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Mount Etna, Sicily: Vulnerability and Resilience during the Pre-Industrial Era

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Abstract

Mount Etna is one of the world's few continually active continental volcanoes and its frequent flank eruptions have been recorded since classical times. These studies have generated a vast literature which, not only enables the impact of eruptions, recovery from them and aspects of human vulnerability and resilience to be brought into focus, but also provides information that allows an assessment to be made of the interplay between environmental, economic and social forces which has shaped this area into Sicily's most distinctive region. In this paper we argue that a unique agriculturally-based society, largely developing indigenously and without significant outside assistance, evolved during a long pre-industrial era, which stretched from late antiquity until the 1950s. In terms of loss-bearing, responses were also typically pre-industrial, with the 1923 eruption denoting the close of this period. Responses were managed with relatively little outside help or intervention. The 1928 eruption marked a transition, after which responses involved progressively greater State intervention. In the pre-industrial era eruptions were managed at three levels: through limited State involvement; by mutual support within village communities, in which religious belief and explanations for losses provided both a social cement - the church often providing leadership and pastoral support - and a context in which losses could be explained; and by family and extended family groups. Finally we argue that these indigenous mechanisms of coping hold important lessons about how disasters on Etna may be managed today.

Key Words

Mount Etna, vulnerability, resilience, pre-industrial era, agriculture, eruptions

Introduction

In her seminal paper on historical disaster research, Virginia García-Acosta (2002, 65) makes the important point that 'disasters serve as social laboratories' revealing the ways in which people develop survival mechanisms through boosting resilience to extreme natural events, and providing insights into the structure of societies living in vulnerable locations. Mount Etna is one of the world's few continually active continental volcanoes and its frequent flank eruptions have been studied since classical times. A vast literature has been generated which enables, not only the impact of eruptions, recovery from them and the nature of human vulnerability and resilience to be brought into focus, but also provides knowledge about interactions between environmental, economic and social forces which acting together have moulded the flanks of Etna into Sicily's most distinctive region, and one that is amongst the most agriculturally productive and densely settled in southern Europe.

A pre-industrial society is characterised by: a predominantly rural location; an agricultural economic focus; artisan handicrafts rather than industrial production; parochialism, with people rarely travelling outside their local area and being little affected by external events and a feudal or semi-feudal social structure. The hazard scientist Gilbert F. White (1974, 5) extended this concept to describe how a pre-industrial society will respond when struck by hazardous events. According to White and later writers (e.g., Chester *et al.* 2005; 2010), such responses are typified by: a wide range of actions by individuals or small groups, government only being peripherally involved;

harmonisation with, as opposed to technological control over, nature; low cost; a variation of initiatives over short distances; flexibility, so that interventions may be abandoned if unsuccessful; vengeful deities being assumed to control human destinies and the accumulation of knowledge from previous events of a similar magnitude and type. In Sicily a traditional agriculturally-based society continued largely unchanged until the early 1950s and even later.[1] When change did occur it was through policies that included irrigation, land reform and reclamation of the Plain of Catania[2] (King 1971; 1973; Chester *et al.* 1985) and which were largely funded by the Italian State. Later the Common Agricultural Policy and other rural development initiatives were inaugurated under the auspices of the European Economic Communities, producing even greater changes in rural well-being. For example, land improvement schemes meant that new land, particularly on the Plain of Catania, was reclaimed for cropping whereas more marginal land towards the altitudinal limit of cultivation was abandoned (Chester *et al*. 2010). Overall increases in material living standards meant that younger members of traditional farming communities had alternative employment opportunities which resulted from the 1970s in an aging agricultural labour force (King, 1971). In southern Italy and Sicily the pre-industrial era of hazard management drew to a close decades before and was marked by increasing State involvement, which began with the 1908 Messina earthquake (Dickie 2000) and 1928 eruption of Etna, though in both cases many pre-

[1] Even as late as the 1971 census, the percentage of people employed in agriculture in Sicily varied by province from 20-40%, with *c*.50% of the island's population being dependent on agricultural activities. On Etna some local authority areas (*comuni*) located close to Catania supported populations densities of 800 per km^2, while elsewhere on Etna densities of 500 per km^2 were common. For the Sicily as a whole the density was 181 km^2, reflecting the poor agricultural potential of the arid interior (King 1971; Chester *et al.* 1985).

[2] Today the Plain of Catania, to the south of the City, is one of the most agriculturally productive areas in Sicily and supports a large rural population, yet in the pre-industrial era it was hardly settled because of its malarial character (Chester *et al.* 1985).

industrial elements were still in evidence (Duncan *et al.* 1996; Chester *et al.* 1999; 2008 – see below).

In this paper we argue that the distinctiveness of Etna reflects two sets of inter-linked processes working historically, but expressed spatially to produce a unique region. First, there is a blend of environmental, social, economic and cultural forces that makes the flanks of Etna quite different from the rest of Sicily and, secondly, in studying the ways in which people have responded to frequent eruptions reveals how characteristic methods of coping developed which served to enhance resilience, reduce vulnerability and allow long-term sustainability to be achieved.

