have been available daily to Siau from Manado since 2009. Mount Karangetang dominates the landscape of Siau and is 5 km from Kinali village. Karangetang is one of the most active volcanoes in Indonesia and has experienced 53 major eruptions between 1675 to 2012 and a continuous series of smaller eruptions. Molten lava has been continuously visible on top of the volcano since 1973 (Wattiri, 2008; Global Volcanism Program, 2013).

Kinali village is located in the Kecamatan (sub-district) of Northwest Siau and is about 4 km from Ondong, the capital city of Sitaro district. Kinali lies on the western slopes of Mount Karangetang and faces the Sulawesi Sea to the west. Kinali village is located in an area exposed to eruptions from Mount Karangetang and is classified as both category 2 (high risk of lava, lahars, dense volcanic ash, and the possibility of pyroclastic flows) and category 3 (frequently affected by pyroclastic flows, lava, lahars, dense volcanic ash) by the Indonesian Government (Figure 2).

Kinali village is mountainous and most of its area is planted with agroforestry trees, mainly nutmeg (Figure 3). Kinali, in the local language, means 'digging', because whenever the villagers want to build, they have to dig to create a flat space (Pemerintah Desa Kinali, 2012). It has an area of 387 ha and in 2013 had a population of 445 people in 125 households. The people are Christian and ethnically homogenous, belonging to the Sangir ethnic group. Farming is the principle occupation. In 2011, of a total of 237 working people, 174 were farmers, 15 were fishers, and the remaining 48 were carpenters (8),

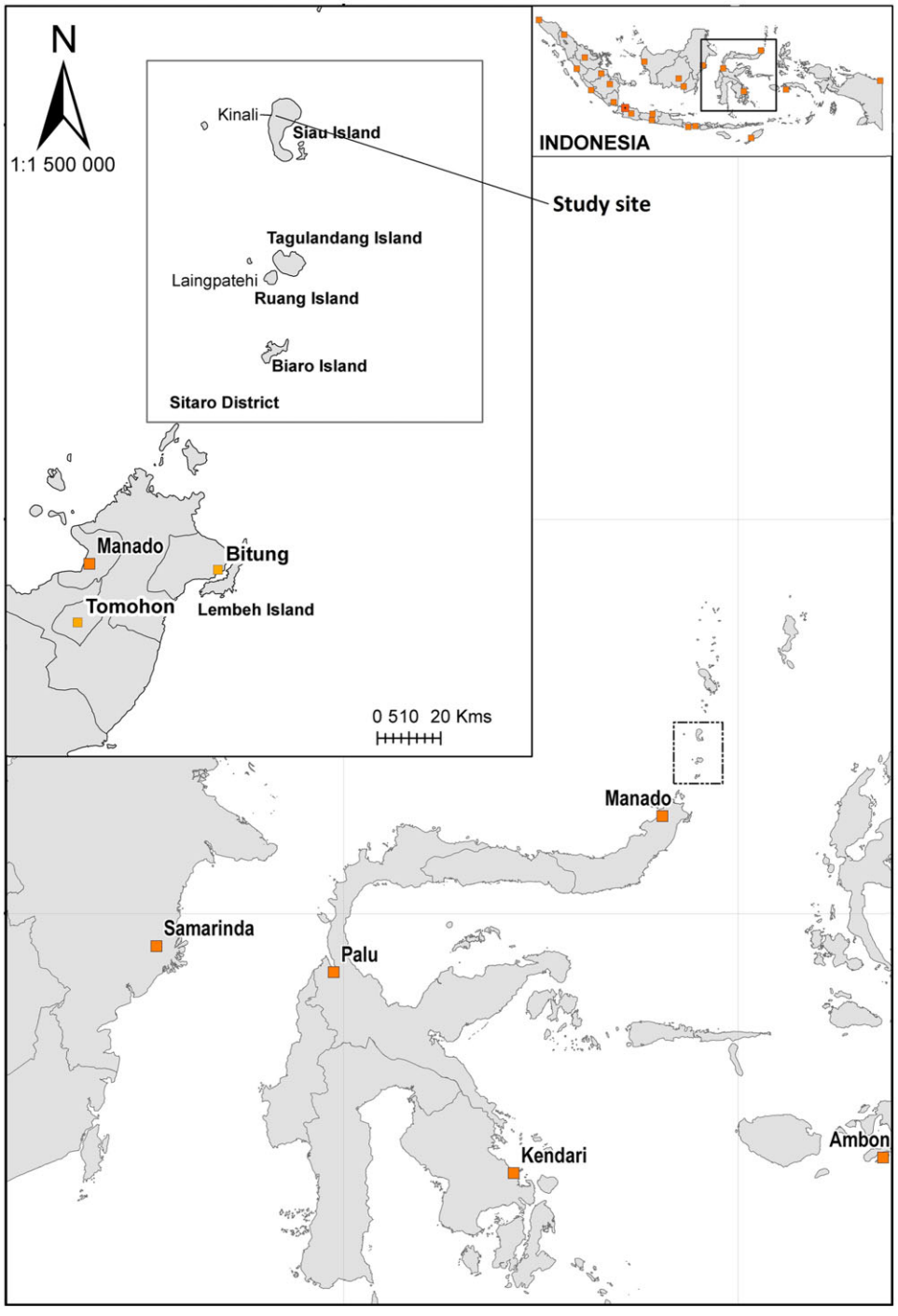

Figure 1 Map showing the approximate location of Kinali village on Siau Island within the District of Sitaro. The island is remote from Manado, the capital city of North Sulawesi Province. Bitung and Tomohon are satellite cities within North Sulawesi Province. Insets show principal cities in other neighbouring provinces.

