Chapter 15
Mount Etna, Sicily: Landscape Evolution and Hazard Responses in the Pre-industrial Era

David K. Chester, Angus M. Duncan, and Peter A. James

Mount Etna dominates eastern Sicily, being over 3000 m in height and covering an area of some 1750 km^2. Etna has instilled a sense of awe in men and women for thousands of years (Fig. 15.1); to voyagers in the Classical Age it was considered the highest point on Earth (King 1973a) and, even before the colonization of the island by the Greeks ca. 740 BC, members of Sicel culture were practicing cults that associated volcanism with subterranean processes (Chester et al. 2000).

Volcanologically Etna is not only large, but also one of the few continental volcanoes that is continually active. Etna's volcanic activity was initiated about 300–400 ka BP in what was then a marine gulf on the east coast of Sicily (Bonaccorso et al. 2004). Etna's last catastrophic eruption occurred around 15,000 years ago, led to caldera collapse and the eruption of hot and potentially highly destructive pyroclastic flows, which swept down the southwestern flank of the volcano (Guest et al. 2003). Since then Etna has been characterized by basaltic activity, with the principal hazard being posed by lava flows. The vast majority of lava flows on Etna show *aa* morphology with a rough surface made up of irregular lava fragments. The name 'aa' is derived from the onomatopoeic Hawaiian word *a'ā*, which means hard to walk on, but a small proportion of flows show 'pahoehoe' morphology, again an Hawaiian word and typically describing a flow with smooth, lobate and undulating surfaces. There have been very infrequent explosive eruptions, which are unusual on a basaltic volcano, and these have deposited a few centimeters of tephra (volcanic ash) beyond the margin of the volcano. One example of such an event was the eruption of 122 BC when tephra fall brought about extensive damage to Catania during the Roman era and, more recently, tephra from the 2001 eruption caused considerable disruption to communications.

In terms of the relationships between people, land, and the creation of distinctive landscapes, Etna is fascinating because, in spite of the ever present threat of volcanic eruptions and earthquakes, since ancient times the region has attracted settlers in large numbers. Catania, the principal city of the Sicilian east coast, has been badly affected by both these phenomena, and during the past 2000 years has been destroyed in part by earthquakes in 1169 and 1693, and by lava flows in 1669 and probably also in 1371 or 1381, the dating being uncertain (Chester et al. 1985, 2005). This paradox between the hazardous character of the environment and the region's attractiveness for settlement may be accounted for by a number of physical and human factors which operate at two distinct scales. Etna occupies an east coast location within Sicily (Fig. 15.1) and at an all-island scale part of the reason for its development is related to deep-seated and long-recognized contrasts between the coastlands and the interior, which Italian geographers commonly refer to as the "ugly picture in a frame of gold: the dry poverty-stricken core of the island contrasting vividly with the intensively-cultivated, irrigated coastal periphery" (Fig. 15.2; Milone 1960; King 1973a, p. 112). At the more detailed scale Etna has developed in a distinctive way, not just because people have had to respond to hazards, but also through a combination of factors that include not only particularities and variations in climate, vegetation and soils, but also distinctions caused

D. K. Chester (✉)
Department of Geography
University of Liverpool
Liverpool, L69 3BX, UK
e-mail: jg54@liverpool.ac.uk

See Plate 14b in the Color Plate Section; also available at: extras.springer.com

I. P. Martini, W. Chesworth (eds.), *Landscapes and Societies,*
DOI 10.1007/978-90-481-9413-1_15, © Springer Science+Business Media B.V. 2010

Fig. 15.1 Mount Etna region and Sicily: general location map. (From Chester et al. 1985)

by history, economy and culture. This makes the Etna region in some respects similar to, yet distinct from, other portions of the "frame of gold" (King 1973a, p. 112) and its unique character has made it of interest not just to volcanologists and other earth scientists, but also to classicists, historians and prehistorians, geographers and rural-sociologists (Leighton 1996, 1999; Chester et al. 2000; Malone and Stoddart 2000; Duncan et al. 2005; Smolenaars 2005).