The Uniqueness of the Etna Region

With a height of over 3000m and an area of some 1750km^2, Etna is the principal landform of eastern Sicily (Figure 1). Geologically Etna is 'youthful', its vast edifice having been built in just 300-400 ka years (Bonaccorso *et al.* 2004). Its last catastrophic eruption took place *c.*15,000 years ago, being associated with caldera collapse and the generation of trachytic pyroclastic flows. Since then activity has been predominantly basaltic and has comprised: persistent summit activity; with frequent periodic flank eruptions producing a significant threat of inundation by lava flows (Table 1). In addition, the Etna region is exposed to both tectonic and volcano-related earthquakes. The former caused major localised damage in Catania – the principal city of the region (Figure 1) – in 1169 and 1693 (Chester *et al.* 1985), whereas the latter produced major destruction in the region during the 1865 and 1911 eruptions and minor damage in many

more (Chester *et al.* 2012). From time to time, more explosive sub-plinian and plinian eruptions have deposited tephra both on the flanks of the volcano and further afield, and during Roman times extensive damage occurred in Catania in 122 BC (Table 1 and Coltelli *et al.* 1998), while tephra from the 2001 eruption caused the temporary cessation of flights to and from the city's airport on a number of occasions (Chester *et al.* 2010).

As well as being significantly damaged twice by earthquakes, Catania has been severally impacted on four additional occasions (i.e., 1542, 1716, 1818 and 1848), has been slightly damaged an additional eight times (Azzaro *et al.* 1999), has been destroyed in part by lava in 1669 and threatened in 1381, when lava caused extensive damage to cultivated land in the vicinity of the city (Tanguy *et al.* 2012). Tsunamis initiated extensive damage in 1693 and probably also in 365 AD (Tonini *et al.* 2011), yet the paradox which lies at the heart of the geography of Etna is that since prehistoric times and despite its hazardousness, the region has proved a magnet for human settlement. Reaching its apogee as a pre-industrial region in the late nineteenth and early twentieth centuries, Catania Province[3] had by that time increased its share of the population of Sicily to 19% from 15% in 1861, against a background of massive emigration to the USA mostly from the impoverished interior of the island but including the agricultural hinterland of Palermo (Figure 1). The population of the city of Catania also rose from *c.* 70,000 in 1861 to *c.* 253,000 in 1921 (Pecora 1968; King 1973; Chester *et al.* 1985; Ligresti 2002). The manner in which the Etna region developed and the reasons why its geography contrasts so markedly with that of the rest of Sicily requires answers at two

[3] Catania Province contains the land area of Etna. The rise in population as documented in the 1921 census is even more remarkable than the figures imply because the province extends to the south and west and includes some *comuni*, which are located on the dry impoverished interior of Sicily.

scales: the Sicilian and the Etnean; the former emphasising dissimilarities between the interior and periphery that are largely independent of Etna being a volcano and the latter showing how hazard coping strategies worked hand in glove with developing the resource potential of the volcano so it could support a large population which continued to grow throughout the pre-industrial era.

Sicily 'an ugly picture in a frame of gold' (King 1973, 112)

Writers have often drawn contrasts between the poor interior lands of Sicily and the intensively farmed – in places irrigated – coastal lands, thereby earning the island the epithet of 'an ugly picture in a frame of gold' (Milone 1960). Poor land-use decisions made by a succession of rulers[4] largely accounts for the origin of the 'ugly picture'. Under the Romans, Arabs and continuing into the early Middle Ages, land was cleared for settlement, timber was harvested – often being exported – and large areas of land were grazed. Subsequently, cropping on large estates (*latifundia*), owned by absentee and largely agriculturally uncommitted aristocratic proprietors and first developed to feed the Roman army, was further developed and intensified. In southern Italy, there is a distinction between soils developed on Pliocene and other clay substrates and those that occur on outcrops of other rock types. The interior lands of Sicily fall into the former category. Baked during the long Mediterranean summer drought, viscous, water-saturated and impermeable in winter, such soils are highly susceptible to erosion under traditional peasant farming techniques of shallow ploughing in spring and autumn.

[4] Since classical times, Sicily has been controlled of the following rulers: Romans (264 BC-827 AD); Arabs (827-1091); Normans (1091-1194); Swabians (1194-1268); Angevins (1268-1282); Spanish (1282-1713); Austrians (1720-1734); Bourbons (1734-1860 - Kingdom of the Two Sicilies and administered from Naples, with an interval of British administration from 1806-15) and Italians (from 1860).

Erosion potential was exacerbated, because land agents (*gabelloti*) were anxious to maximize estate yields under conditions of severe population pressure and concomitant land hunger, so raising rents and sub-dividing estates into smaller plots. In order to survive peasant farmers were forced to adopt a virtual wheat monoculture, with a lack of appropriate rotation or fallow to allow land to recover. They also cultivated steep unstable slopes. Soil erosion, falling yields per hectare, and soil exhaustion were the inevitable result and by the nineteenth century rural impoverishment was one of the principal factors encouraging emigration (Chester *et al.* 2010).