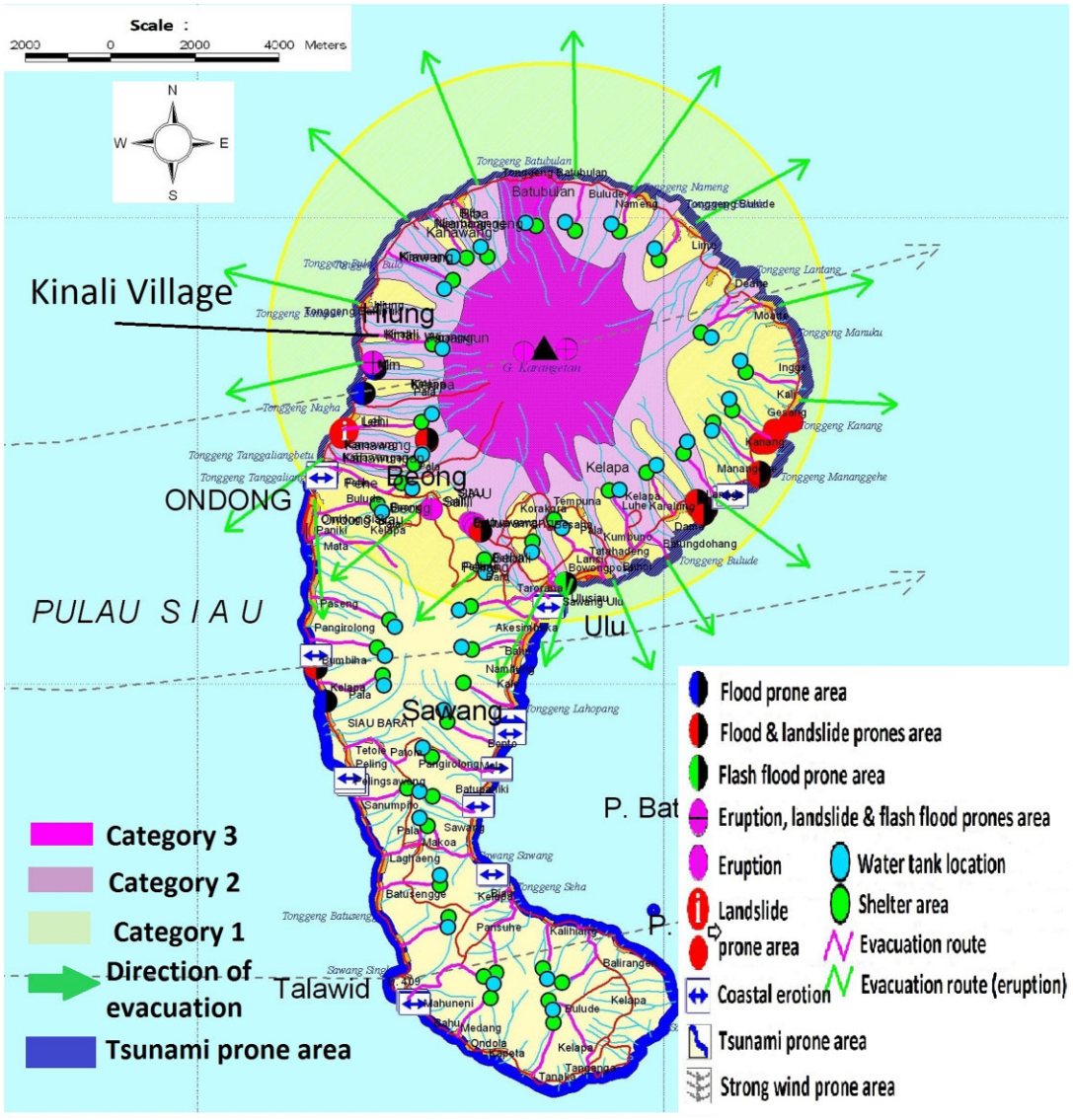

Figure 2 Map showing the position of Kinali village and the vulnerability categories of Siau Island (Pulau Siau) and areas prone to tsunamis (adapted from map of vulnerable areas of Sitaro District by Bappeda Sitaro 2013).

civil servants (10), traders (7), pensioners (4), village officers (10), livestock herders (7), a tailor (1), and military (1) (Pemerintah Desa Kinali, 2011). These administrative statistics fail to reflect the reality that almost all of the people work periodically on farms. Fishermen are farmers who fish part-time to supplement their food supplies. The same situation is found for carpenters who are farmers that do part-time woodwork. Civil servants and traders do some farming and fishing. Moreover, data from the village office did not mention *ojek* (motorbike) taxi drivers or those who quarry local volcanic rock for building materials, which are common income-generating activities among the villagers (the latter also reduces potential downstream lahars hazards). In addition, about 20 villagers currently work as sailors mainly on boats based on Batam Island (close to Singapore) and in Jakarta as well as overseas (A. Raule, pers. comm., 2012).

The research presented in this paper draws on three field trips undertaken between November 2011 and October 2013. During every visit,

Figure 3 Kinali village (the houses to the left of the photograph) and the Karangetang volcano seen from a distance showing agroforestry on the slopes.

meetings with the head of the village and church leaders were a first priority. The first, from November 2011 to January 2012, produced basic descriptive information on the communities and islands and developed links with local government institutions, the local Red Cross, and village leaders. During the second visit, from June to December 2012, data were collected from local communities with additional information obtained from local governments, the local Red Cross, newspapers, and other available documents. The last visit, from August to October 2013, confirmed the findings from previous visits and was completed with transect walks around the village.