Although important social and cultural particularities remain, today Sicily is closely integrated into the economies of Italy and the wider European Union, but even as late as the late 1960s and early 1970s major elements of the pre-industrial society still persisted and reflected an interplay of people and environment that had produced distinctive agricultural landscapes and which had developed over hundreds, in some cases thousands, of years of settlement. For instance, the 1971 census recorded a Sicilian population of around 5 million, of which the percentage employed in agriculture varied from 20% to 40% depending on province, with an estimated 50% of the island population still dependent on agriculture to some degree (King 1971). Administratively most of the land area of Etna is contained within the Province of Catania and, reflecting its "frame of gold" location and other more localized features of attraction, accounted for 20% of the population of Sicily and some of the highest popu-

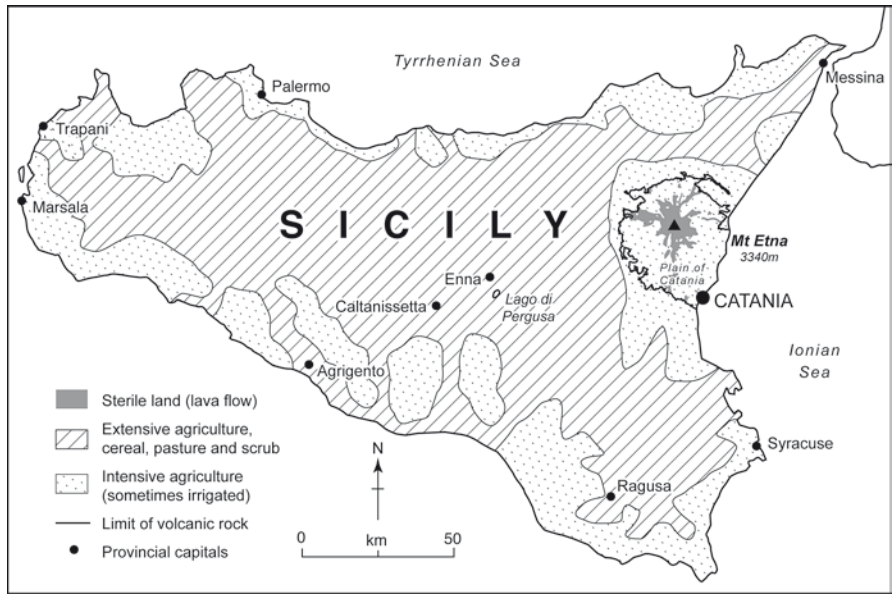

Fig. 15.2 The contrast between the intensive and extensive agricultural areas in Sicily. It should be noted that the Plain of Catania only became an area of intensive cultivation late in pre-industrial times. In the 1940s this area had a low population and little commercial agriculture due to its malaria character. From the 1950s new irrigation techniques were introduced and malarial was eradicated. (From King 1971)

lation densities found on the island. In 1971 figures of up to 800 persons/km^2 occurred in local authority areas ('comuni') located close to Catania, whilst elsewhere densities of 500 persons/km^2 were far from uncommon, densities declining with both increasing height on the volcano and with increasing distance from Catania. In contrast, for the island as a whole, an average population density in 1971 was 181 persons/km^2.

15.1 The Ugly Picture in the "Frame of Gold"

The reasons for the contrasts between central Sicily and its coastal margins, including Etna (Fig. 15.2), are due to both environmental differences and contrasting historical, social, and economic circumstances. With regard to environmental factors these include: higher annual rainfall on the north coast (up to 800 mm) and on Etna (700 mm to over 1250 mm), in comparison with totals of only 700 mm and usually far less in the interior (Fig. 15.1); the fact that flat land is rare in Sicily, plains only accounting for just 7% of the land area and with a strong concentration near to the coast; and the greater soil and irrigation potential of the island peripheral margins (Pecora 1968; Chester et al. 1985).