Gabelloti were the social class most strongly associated with the mafia, with banditry and crime becoming an accepted part of life in both the Sicilian interior and the fertile northern coastlands near to Palermo. Eastern Sicily in general and the Etna region in particular were, in contrast, largely free from organized crime (Rochefort 1961; King 1974; Dickie 2011)[5]. Irrigation was introduced by the Romans and became commonplace in Sicily from the time of the Arabs, diffusion being largely dependent upon ground water availability. In this regard, the northern coastlands and Etna were particularly favoured, allowing an alternative system of agriculture to develop (Figure 2).

[5] Feudalism was abrogated in 1812 and other feudal institutions were abolished by 1861, but in the interior of Sicily its effects on the rural poor were disastrous leading to a loss of rights to pasture animals, hunt and glean land (King 1973; 124). After Italian unification in 1860 there was further State enforced redistribution of private land and church property (Bandiera 2003, 224). Mafia activity also increased, because there were more individual farmers demanding protection. Some authors argue that the mafia only emerged in the nineteenth century, though others trace it to the seventeenth and eighteenth centuries, but it is without doubt that its malign influence was strengthened after feudalism ended. The Etna region was relatively free of organised crime, and the negative effect of these measures was muted since land was already subdivided into a large number of small productive plots under various systems of tenure. When more formal land reform occurred under a law promulgated in 1950, maps produced by Diem (1963, 188, figure. 5) show that no land on Etna was affected, even though the *latifundia* system was found on parts of the north and north-west flanks (King 1971, 183).

At a more focused scale, Etna and its flanks contrast with other areas of the ‘frame of gold’ in a number of important respects, which not only relate to features of the physical environment, such as soils, vegetation and climate, but also reflect factors fashioned by history, culture and economics.

The agricultural development of Etna

In comparison with the dry interior of Sicily, the flanks of Etna are favoured by a number of environmental factors, which increase its potential to sustain intensive agriculture and, thereby, to support a high population density. This is especially true with regard to its eastern, south-eastern and southern flanks[1]. Environmental factors increasing the agricultural potential of the region include: a steep decline of temperature with height and an increase in precipitation to over 1200mm near the summit; temperature contrasts between the warmer north, north-west and west flanks of the volcano, and significant irrigation potential. Lavas are permeable and recharged by rainfall in winter and snow-melt in spring.

Superficially the link between land use and climatically-related factors appears to be deterministic, with more intensive cropping taking place on the irrigated slopes of the east, south-east, south and south-western sectors in the *regione piedmontese* (mountain foot region), which stretches from sea-level to 1000m asl (Cullotta and Barbera, 2011). Throughout the pre-industrial era the relationship was, however, more multifaceted, with the north and north-western sectors being isolated from Catania the principal port for exports, and cropping intensity decreasing in all directions with increasing distance from

the city (Figure 1). In the final decade of the pre-industrial era, the percentage of land below 2000m asl, which was utilised intensively for the cultivation of vines, orchard and plantation crops varied from 69% in the south-east to only 3% in the north-west (Figure 3 and Chester *et al.* 1985).

Soils developed on volcanic products are not intrinsically but only potentially fertile, often requiring careful management to bring out their full potential (James *et al.* 2000). This is certainly the case on Etna, where field work by the authors and the analysis of aerial photographs has demonstrated that even where weathering conditions are most favourable (i.e., high rainfall and temperatures occurring below 1000m asl on the eastern, south-eastern and southern flanks), many centuries must elapse before soils are sufficiently mature to allow farming to be practiced (Chester *et al.* 1985; James *et al.* 2000; Chester *et al.* 2010). Even flows from the seventeenth century only support low-intensity grazing, though tephra-derived soils of the same age are often cropped. The poorest soils are lithosols, eroded, shallow and found on young lava and tephra (andosols) and the richest the cambisols, luvisols and fluvisols, which are deep brown soils found on the eastern, south-eastern, southern and south-western lower flanks of Etna, that are developed on old lava flows and tephra (andosols)., but even these require careful management both to liberate their fertility and maintain it over thousands of years (Table 2). Initiatives have included: the integration of animals into the system of cropping, not just to produce meat and other products, but to provide a source of manure, and the construction and continual repair of lava-block terraces, that have been a feature of Etna since at least the thirteenth century AD and which serve the dual purpose of

forming flat productive land and acting to reduce soil erosion on steep slopes particularly under intense winter rainfall. Output has also been enhanced and sustained by the inter-cropping of cereals, vegetables usually being sown under productive tree crops, and the extensive use of wood-mulch to reduce evaporation and increase organic matter. Great care was taken in the past to choose cultivars that were suited to the particular conditions of the volcano (Table 3). The *Nerello Mascalese* and *Carricante* grapes were, for example, particularly adapted to Etnean conditions, though additional varieties were introduced late in the pre-industrial era (Dazzi 2007; Chester *et al.* 2010).