As local acceptance of research is important (Swanson, 2008; Terry and Khatri, 2009), the lead author presented the purposes of visits to the local communities during Sunday services in their local church (GMIST Galilea). All the community members are Christian and the majority are members of the biggest local church denomination (GMIST Synod). Strong social cohesion centres around Church activities and is an important factor in the daily life of the villagers. Church influence can be seen in that no farming or other activities are conducted by villagers on Sunday except when directly related to religion. Even the temporary emergency evacuation shelter is a Church building. Government announcements and hazard warnings are made during Sunday services and at other church-related meetings. The Church and primary school, owned by the church, were built in 1882 and are maintained by the church and are still in use.

The Manadonese language was used in interactions with villagers because it is the most common language on the island, although many people also speak the local Sangir language. The use of Manadonese enabled the lead author to communicate easily about the research and its purpose, and helped in building rapport with local communities.

Data were collected using several participatory methods and from published reports, newspapers, and government documents. Participatory methods used included mapping people's knowledge of their livelihood assets and their perceptions of the hazards they encounter. A seasonal calendar was used to explore the activities of villagers taking place over the period of one year. Venn diagrams were drawn to understand the roles, services, and suitability of various institutions. Historical timelines were used to track changes in the history of the environment, livelihoods, and village development. Transect walks were used to study the topography of the area. Vulnerability matrices were developed to determine important hazards that affect the most important livelihood resources.

Based on a sustainable livelihood approach (Chambers and Conway, 1992), an approach to understanding people's capacity in dealing with volcanic hazards was used. This conceptual framework is adapted from Wisner *et al*. (2012)

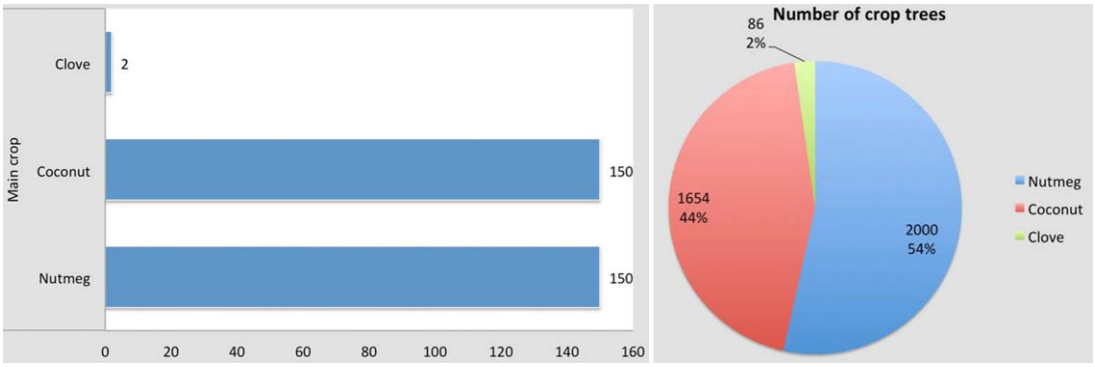

Figure 4 Area of main crops and number of crop trees in Kinali village (Pemerintah Desa Kinali, 2011; Pemerintah Kecamatan Sibarut Kabupaten Kepulauan Sitaro, 2012).

and allows the use of livelihood resources to understand local capacities. All the resources are interlinked (Sayer and Campbell, 2004) and combine to determine capacity. The availability and access to resources will determine their ability to face hazards (Gaillard *et al*., 2009); therefore in this study, capacity is understood as 'the set of knowledge, skills and resources people resort to in dealing with natural hazards and disasters' (Cadag and Gaillard, 2013, 269). They have traditions that enable them to cope with disasters (Campbell, 2006) and that traditions underpin the fabric of their societies based on beliefs and behaviours (Paton, 2006; Campbell, 2009).

Local communities were encouraged to describe their own social dynamics (Mercer *et al*., 2008) and use their own words and frameworks (Chambers, 1994b; Pain and Francis, 2003) in interactive and collaborative ways rather than simply responding to questions (Ivanitz, 1999). This approach helped understand local community perceptions of agroforestry as it links to local livelihoods (Dove, 1992). The level of engagement with local participants and the more general approach of the research were at least as important, if not more so, than the specific participatory technique applied (Kumar, 2002; Rampengan, 2014).

Although group participatory exercises yielded crucial data, semi-structured interviews were also used to explore sensitive information that was difficult to obtain in group situations. This gave an opportunity for shy participants to express their views. Interviews were held in people's homes or in gardens during or after work. These individual interviews were conducted after the group activities.

The last field visit was used to share and discuss findings gained from previous visits. The findings were disseminated and feedback was solicited from large group meetings. Incomplete information from previous findings was added. Villagers who did not attend the bigger group meetings were reached through smaller meetings. The smaller groups also provided a chance to deepen information feedback from elders and religious leaders. Transect walks enabled us to draw a topographical map of the village (Figure 5).

Kinali village nutmeg agroforestry

Nutmeg, coconuts, and cloves are the three main crops in Kinali (Figures 4 and 5) as well as elsewhere on Siau. Nutmeg is the most important cash crop. Coconuts and cloves, which sell for less than nutmeg, provide additional income – but coconuts and clove trees are old and unproductive and are slowly being replaced by nutmeg. The agroforestry system of Kinali village includes a range of different types of fruit and shade trees including durian (*Durio sp.*) and canary (*Canarium sp.*). The function of shade trees, especially during the early growth stage of nutmeg, is to protect the nutmeg from strong winds which can uproot nutmeg seedlings and cause unripe fruits to fall. Canary trees also give additional income to the farmers as they produce valuable nuts and durian is a popular local fruit fetching a good price in local markets. When these canopy trees reach sufficient diameter, their owners sell them for timber to Siau villagers as well as to inhabitants of neighbouring Makalehi Island as raw materials for building fishing boats (canary) or for use in building construction (durian).