There is a lack of certainty about when humans first became established in Sicily, though stone implements on the plain of Catania and in the Province of Agrigento (Fig. 15.2) point to Lower Paleolithic times, but the evidence is ambiguous. By the Upper Paleolithic (ca. 18,000 ^{14}C year BP; Table 15.1) human presence is more certain and Sicily was widely inhabited (Leighton 1999), though recent palynological studies based on evidence from lacustrine sediments from the Lago di Pergusa in Central Sicily (Fig. 15.2) suggest that the first major impact of people on the vegetation of the island occurred much later, by 2800 ^{14}C year BP if not slightly earlier (Sadori and Narcisi 2001; Sadori et al. 2008). This date coincides with the early Bronze Age, a time of population growth in the lowlands and some expansion into the uplands including Etna (Table 15.1; Malone and Stoddart 2000). Indeed Leighton comments, "Etna, Europe's largest volcano, (is) characterized by an extraordinary ecosystem. Here one may detect human adaptations peculiar to the environment of its lower slopes: well-watered fertile, with a rich and varied fauna and flora, and numerous caves. If it were better documented the archaeology of Etna would constitute a remarkable case study in European prehistory" (Leighton 1999, p. 4). Lava-flow caves provide convenient sites for habitation and several on Etna have yielded Copper Age material. Lava-flow caves are lava tubes and these develop on lava flows when an active feeding channel roofs over. When lava supply ceases the active lava drains and produces a lava tube (Table 15.1).

The contrasts between the center and the coastal periphery are largely the result of both farming techniques and social and economic systems introduced by

Table 15.1 Sicily: Phases and dating of prehistoric and historical development. (Based on information in Finley 1968; King 1973a; Leighton 1996, 1999; Malone and Stoddart 2000; Ayala and French 2003, 2005). The locations of places mentioned in the Table are shown on Fig. 15.1

Phase	Date
Prehistoric Times	To ca.740 BC
Lower Paleolithic	From ca. 500,000 BP
Evidence about population densities is unreliable for the lowlands of Sicily. Densities were low in the uplands[a]	
Upper Paleolithic	Late stage ca. 18,000 ^{14}C BP
Sicily was widely inhabited. In the lowlands high population densities occurred in river valleys and low densities were maintained in the uplands. The lowland margins of Etna became important foci for settlement from this time	
Neolithic	
Some renewed colonization took place, but there was also a continuity of settlement. Neolithic farming communities became established: in the Simeto Valley on the southwest margins of Etna at Adrano, Biancavilla, Paterno; to the north of Etna (on the Bolzano Soprane lava flow near to Maletto); and at other sites. Some of the sites in the Adrano area yield pottery with stamped and incised motifs, which is known as 'impressed ware', and dates from ca. 6000 to 5000 BC. Typical settlement pattern throughout Italy is based on floodplain sites, near to a water course where early agriculture was practiced	7th millennium BC, a jar from near Paterno yielded a date of 5000–6000 ^{14}C year BP
The Copper Age and the Bronze Age (including the Thasos and Pantalica cultures)	Copper Age—second half of 4th millennium. Early Bronze Age—late 3rd millennium BC
Copper Age—circular and oval huts are found near to Adrano. Lava caves in lava flows were convenient sites for habitation and are commonly developed on pahoehoe flows, but are also sometimes found on *aa* flows. Some evidence of soil erosion in the northern mountains of Sicily	Thapos—Mid 2nd millennium BC
Metal items were rare until *Middle Bronze Age*. Dense Bronze Age settlement was found in the Bronte, Adrano, Biancavilla and Paterno areas on the south west margins of Etna, where closely-spaced settlements occurred and a mixture of arable farming and pastoralism was practiced. Sites have also been found at Catania and Naxos. A very important site occurs at the Salinelle di San Marco at the Paterno mud volcano, showing settlement from the Neolithic onwards. Signs of 'demographic saturation' within the limits of the agricultural economy of the time in the lowlands and expansion in upland area have been suggested during the Bronze Age	Pantalica—Late 2nd millennium BC
Iron Age	ca.1000 BC
Phoenicians	
Objects from throughout the circum-Mediterranean were traded with Sicily. Iron implements may have been introduced for the first time	
Immediately before the Greek settlement, the island was dominated by three tribal groups: Sicals (Sikels) in the east; Sicans (Sikans) in the west and the Elymians in the extreme north west. Many hill top towns were originally Sical strongholds. There are no written records of Sicily before the Greeks, but Greek myths about earlier times (Daedalus and the travels of Heracles and Odysseus) refer to the Sicans and the Sicals. These accounts should be treated with caution because they are not always substantiated by archaeological evidence. It is possible that some agro-towns date from Sical times	
Historical Times[b]	
Greek	ca.740 BC–264 BC
The first Greek settlement occurred at Naxos in 734 BC and later Catania was occupied. The Greeks settled the eastern coastal margin of Etna, with the Sicals continuing to occupy inland sites. Within less than 140 years most of coastal and eastern Sicily, including Etna, had been settled. A further century was required before the interior was Hellenized. Lasting memorials include the Greek temples at Agrigento (Fig. 15.2). The Greeks introduced the vine, olive and fig and left a lasting imprint on the culture and language	
Roman	264 BC–827 AD
Although conquest began in 264 BC the whole island was not occupied until 210 BC. The Romans farmed large estates (latifundia) in the interior, the principal crops being wheat, olives and barley. Wine was exported and cattle, sheep and pigs were plentiful. Roman rule also strongly influenced the language and introduced Catholicism. Towards the end of Roman times, when the island was part of the Byzantine Empire, Vandals and Ostragoths raided Sicily	