Agricultural settlement in Sicily was not diffuse and farmers and their families lived in large nucleated *agro-towns*[6] and travelled to their fields on a daily or twice daily basis. Classic studies of *agro-towns* (e.g., Demangeon 1927, 4) have concentrated on those found in the interior of Sicily and have argued that they are symptomatic of agricultural inefficiency, because they serve to alienate and separate farmers from their land due to the increased time it takes to travel to work. *Agro-towns* on Etna, in contrast, rarely have remote hilltop locations and frequently the roughly circular area immediately surrounding the town - the *corona* - was a zone of particularly intensive cultivation. *Agro-towns* were also places where a unique 'Sicilian way of life' (King 1973, 51-65) held sway, and this culture had a profound influence on the ways in which volcano-related emergencies were handled (see below). On Etna this involved:

[6] These were peasant cities, frequently occurred on hilltops and commonly had populations of between 3 and 15,000 people, or even more. At least 50% - sometimes 90% - of their inhabitants were engaged in agriculture (King and Strachan 1978).

a. Robust linkages within families and extended families, which were often extended to other settlements through the institutions of God-parenthood and marriage. Several generations often lived under the same roof.

b. In the interior of Sicily gender roles were clear cut: women lived and worked in the home, men in the fields; but on Etna as many members of the family as possible were required to care for the highly intensive agricultural system.

c. Outsiders, especially government and its officers were mistrusted. Allegiance was to: family, first; followed by the village, often dominated by one or more extended families and local patron saints; with local leaders – aristocratic, ecclesiastical and civil – a poor third.

d. A unique form of popular Catholicism was common in southern Italy and Sicily. The intercessory power of the Madonna, St. Joseph and local saints was paramount, with votive objects and relics being assumed to have the power to remove or diminish the influence of disasters, both collective and individual (Carroll 1992; 1996; Chester *et al.* 2008).

The pre-industrial system of sustainable agriculture on Etna needed plentiful labour and required the recruitment of workers from a farmer's family and extended family. By the close of the pre-industrial era the system was breaking down due to alternative employment opportunities, falling birth rates and an unwillingness of farmers' children to work on family-owned plots (King 1971; Chester *et al.* 1985; 2010). Indeed, by the 1970s many terraces, especially those located towards the altitudinal limit of the *regione piedmontese* (Figure 2), show cropping being replaced by grazing, a process that was

greatly assisted by investment by the Italian State and later the European Economic Communities in mechanisation, less labour intensive methods of irrigation and larger field sizes. The scale economies so produced led to a spatial concentration of cultivation on larger plots at lower altitudes and using lower inputs of labour (King 1971; Chester *et al.* 1985; 2010).

Coping with Disasters

As mentioned in the introduction, the large volume of publications on Etna's historic eruptions not only reveals how people coped with disasters, but also casts a spotlight on the pre-industrial society, which occupied the flanks of the volcano. For eruptions occurring between 1792/3 and 1923 this extensive literature has been discussed in detail by Chester *et al.* (2012), and may be sub-divided into: primary sources (i.e., contemporary books, journals and information gleaned from newspapers of record) and summary texts published from the eighteenth century onwards (Table 4). For eruptions that took place before 1792 and with the exception of the large 1669 event, records are meagre in comparison with those of later centuries. The only information on some eruptions comes from the radiometric dating of volcanic products (Table 1), other accounts are too brief to allow anything to be written about how the society was impacted by even large-scale lava inundations, but for some eruptions – especially those of high magnitude occurring on the heavily populated southern and eastern flanks – the record is much richer, with useable data being available from the classical period onwards (Table 4). For the 1928 and to a more limited degree from the 1923 eruption, newsreel films provide additional visual evidence about how the people of Etna managed to cope during

times of crisis. Ideally information on eruptions could be supported by artefact-based archaeological evidence but as Robert Leighton realised some years ago 'If it [had been] better documented the archaeology of Etna would constitute a remarkable case study in European prehistory' (Leighton, 1999, 4). Unfortunately the situation over the last decade and a half has not improved.

Pre-industrial responses

The manner in which people responded to eruptions may be classified into two categories: responding to crises and restoring affected areas. The former may in turn be further sub-divided according to the manner in which reactions to emergencies occurred:

a. as State responses;
b. by collective action as people work together as inhabitants of *agro-towns* or larger settlements and
c. by people working acting as members of families or extended family units.

State Responses

The State hardly impinges on people living in pre-industrial societies and, even during times of eruption, the people of Etna were no exception. Between the classical era and the late eighteenth century initiatives were both isolated in time and few in number, the most well known examples being a ten year moratorium on taxes granted by the Roman authorities to the people of Catania following the 122 BC eruption (Rodwell 1878) and 1669 AD, when the Spanish Viceroy deployed troops to maintain law and order during the crisis and sent monetary aid to the region following it (Mack-Smith 1968). Similar

interventions continuing after 1792/3 and became more significant with each subsequent eruption[7], but until 1928 indigenous leadership remained dominant as did survival strategies that used purely local resources (Chester *et al.* 2012).