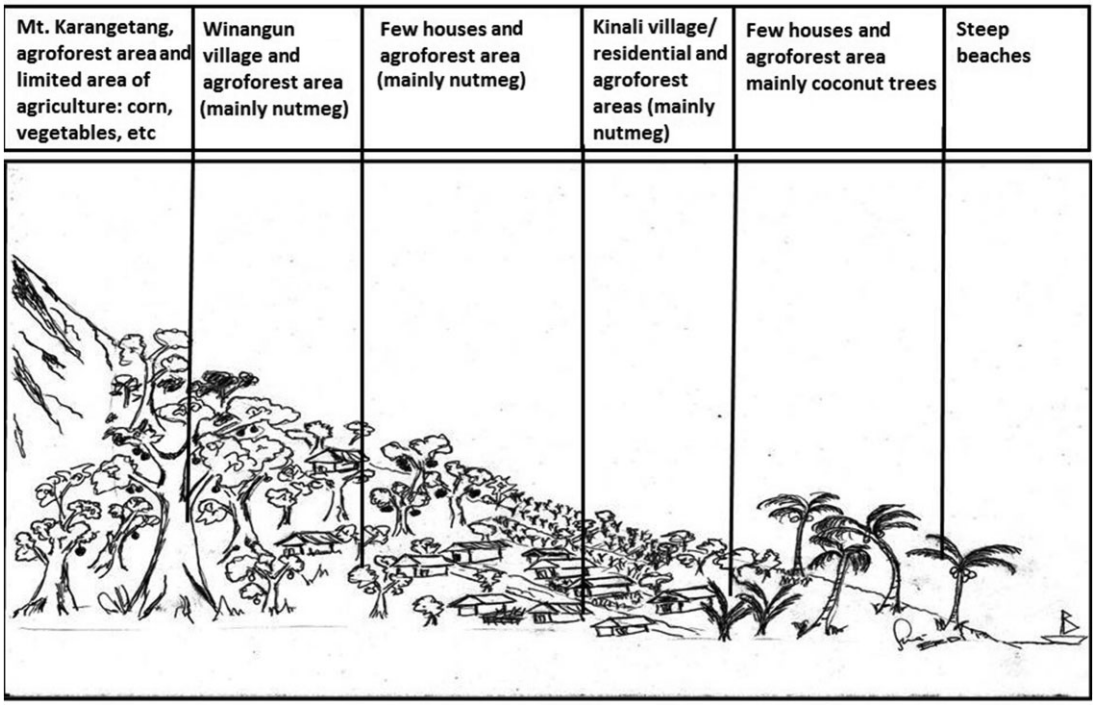

Figure 5 Overview of the village landscape (transect walk in Kinali in September 2013).

Even though tree crops in Kinali village are threatened by volcanic eruptions, farmers are more concerned about the volatility of the price of nutmeg in world markets (Ong and Tran, 2013). These fluctuations are a major determinant of income. The volcanic activity itself is perceived as a benefit because it provides natural fertiliser and protects the crop against fungal pests. These factors are believed by local people to account for the high yield and quality of nutmeg on Siau (Marks and Pomeroy, 1995; Novarianto, 2010) and for the low cost of its maintenance (Marks and Pomeroy, 1995). Low maintenance costs free up villagers for other work outside the main harvesting seasons in March and from August to October. Lower levels of harvesting are possible throughout the year. The nutmeg price is beyond the control of local or national government and as it depends on international trade and exchange rates.

Land and water limitations have led Kinali villagers to use rotating ownership mechanisms in harvesting and maintaining nutmeg and other crops. Each family member has the right to harvest and maintain all of the crop trees that belong to a family for two years, after which time this role is rotated to another family member. This mechanism allows all family members to benefit from collectively owned trees. While waiting for the peak harvesting period or their scheduled turn to harvest and maintain the crops, villagers work in other activities (gleaning fallen nutmeg, collecting building materials, driving *ojeks*, etc.). Kinali villagers use bamboo tubes to inject water into the soil adjacent to nutmeg trees during droughts. This technique allows them to use water effectively as they only make a small hole in the bamboo and allow a small amount of water to flow continuously to the tree. This traditional form of drip irrigation makes efficient use of limited fresh water during long dry seasons.

Ownership of the trees in any location is divided among family members. Therefore, on one piece of land, different people own different trees (nutmeg, coconut, and clove). People have a kind of 'tree-tenure' system rather than land-tenure, as there is no formal land-titling in the village. Moreover, nutmeg, coconut, and clove trees can be exchanged for services. People give trees to non-family member in exchange for help: for example, to a midwife for help with a birth. Transactions are not recorded in writing,

however, and there is potential for conflict related to future ownership claims.

Because land and trees in any location commonly belong to different people, it is difficult for outsiders to acquire land. This enables local people to maintain their limited natural resource assets. If a member of the family moves to another village or island, that person will only give their land to their relatives. In this village there is no public cemetery because there is not enough land; the land is steep and is entirely planted with trees. The tradition is to bury family members close to their houses. This practice strengthens land claims and means that outsiders will not be able to acquire land holdings in Kinali.