Table 15.1 (continued)

Phase	Date
Arab	827–1091
Although the Islamic invaders are often termed Arabs, invaders included Berbers and Spanish Muslims. In 827 the invading army numbered over 10,000	
Norman	1091–1194
Swabian	1194–1268
Angevin	1268–1282
Spanish	1282–1713
Austrian	1720–1734
Bourbon (between 1806 and 1815 Sicily was controlled by the British)	1734–1860
United Italy	From 1860

[a] Upland is defined as land over 750 m
[b] For historical times the influence of different rulers on agricultural landscapes is discussed in the main text

later invaders, particularly the Arab (827–1091) and later Norman, Spanish, and Bourbon rulers (Table 15.1), who in combination produced forms of land use and a social system that remained virtually unchanged for centuries. Small-scale irrigation was introduced by the Romans, but it was only after the Arab conquest from the ninth century AD that these techniques became widespread. Diffusion of irrigation depended chiefly on the ready availability of ground water and here the northern coastal margin and the Etna region were particularly favored, with crops such as bananas, bitter oranges, lemons, melons, mulberries, possibly cotton, sugar cane, the date palm, and pistachio nuts being introduced. Sumac was brought into the island for tanning, hemp for caulking, and livestock rearing was intensified (Mack-Smith 1968; Benjamin 2006). By the Early Middle Ages most of crops found in Sicily today were being cultivated, though maize, the prickly pear cactus, the potato, tomatoes, and tobacco were only introduced from the New World after the close of the fifteenth century (King 1973a).

Decline in the fortunes of the interior lands may be placed firmly at the door of Arab and later rulers. The Arabs cleared vast tracts of land for settlement, later timber was exported and/or used for shipbuilding and large areas of the interior were given over to extensive grazing, an unsuitable land-use for the easily eroded soils of the rolling hills found in the interior. Grazing animals provided hides, wool, meat, and cheese for export. In studies of soils in southern Italy, a distinction is often drawn between those found on Pliocene and other clay outcrops and those which occur on other substrates (King 1973b). The former are characteristic of vast areas of central Sicily, where the clays are described as *scagliose*, or scaly. Here soils are baked during the long summer drought, but become water saturated, viscous, and impermeable in winter. Shallow ploughing in spring and autumn using traditional techniques of peasant farming, has progressively caused the upper levels of soil profiles to become unstable and rendered them highly susceptible to erosion. The soil map of Sicily (Fierotti et al. 1988) records erosion in 24 of the mapped 33 soil associations found on the island, while the CORINE organization (European Environment Agency's Co-ordination of Information on the Environment) also highlights a high risk of soil erosion (CORINE 1994). The worst-case scenario, which assumes no vegetation cover, shows not only high potential rates for the western half to two-thirds of Sicily including the interior, but also for Etna and the highlands of the north east. Actual soil-erosion risk under current land-use and vegetation cover is, in contrast, reduced for the whole island, remains significant for the center and west, particularly for the interior lands, but is greatly reduced for Etna and much of the north east (CORINE 1994). Late in pre-industrial times in the 1920s and 1930s the situation was further exacerbated and the campaign by the fascist government of Mussolini to achieve national self-sufficiency in grains, saw many of the more marginal interior lands being brought under intensive wheat cultivation using fertilizers. The land could not long withstand being sown with wheat year after year, though whether this was due to erosion or because of a decline in fertility is not made clear (Grove and Rackham 2001).