Beginning during the 1832 eruption when Prince Manganelli, the *intendente* (or prefect) visited Bronte (Figure 1 – Radice 1928; 1936), local officials and church leaders are frequently described as showing solidarity with the populace, although the most important ways by which the State viewed its role was in the maintenance of law and order by supplying police officers and/or troops. In fact, as in many other well-documented volcanic eruptions (e.g., Vesuvius 1944 – see Chester *et al.* 2007) or studies of disasters more generally (e.g., der Heide 2004), on Etna there were virtually no examples of civil unrest, looting or the breakdown of law and order, the only exceptions being violence between men from Catania and Paternò when the former tried to divert lava (see Table 4), a 'religious riot' in 1923[8] and an isolated instance of pillaging in 1911, when so-called 'marauders' from Catania were implicated (Anon 1911). With few other duties, police and soldiers commonly acted to reinforce well-established family and village-based methods of coping by assisting evacuation, salvaging crops and removing and storing household effects (Chester *et al.* 2012).

[7] Increased interest by the State was facilitated by improvements in communications: the telegraph from the middle 1850s and railways from 1866 (Anon 2012a; Glover 2012; King 1973, 81-83).

[8] In 1923 people from Linguaglossa took the staff of S. Eglidius and carried it in procession, because they believed it had saved the town in the past. The inhabitants of Castiglione were worried, since the salvation of Linguaglossa could spell doom for their village, and a riot broke out between rival groups. In the resulting *melee* a few members of the *Fascist* militia were injured and eventually the Carabiniere (military police) had to intervene (Chester *et al.* 2012, 74 and Table 2).

The State also attempted to make sure that the lessons and best practice from previous eruptions were not lost. In 1865 troops and fire-fighters, for instance, were used to rescue people from the effects of volcano-related earthquakes (Reclus 1865) and, mindful of the risks of indoor public assemblies, in 1883 and 1892 the authorities closed churches and prevented over hasty re-occupation of homes until the dangers of building collapse had abated (Chester *et al.* 2012). In 1843 fifty-nine people from Bronte (Figure 1) had been killed in an explosion when lava interacted with water, and in subsequent emergencies State officials were fully aware of their responsibilities to publicise this danger (Silvestri 1886). In addition, from the beginning of the 1880s officials regularly consulted scientists on the course eruptions might take.[9]

It was only towards the close of the pre-industrial era that the State's response became wider in scope and more recognisably 'modern'. Both the 1923 and especially the 1928 eruptions were used by the *fascist* government of Benito Mussolini to manufacture prestige and popularity. In 1923 the *Duce* and King Vittorio Emanuele visited Etna, an aircraft was used for the first time to monitor the progress of the eruption and the pro-fascist press even implied that the arrival of the *Duce* was almost messianic as it apparently caused the eruption to end abruptly (Mack-Smith 1983). Propaganda came even more to the fore in 1928 when the village of Mascali (Figure 1) was destroyed. The *fascist* authorities acted, *inter alia*, to provide large drafts of relief workers, to restore communications and to build an imposing new village of modernist design on a greenfield site, the regime publicising its achievements at every opportunity (see below).

[9] The Etna Volcano Observatory was established in 1879, in 1881 Professor Orazio Silvestri was appointed its first Director, but after his death in 1890 it went into decline. The Chair of Volcanology was re-established in 1911 and the observatory re-opened in 1926 (Anon 2012b).

Much nevertheless remained as before and was typically pre-industrial. Well-established private, family and village-based initiatives such as salvage of personal property, building materials and household goods are evidenced in newsreel films (see below) and the authorities continued to act in a reactive way to the emergency, there being no pro-active policy making and planning which is becoming more characteristic of present-day hazard management both in Italy and elsewhere.[10]

Collective action

From the beginning of the fifteenth century records become continuous and severe damage was evident in: Trecastagni and Pedara in 1408, with Viagrande being subsequently built on the flow; Nicolosi and Belpasso[11] in 1537 and in 1646 when several small settlements were impacted on the northern flank. The 1669 eruption and its associated earthquakes laid waste to: Belpasso; Comporotondo, many inhabitants left the village for Catania; Mascalucia; Misterbianco; Mompilieri; Nicolosi; S. Giovanni de Gelermo; S. Pietro Clarenza; some areas of Catania and many lesser settlements. The progressive destruction caused by the 1669 eruption is summarized in Figure 4. In 1689 a number of hamlets were destroyed in the vicinity of Macchia, the 1923 eruption destroyed the small villages of Cerro and Catena (near Linguglossa) and Mascali was destroyed in 1928 (Figure 1 - Anon 2012c; Chester *et al.* 2010, 2012; Gentile-Cuza 1886; Rodwell 1878).

[10] The 1928 eruption has been studied in detail by the authors and reference should be made to Duncan *et al.* 1996 and Chester *et al.* 1999, for a more detailed discussion of this eruption and responses to it.
[11] In this paper and in most accounts of this eruption the village is called Belpasso, even though at the time it was known as Malpasso. After the 1669 eruption a new joint settlement – Phoenicia Moncada – was set up to house refugees from Malpasso, Nicolosi and Mompilieri. Badly affected by the 1693 earthquake, it was only after 1695 that the village became Belpasso and was located on its present site (Anon 2012c, 2012e).