Another sociocultural practice in Kinali is that non-family members are allowed to collect fallen nutmeg. This provides important income to other villagers. All village members therefore benefit from gleaning fallen fruit but may not pick nutmeg directly from trees. The owner of the trees also benefits because the gleaners clean the land while picking up the fallen nutmeg. Gleaning contributes to the more equitable distribution of income among households in the village when compared with villages in other parts of Indonesia.

How social networks help Kinali villagers to cope with hazards

Kinali villagers are dependent upon their environment for their livelihood and have developed an in-depth knowledge enabling them to identify signs of impending volcanic activity. Any signs of activity, such as tremors and earthquakes that suggest an eruption is likely, are communicated to the rest of the community. If no molten lava has been visible on top of the volcano for a long period, then the next eruption is likely to be powerful. Although determining the accuracy of these warning signs is beyond the scope of this study, Kinali villagers claim confidence in their predictive ability. Villagers also monitor the response of people from the small village of Winangun (Figure 5) which lies closer to the crater. If Winangun villagers evacuate to Kinali village, this usually means a serious eruption is about to occur.

Mount Karangetang was named by a German Pastor, F. Kelling, who worked in Siau from the late 1800s to the early 1900s. It was given the name *Yohannes Tamugagolo* which means the volcano that will not harm villagers. This information was confirmed during the last visit by the head of the GMIST Church Galilea, who is also as the chairman of elders of Kinali village and was head of Kinali village from 1990 to 2000 (J. Kalombang, pers. comm., 2012). If Karangetang erupts, all villagers across Siau believe a violation of morality has occurred in one of the villages surrounding the volcano. Villagers are also cognizant that an eruption will not harm them as long as they correctly evaluate whether to stay at home or move to another location. During the eruption in 2011, for example, 13 households were surrounded by lava in two dry rivers that encircled them but did not harm them. Villagers reported that the death of one family during an eruption in 2010 occurred because they decided to attempt to escape by crossing a dry river which then filled with lahars.

Before the Asian economic crisis in 1998 when the price of nutmeg was relatively low, Kinali village was well known as a producer of several local agriculture products such as sweet potatoes, taro, and vegetables (Figure 6). Villagers focused on these agricultural products because of the availability of suitable land on the area of the village close to the crater. Villagers worked together to plant, clean, and harvest the crops in the spirit of *mapalus,* a local name for informal cooperative social work in the community. *Mapalus* represents a form of social network that supports villagers in times of hardship as well as in building private houses. When the price of nutmeg increased significantly from 1998 onwards and the lava covered the area previously used for vegetable production, villagers focused entirely on nutmeg and that situation has continued until the present.

In the context of such risks and village perceptions of risks, the Kinali villagers consulted in this research described their obligation to care for their plantations and for their animals. Villagers wanted to protect their sources of livelihood and treated nutmeg as a prime asset. The existence of nutmeg as a factor encouraging people to live in hazard-prone areas was emphasised by the Chairman of Sitaro Parliament (DPRD Sitaro) (D. Tamudia, pers. comm., 2012) and the Head of the Education Department of Sitaro (S.W. Katiandagho, pers. comm., 2012) who argued that high yields, good quality, and relatively high prices for nutmeg, together with their attachment to the land justified people's decision to live in locations exposed to major volcanic hazards. Consequently, if faced with the need to evacuate, they have a dilemma: to abandon their tree crops or not. Their experience of past eruptions