Socially as well as economically, core and periphery were very different, the latter having greater prosper-

ity, being more cosmopolitan and with a more innovative population than was to be found in the interior. *Latifundia* estates were established in central Sicily by the Romans (Table 15.1), but their diffusion over the interior lands was largely the result of later rule, gifts of estates under a system of patronage often being granted as rewards to nobles who had rendered service to the ruler (King 1973a, b). Estates were almost invariably subdivided and under the management of agents ('gabelloti', in Italian) who controlled the renting of small plots to peasant farmers. Landowners ('baroni', in Italian) were usually absentee and the gabelloti had untrammeled power to raise rents against a background of severe population pressure that produced widespread land hunger. In order to survive, farmers had to maximize their incomes by adopting a virtual wheat monoculture, by over-cropping without rotation or fallow and by cultivating steep slopes. Widespread lawlessness made the situation worse. The gabelloti class was strongly associated with the mafia and, in addition, banditry and crime became part of the way of life and death throughout much of interior Sicily. In contrast eastern Sicily, including most of the Etna region, was relatively free of organized crime (Rochefort 1961). In the late nineteenth century especially after 1890, conditions did improve somewhat due to an opening of the safety valve of emigration especially to the USA (United States of America), but poverty remained endemic for many more decades. Demographic change introduced a further element of contrast with the coastal periphery, which did not lose population at anything like the same rate. The population of the Etna region in fact increased. This phase of migration peaked in 1913 at a figure of over 148,000 persons/annum and thereafter fell rapidly especially following the introduction of immigration controls by the USA in the 1920s (Benjamin 2006). The 30 years from 1947 saw a new phase of emigration which involved young skilled workers, rather than landless peasants. Emigration was primarily to northern Italy and other countries of Western Europe and this time the Etna region and the rest of the "frame of gold" were not immune from its effects. The impact in the interior was far more significant, however, and throughout all phases of migration the Province of Catania increased its share of the island population, due to a combination of natural increase and internal migration from other areas of Sicily. For instance, in 1861 the Province of Catania accounted for 15% of the population of Sicily, by 1901 this had risen to 16% and stood at 20% of the island's total in 1971 (Chester et al. 1985).

In Sicily agricultural settlement was not diffuse and farmers usually lived in large agro-towns or peasant cities, commuting to their agricultural holdings on a daily and sometimes on a twice daily basis. Agro-towns had populations of between 3000 and 15,000 people or even more, and in pre-industrial times had at least 50%, sometimes 90%, of their inhabitants engaged in agriculture (King and Strachan 1978). A few settlements are known to have been continuously occupied since pre-Hellenic Sical times (Table 15.1), but many have no certain date of foundation. Alfred Demangeon (1927) has argued that agro-towns were founded as a result of several interlocking factors, which included natural conditions, plus ethnic and social linkages between the first settlers, but his principal insight was that these peasant cities continued to exist because of social and economic inertia, since they served to alienate and separate farmers from their land and so reduced agricultural efficiency—not least because of lengthy journeys to work.

In the coastal margin, agro-towns are also a feature of the landscape, though on Etna they are not found on hilltops so shortening journeys to work and reducing the negative effects on agricultural efficiency. In pre-industrial times the residents of these villages were more open to outside influences (Chester et al. 1985).

15.2 The Uniqueness of the Etna Region

In contrast with the interior of Sicily, during pre-industrial times the Etna region was marked by greater affluence, which was based on more productive agriculture. Etna not only showed a unity in terms of its relative prosperity, but also contrasted with the interior in other respects. Despite often continuous cropping of some areas for over two thousand years, production on Etna was sustained without either reduction in yield or significant soil erosion, and this is further discussed in Sect. 15.2.1. At a more detailed scale and within the overall unity of relative wealth and sustainability, there was a diversity in the distribution of land uses on the volcano, which demonstrated a fine adjustment to both: the physical environment and the eco-