In an agriculturally-based society it is not just the destruction of *agro-towns* and larger population centres that is important, but the loss of agricultural land is even more significant, and throughout its history the cultivated area of Etna has suffered from lava inundation. Between 1500 and 1900, 8% of area of the volcano below 2000m was effectively sterilized by lava, a figure which falls to *c.* 3.5% for flows erupted between 1792/3 and 1923, reflecting the severe impact of the 1669 eruption (Chester *et al.* 2012, 71-72). From the 1790s, the intensely worked *coronas*, which surrounded *agro-towns,* were severely impacted in: 1792/3, Zafferana; 1809, Rovittello; 1832 and 1843, Bronte; 1852/3, Milo and Zafferana; 1879, Passopisciaro; 1883, 1886, Nicolosi; 1910, Borello and Nicolosi; 1911, Rovittello; 1923, Linguaglossa and Rovittello and 1928, Mascali, Nunziata and Carrabba (see Figure 1 for locations).

In pre-industrial societies harmonization with nature is a facet of hazard management which was achieved by accepting that, although loses were inevitable, these could be minimized with appropriate interventions. Examples of the ways in which the people acted collectively on Etna to cope with the loss of home and/or productive land are listed in Table 5, but responses also involved trying to explain losses and, indeed, propitiated them through the practise of popular Catholicism.

The notion that disasters are visited on people to punish transgressions is not confined to pre-industrial societies (Bowker 1970), but in southern Italy and especially on Etna such an attitude had a profound influence on the manner in which society reacted to eruptions

and earthquakes (Chester *et al.* 2008). The divine status of Etna is a pagan concept and can be seen even before the Hellenic era with the Sikel god, Hybla, being associated with the Paternò's mud-volcano (Maniscalco 2005). The idea that appeasement of the volcano was required to reduce losses was well-established by the classical era, with Lucilius Junior (first century AD) recording how the inhabitants would offer incense to the gods who controlled the volcano (Hyde 1916; Chester *et al.* 2000). This idea of propitiation was taken over and developed in Christian times and became an integral part of Catholic observance. In the Christian tradition, theodicy refers to arguments advanced to resolve the dilemma between a loving God and the occurrence of human suffering, with Sicilian popular Catholicism maintaining that disasters were instruments by which a vengeful God could punish human sinfulness. A limited understanding of the 'greater good' was also recognised[12], involving qualities of public service, communal solidarity and not least self-sacrifice, which the latter being lauded in some of the earliest records. For example, the Roman Stoic philosopher, Seneca (4 BC-65AD), recounts the narrative or legend of the *Fratelli pii* (the pious brothers) who rescued their parents from Catania, with the lava opening to allow them to escape, while more than 1500 years later the actions of Diego Pappalardo and his band of helpers during the 1669 (Table 5) quickly became an inspirational story.

Under the prevailing theodicy of divine punishment, the inhabitants of Etna: appealed to God's mercy through prayer; attempted appeasement by liturgical action and, after the

[12] A 'wrathful God theodicy' is strongly grounded in scripture, especially in the Old Testament (i.e. Hebrew Bible) and dominated Christian theology until the European Enlightenment. From the Eighteenth Century, other models of theodicy came to the fore including one focused on the 'greater good' i.e. notwithstanding suffering, the laws of nature dictate that the world is the best that could have been created (Chester 2005).

eruption ended, resolved to lead better lives. Conventional Catholic teaching embraces intercession through the intervention of the saints and the Madonna, but on Etna this was not just distinctive, but also extreme. Saintly relics, votive objects and, indeed, temporary altars were displayed at flow fronts on many occasions in order to arrest the advance of lava. St. Agatha was martyred in 251 AD and shortly after this her veil was displayed in front of the lavas of 252/253 AD, with people claiming that it had prevented Catania from being destroyed. Later on the veil was used many times with its efficacy being tested, for instance, in 1669 when it was asserted that it prevented even more damage being caused to Catania, while in 1886 people believed that the veil forced lava to pass close to, rather than destroy, Nicolosi (Chester *et al.* 2010). One feature of the Etnean landscape are the many shrines dedicated to local saints and martyrs, many of whom are commemorated by elaborate memorials drawing attention to their roles in preventing the destruction during particular eruptions (Figure 5). Each year an aspect of village life is the festival (*festa*), which is held in the name of a local saint.

Finally, a noteworthy feature of peasant Catholicism was the mismatch between belief and action. Originally called cognitive dissonance, this was first described by Chris Dibben (1999) and later the term parallel practice was more widely adopted by both Dibben and others (e.g., Chester *et al.* 2008). This involved the simultaneous acceptance by the region's inhabitants that eruptions and earthquakes: represented divine wrath and that reductions in hazard exposure was both necessary and likely to succeed, through the application of techniques, not solely those of collective action, but also including the those of the State and families/extended families.