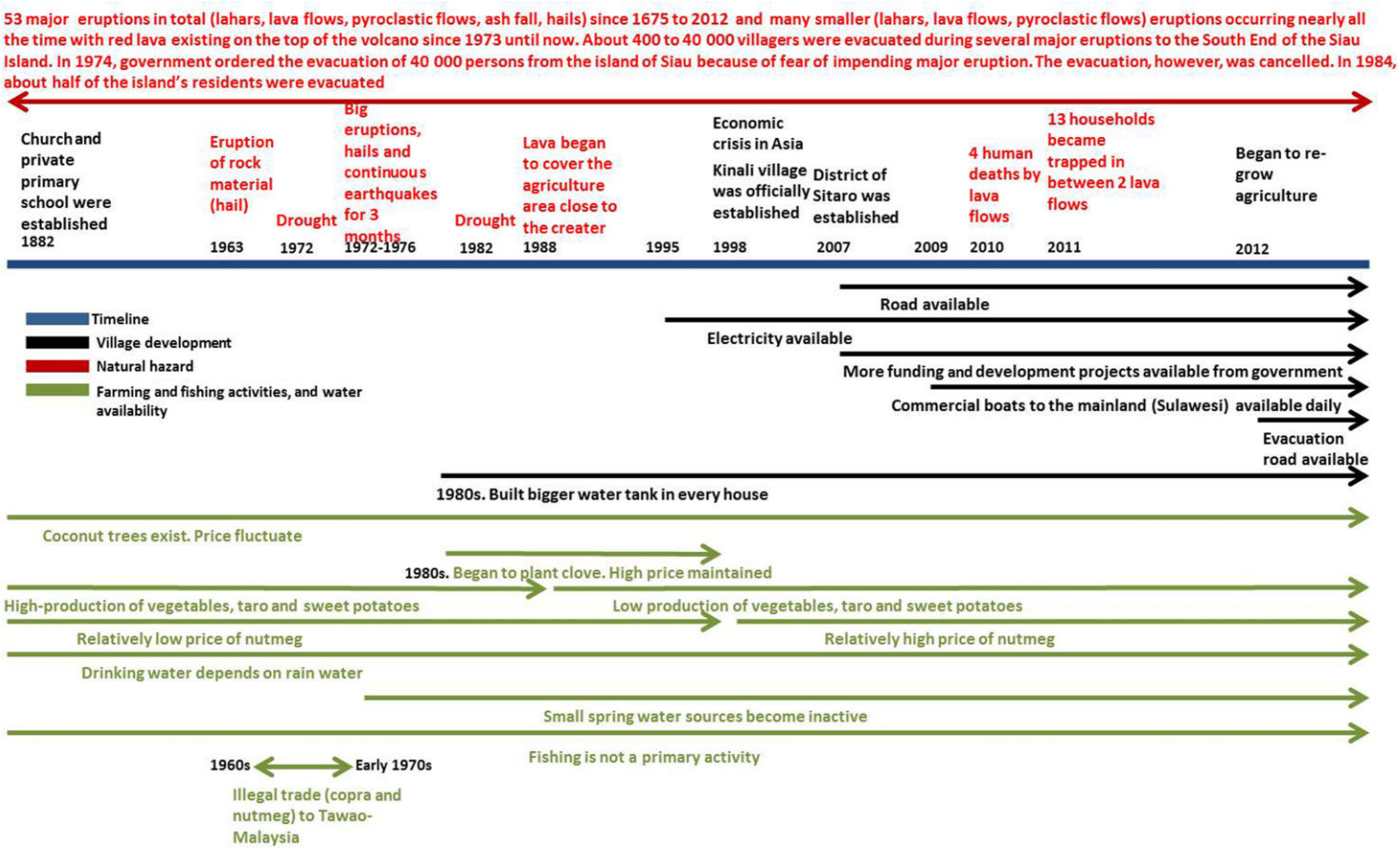

Figure 6 Historical events influencing Kinali village, Siau Island, North Sulawesi province, Indonesia, 1882–2012 (derived from historical timeline activities with the villagers and GVP-Global Volcanism Program, 2013).

suggests that lava and lahars only follow dry rivers to the sea, therefore only houses and plantations close to the rivers are at risk (Head of Sibarut Sub-District/former Kinali Head of Village, A. Raule, pers. comm., 2012). The spirit of *mapalus* is manifest in all activities during hazard events. It is common for villagers to warn each others, evacuate old or sick people who live on the uphill side of the village, provide food in the temporary shelter, and maintain the road and village infrastructure.

Pyroclastic flows are known to follow the lava's path and occur subsequent to lava flows (Karangetang-type eruption) and can travel 1–2 km downhill (Wattiri, 2008). During ash falls associated with eruptions, all the water tanks in the village are covered. When the need to protect plantations is combined with belief that homes are safe, villagers see no reason to evacuate. Even if ordered to evacuate by the government, the villagers will return to plantation areas during the day to check on their crops and return to evacuation shelters in Church buildings at night.

In the past (<1980) (Figure 6), during eruptions, earthquakes, and hail storms, most of the villagers had to move temporarily to the southern part of the island. They lived with their relatives. They experienced a continuous period of earthquakes for about three months in 1974. That event caused significant difficulties for villagers in conducting their routine activities such as cooking and farming, and caused damage to their houses. The government ordered the entire population of 40 000 people of Siau to be evacuated, though the evacuation was cancelled because of a reduction in volcano activity (Figure 6). Recently, they experienced mostly minor eruptions except in the year 2011 and 2012 when they had to stay for several days in a temporary shelter in local church buildings. In those times, the access to the village was disrupted because the lahars damaged the road. Though the villagers claimed that food was sufficient and available in several local shops, government supplied supplementary food with the use of boats. In 2012, with funding support from government, villagers built an evacuation road, connecting Winangun village and Kinali village through the nutmeg plantation to provide access to a temporary shelter in the local church (GMIST Galilea). The road will be upgraded later to provide access to the coastal area of the village where the government has a plan to build a jetty. However, several villages on the other slopes of the volcano recently experienced major threats because lava and pyroclastic flows approached their dwellings.

Discussion

McCall (1994) has stressed that studies of islands must consider both their physical and sociocultural contexts. This study suggests that understanding agroforestry on small tropical volcanic islands requires understanding of the ecological, socio-economic, and cultural attributes that shape the perceived risks and benefits associated with farming. Each of these attributes contributes to the ability of Kinali villagers to flourish in the face of apparent adversity, and have helped Siau to become the centre of nutmeg production in Indonesia, both in terms of quality and productivity (Hadad and Hamid, 1990; Marks and Pomeroy, 1995; Novarianto, 2010).

Nutmeg is originally from Banda island in eastern Indonesia (Joseph, 1980), an island with similar physical conditions to Siau. Both have active volcanoes that produce rich soils and gaseous emissions that act as a natural pesticide that protect nutmeg and other crops. Indeed, nutmeg trees are well suited to the ecological characteristics of the island where there is a limited availability of arable land. Yet the cultural practices that support agroforestry activities in Kinali, e.g. communal ownership, 'tree tenure', collaborative hazard knowledge, are key assets that underpin nutmeg's viability as a crop. As Scheyvens and Momsen (2008, 499) suggest, the 'high level of cultural, social and natural capitals' is a key strength of small island communities. Lowenthal (1992) likewise stresses that islanders' control of their environmental and cultural assets helps safeguard both natural resources and social cohesion more effectively than in mainland communities. Of particular relevance here is Lowenthal's (1992, 27) insight that 'Communal ownership and control ... help to promote insular conservation measures'. Communal ownership promotes effective management of limited natural resources within the limited space available on small islands.