Family and extended family responses

As discussed above, families and extended families are central to the cultural *milieu* of Etna and these social units played crucial roles in pre-industrial responses to flank eruption, examples of which are listed in Table 6. A popular misconception is that people and families panic when confronted with disasters, but both on Etna and more generally (der Heide 2004) this was not the case. Although fear and trepidation were encountered, first-hand accounts emphasise stoicism, rational decision-making and family solidarity. In 1843 36 people from Bronte were killed and a further 23 died later when a *phreatic* (i.e., water/lava) explosion occurred, with surnames indicating that many came from a small number of families, while in 1865 61 people were killed and a further 45 wounded, some mortally, by volcano-related earthquakes. In neither case was there any evidence of a 'disaster syndrome' (der Heide 2004), i.e., people being so distressed by grief that they were incapable of caring for themselves or their families. In both 1843 and 1865 the evidence implies quite the opposite with such feeling being confined to close families of the deceased and not spreading more widely (see Chester *et al.* 2012).

In the particularly well-studied eruptions of the nineteenth century there are many examples where distress is reported, for instance in 1809 (e.g., Anon 1809); 1843 (Anon 1843); 1886 (Anon 1886), while in 1879 residents are described as wandering aimlessly in the streets (Anon 1879). These are accounts by outsiders and, although distress was obviously a feature in the immediate aftermath of an eruption, it was not only mitigated by the measures listed in Table 5, but also by employment practices which showed

considerable resilience. Peasant farming is geared to security over profit and diversity over specialization, and most families did not rely solely on small-scale cropping, but additionally acted as waged labour and grazed animals on high altitude pastures (Cumin 1938; Chester *et al.* 1985; 2010).

Recovery

Virginia García-Acosta's (2002, 65) assertion that disasters reveal both mechanisms of resilience and the deep structure of a society is exemplified by the ways in which the Etna region recovered from volcanic eruptions and earthquakes during the long pre-industrial era. Moreover, until the eruption of 1928 this was achieved with minimal external assistance from the State. As we have argued in a previous report (Chester *et al.* 2012), even as late as the nineteenth century State aid together with that provided by other agencies including the Catholic Church and personal donations (i.e., often from the monarch and royal family), was small in comparison with estimated monetary losses. In 1928 Mussolini and the *fascist* government deployed the resources of the State to rebuild Mascali as an idealized 'modernist' village on a new site (Figure 6), their efforts being widely publicized for propaganda purposes, but even here many initiatives remained indigenous in character forming a continuum with what had developed and matured throughout the pre-industrial era.

Settlements of various sizes were destroyed and much agricultural land was sterilised, but the remarkable feature of loss-bearing was that recovery occurred rapidly. More than forty settlements suffered losses between 1400 and 1928 – some more than once – yet a

productive flank of the volcano was never abandoned even though some of it was covered by lava, with villages either being rebuilt in the same location or close to it (Chester *et al.* 2005; 2010). In spite of being devastated many times by earthquakes and eruptions, Catania was never fully destroyed and continued to function as both a regional capital and as a port. Although lavas took time to cool, eight months in the case of flows erupted in 1669 (Rodwell 1878), eventually the city expanded over the land that was sterilised, a policy of hazard adjustment that held two advantages: cheap building plots; and no loss of agriculturally productive land (Chester *et al.* 2010). At a smaller scale, new villages were sometimes built on old flows, for instance Fornazzo (Figure 1), following the 1689 eruption (Anon 2012d), and existing settlements such as Zafferana and Passopisciano grew, respectively, over the 1852/3 and 1879 lavas (Chester *et al.* 2012).

The most severe losses occurred in the second half of the seventeenth century in the densely populated and highly productive eastern, south-eastern and southern sectors of the volcano, the largest historic eruption in 1669 (Corsaro *et al.* 1996) being followed by a destructive earthquake in 1693. In Camporotondo Etneo rebuilding was delayed until 1681; Misterbianco's population of 3656 in 1652 did not recover until the early eighteenth century and was only *c.*2500 in 1798; Pedara lost over 25% of its population following the 1693 earthquake and after 1669 Nicolosi was reconstructed on a new site which also housed refugees from Malpasso and Mompilieri. This village was named Phoenicia Moncada[13], but was quickly abandoned – possibly because it was an unhealthy site – and after 1671 the original location was redeveloped under priestly patronage.

[13] In some accounts this new town was named Mezzocampo (e.g., Chester *et al.* 2010), but may refer to the post-eruption site of Misterbianco.

Nicolosi's pre-eruption population of *c.*2400 was not surpassed until the end of the eighteenth century, standing at 2520 in 1798 (Anon 2012c; Anon 2012e).