Despite all the environmental and economic risks of living on a small volcanic island, Kinali villagers have prospered by growing and selling nutmeg. The results of this study show that traditional knowledge and a traditional, culturally specific way of managing natural resources has helped bring about this prosperity. The rational management of limited land and natural

resources combined with strong social cohesion and strong cultural links to the island are keys to success.

The income from agroforestry, in conjunction with a traditional agroforestry management system and local resource tenure, has enabled Kinali villagers not only to survive in the face of hazards, but to build a better life and create wealth. Only four families, 5% of the total, in the village in October 2012 were below the poverty line set by the Indonesian government (Kinali Head of Village, R. Kanine, pers. comm., 2012) compared with a national average of 11.25% and a North Sulawesi level of 8.7% (Badan Pusat Statistik, 2014). The production of nutmeg and other crops gave Sitaro the lowest poverty level among all districts in North Sulawesi Province (Badan Pusat Statistik Kabupaten Kepulauan Sitaro, 2012b; Pemerintah Kabupaten Kepulauan Sitaro, 2012; Manado Post, 2013). Therefore, Mount Karangetang is materially significant to the villagers in providing fertile soils but this is complemented by ethical values and complementary cultural norms and customs.

The fact that nutmeg has an international market enabled Kinali and other Siau villagers to prosper during the Asian economic crisis of 1998. The Mayor of Sitaro explained that people from Siau made significant profits as the price of nutmeg rose as a result of the appreciation of the US dollar against the Indonesian rupiah (T. Supit, pers. comm., 2012). The ability of people on Siau to benefit from nutmeg while living with such environmental constraints encouraged people on Lembeh Island (Mawali village), near Bitung city and about 150 km away (Figure 1), to replace coconut and other trees with nutmeg (K. Lombonaung, pers. comm., 2012). Currently, in order to help protect the income of farmers in Kinali and Siau, the district government is attempting to establish an association to empower small farmers in Sitaro district to better access foreign markets and to promote 'Siau nutmeg' as an international brand (T. Supit, pers. comm., 2012).

Nutmeg requires less time and labour to maintain and harvest than other tree crops. This makes the crop attractive in the small island context where labour is limited (Giavelli and Rossi, 1990). There is no cost for fertiliser and pesticides as these functions are replaced by the 'gift' of volcanic ash and gaseous emissions (Philogene, 1972; Edwards and Schwartz, 1981; Arnberger and Arnberger, 2001; Mercer and Kelman, 2010) from Mount Karangetang. Villagers can harvest nutmeg throughout the year although the peak harvest times are March and from August to October. This means that they have relatively continuous incomes and can undertake other activities that provide additional income between the main harvesting periods.

Mercer *et al*. (2007) stress that indigenous communities have adjusted their livelihood strategies to adapt to environmental and social changes for centuries. When livelihoods are sustainable, communities are equipped with capacities and are less vulnerable in facing hazards. Gaillard *et al*. (2009) describe how local communities are able to resort to a range of adjustments in their daily lives and this relates to the strength and diversity of their livelihoods. Nutmeg has been grown on Siau Island since the trade between Siau villagers and people from Kingdom of Ternate in North Maluku began several centuries ago. Siau villagers sold copra in Ternate and brought nutmeg seedlings to Siau (Suara Manado, 2011). Kinali villagers have thus adopted agroforestry practices that maximise production and have adapted social and cultural practices that share the benefits throughout the community. Nutmeg agroforestry and its traditional management therefore provide a basis for sustainable land use. Traditional management practices must be considered in any community-based sustainable development plan, and it is therefore essential that local knowledge is drawn upon in developing disaster risk management plans for communities living in hazard-prone places (Mercer *et al*., 2007). Villagers perceive the landscape in which they live as 'their land of life' and have a cultural attachment to it (see also Dibben and Chester, 1999).

Kinali villagers have evolved a distinctive culture which retains strong connections between the land, natural resources, and people. The change from agriculture to agroforestry, mainly nutmeg, shows a diversification strategy that enables the population to survive hardship situations (Scoones, 1998) and prosper. Villagers learnt to adapt their livelihood strategies to deal with the threats from the volcano. They exploit hazards and disasters and have developed improved livelihoods (Rampengan *et al*., 2014). Figure 7 shows how the different livelihood resources interacted to enable the villagers to cope with the volcanic hazards and succeed in their stewardship of a very well adapted agroforest. The key strength of Kinali villagers was a social network that was reinforced by Church activities. The combination