The ways in which recovery proceeded were varied. Whereas lava may advance at velocities of several kilometres per hour near eruption sites, by the time it reaches more densely peopled areas rates of tens of metres per hour are more typical, giving residents time to remove materials, not just personal affects but also tiles, windows, door and other building materials as well for re-use when villages were reconstructed or re-sited (Table 5). Harmonisation with nature has already been noted, with farmers recognizing that losses were inevitable and so holding spatially dispersed cultivation plots (Table 6) and working to conserve and enhance soils, but there is also evidence that farmers adopted a longer perspective by assisting natural processes of vegetation succession. This took place through the planting of species that were capable of breaking-up lava through root development. Prickly pear cactus (*opuntia ficus-indica*) was deliberately introduced from South America (King 1973), while the pioneer geologist, Sir Charles Lyell (1858, 726) notes in connection with the 1852/3 lavas that 'proprietors have already planted certain tracts…with broom, which is growing freely'. Broom had the added advantage of being a traditional charcoal crop, providing an income many centuries before farming could be undertaken on new lava (Certini *et al.* 2001), while prickly pears were edible by humans and animals alike. Farmers also knew by experience that volcanic ash weathers quickly to useable *andisols* and since the nineteenth century vines have been grown on ash soils from the 1669 eruption, whereas lavas were suitable for only low intensity grazing (Chester *et al.* 2010). Construction of agricultural land on lava also involved new

terracing and soil brought in from outside, and was a feature of both the 1843 and 1911 flows (Chester *et al*. 2012, 76). Finally flows could be used for non-agricultural purposes including quarrying and, as noted above, the expansion of existing villages.

Conclusions and the situation today

Close study of the major eruptions of Etna during the pre-industrial era shows a resilient society and one that is not able just to survive but to prosper. Indeed in the period from the 1792/3 eruption to 1923, when much land was sterilised but only two small settlements were destroyed, the region managed to increase its population both in absolute terms and relative to other regions of Sicily. On Etna, earthquakes affect people and dwellings whereas basaltic eruptions predominantly affect land, with settlements only occasionally being affected. The only time when the region's resilience was almost overwhelmed by its vulnerability was the second half of the seventeenth century when in less than 25 years, the combined impacts of the largest historic eruption in 1669 and the 1693 earthquake inhibited production in the productive south eastern sector, which was the hinterland of Catania and the economic heart of the region, until well into the eighteenth century.

Etnean society has changed since the 1950s, poverty has been reduced, agriculture mechanized and many changes in the traditional farming of the *regione piedmontese* have occurred, the effects being less evident on the more remote western, north western and northern flanks. Especially within what is now officially described as the Metropolitan Area (*Area Metropolitana*) (Anon 2012c), commuting rather than agriculture dominates

the life of many villages within driving distance of Catania. Many people are divorced from the land and traditional culture and are less aware of the vulnerabilities of location than their historic counterparts (Dibben 2008). State-based policies[14] have boosted overall resilience and today a major disaster would probably see far less human distress, mortality and morbidity than was the case in the past. Indigenous, deep-seated resilience, which was so characteristic of pre-industrial times has, however, been reduced these trends being exacerbated by a break-down in the centuries-old 'Sicilian way of life'. Commuting is not the sole reason for change and many villages have seen large increases in population fuelled by in-migration and building of second homes either within or adjacent to the scenically attractive slopes of Etna.

Some features of *pre-industrial* coping survive including salvage from buildings and agricultural holdings, a feature of inertia which may well reflect the low take-up of household insurance (Chester *et al.* 1985), although the *Dipartimento della Protezione Civile* in conjunction with private insurers, is currently seeking to address this issue (see Chester *et al.* 2012). The principal legacy of the past is the practice of liturgies of divine propitiation that still occur every time an eruption threatens a village and, in a detailed study of Trecastagni, Christopher Dibben (1999, 196) concluded that 'for many, religious beliefs (still) play a significant role in their presentation of the volcano', with 'parallel practice' remaining an integral element in the religious and psychological make-up of

[14] After 1928, flank eruptions had a significant impact on the region in 1971, 1974, 1981, 1983, 1991-3 and 2001 (Guest *et al.* 2003) and 2002-3. State involvement increased in each successive eruption. Today volcanic and earthquake-related emergencies are managed by the Ministry of Civil Protection (*Dipartimento della Protezione Civile*), who use local knowledge and equipment from the *comuni* and scientific expertise from the Institute of Geophysics and Volcanology in Catania (*Istituto Nazionale di Geofisica e Vulcanologica INGV - sezione Catania*) (Chester *et al.* 2012).

much of the population and as in the past, does nothing to prevent the State or the community adopting policies to reduce risk exposure.

It is increasingly apparent that the education of local people about how they should react in a disaster is a vital element of Civil Defence (Chester *et al*. 2012). For example, in the *comune* of Mascali the eightieth anniversary of the eruption was commemorated in November 2008 by a number of events (e.g. local exhibitions and interviews with local people). Emphasis was placed on the role of the local people, the sacrifices they made and the processes by which they recovered. Another recent initiative of the *Instituo Nazionale di Geofisica e Vulcanologica* (*INGV*) is *Edurisk* (*Itinerari per la riduzione del rischio* – programmes for Risk Reduction – our translation), that focuses on the ways in which school children may reduce their own risk exposure, and also educate their families (Edurisk, 2011).

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