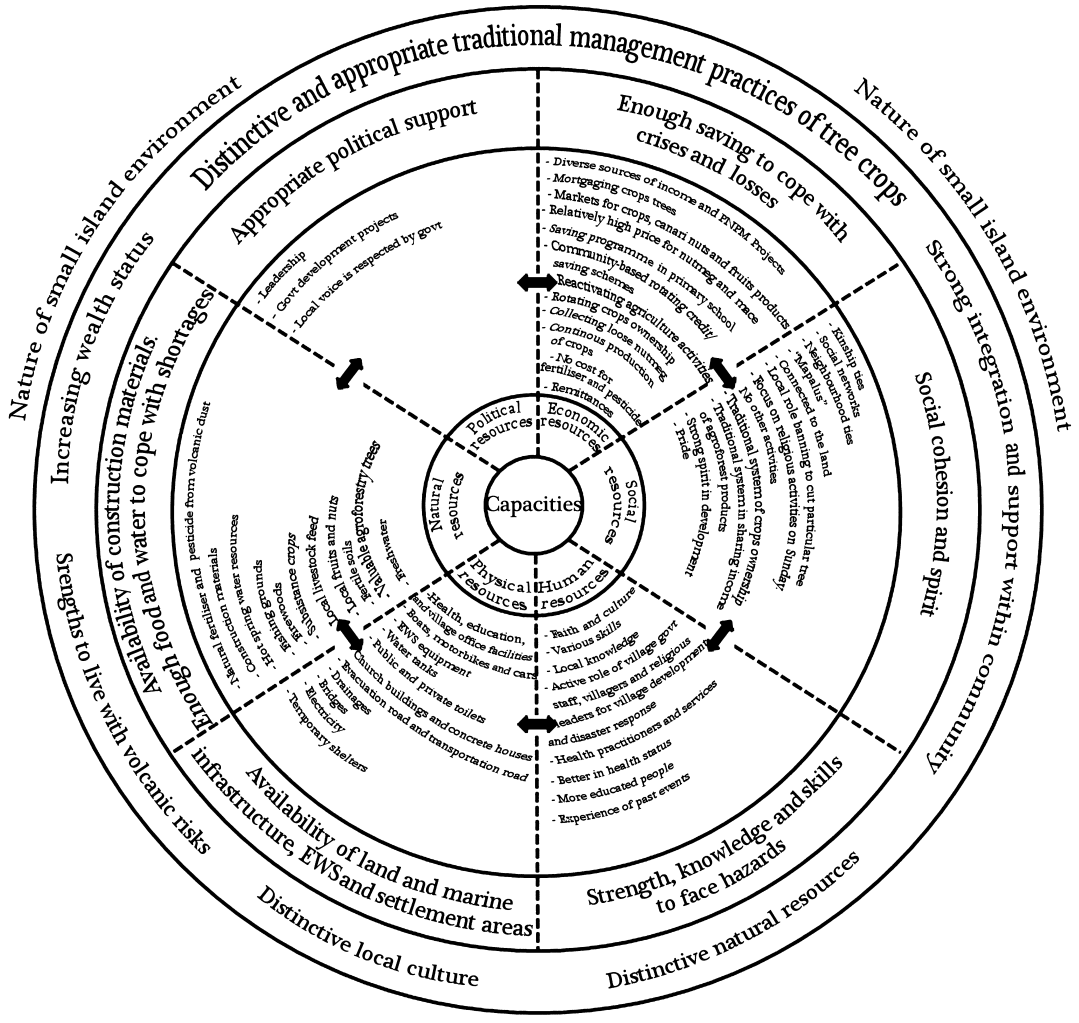

Figure 7 Capacity framework for Kinali villagers, Siau Island. The framework shows the livelihood resources that underpinned the capacity of Kinali villagers in facing various volcanic hazards in the context of their small island environment.

and integration of all resources have enabled villagers to face hardships and shape their livelihood outcomes (Figure 7).

The physical characteristics of the island, notably its small size, have contributed to a spirit of solidarity and a sense of community (Anckar and Anckar, 1995; Rampengan *et al*., 2014). This observation is consistent with several studies of sustainable development and environmental management on small islands in various regions (see Beller, 1990; Giavelli and Rossi, 1990; Hanson and Lamson, 1990). In the context of hazards, including volcanic hazards, local traditions and beliefs can significantly influence local reactions during and prior to the hazard events (Schlehe, 1996; Gaillard, 2006; Gaillard and Le Masson, 2007; Cashman and Giordano, 2008; Dove, 2008; Gaillard *et al*., 2008; Mei and Lavigne, 2012). In Kinali, there is a belief that their village is safe because Mount Karangetang has been baptized and because rivers act as drains for lahars and lava. Until the present, houses and nutmeg trees near dry rivers have only experienced minor damage. The people's responses are expressed as a cultural adaptation by way of belief or warning messages in ways described by Reser (2007) and Gaillard (2007). These issues deserve serious attention in disaster risk management (Chester, 2005; Gaillard and Dibben, 2008; Lavigne *et al*., 2008). Ignoring the local cultural context will reduce the effectiveness of any disaster risk-reduction programme (Hewitt, 1983).

Kinali villagers also demonstrate that responses to disasters in traditional societies are varied, and usually rooted in morality, ethics, and sin. This kind of reasoning exists in many places (for details, see Bode, 1977; Oliver-Smith, 1996; Cashman and Giordano, 2008; Dove, 2008; Lavigne *et al*., 2008; Chester and Duncan, 2010; Mei and Lavigne, 2012). Villagers justify their decision to live where they do in the belief that it is a safe place – that the threat only occurs elsewhere. As a result, people feel they can live 'normally' and there is no need to relocate (Chester *et al*., 2002). The community's volcanic risk perception thus plays a significant role in disaster risk management as the perception of risk and the success of actions to minimise risk are correlated (De La Cruz-Reyna and Tilling, 2008).

Conclusions

Kinali, a seemingly small and marginalised village on a small Indonesian island, expresses strong sociocultural dynamics in the face of a significant natural hazard and limited natural resources. Volcanic eruptions, the biggest threat, turn out to be advantageous as they bring high fertility to the soil – and in so doing prosperity to the villagers. The suitability of Kinali village's volcanic soil for agroforestry production, especially the production of nutmeg, has resulted in high yields and a unique crop quality recognised nationally and worldwide. Kinali village has over time adopted environmentally sound and sustainable management practices that address the constraints of a limited land area. The community's strong social cohesion has enabled the benefits to be shared widely among the villagers. For all these reasons, Kinali villagers do not merely cope with the natural hazard that the volcano represents; they prosper in the face of this adversity. This needs to be taken into account in developing more informed responses to managing volcanic risk.

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