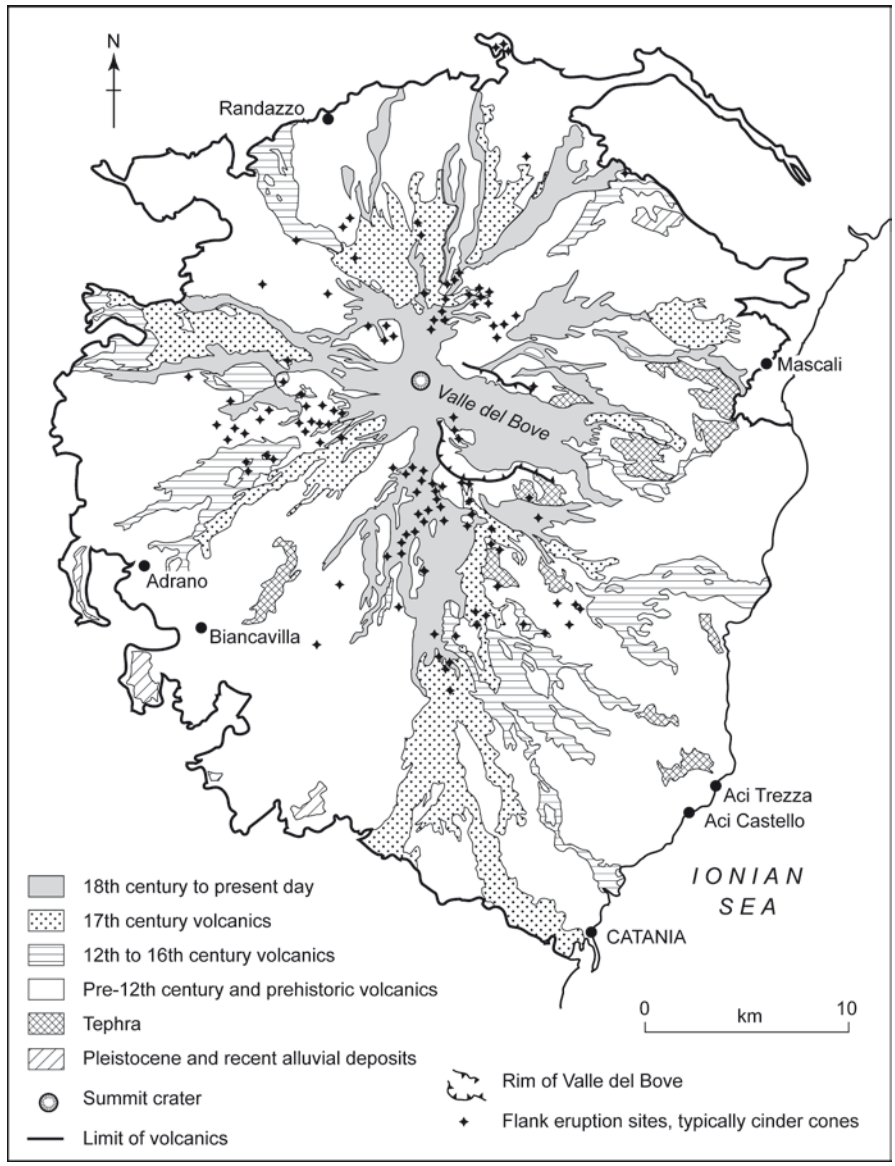

Fig. 15.3 Geological map of Mont Etna. (From Guest et al. 2003)

nomic potential of different sectors and height bands on the volcano, and the ever present danger of earthquakes and volcanic eruptions, particularly the threat of lava inundation. The proportion of the surface area of Etna covered by lava since 1600 AD is significant (Fig. 15.3; Table 15.2) and includes flow fields that have extended to the margin of the volcano. The hazard can be assessed and, as demonstrated by Guest and Murray (1979), many of the towns and villages on the flanks of the volcano are located in low hazard zones, through a process of natural adaption which is further discussed in Sect. 15.2.2. Although lava flows have caused considerable damage to agriculture, communications and occasionally settlements, on Etna they do not pose a significant risk to human life.

15.2.1 Adjustments to Environmental and Economic Factors

The agricultural landscapes of Etna have fascinated scholars for many centuries and the following account is based largely on the works of these writers, plus field observations and other referenced sources where appropriate (Rodwell 1878; Basile 1941; Milone 1960;

Table 15.2 Details of principal crops and agricultural activities during the pre-industrial era. (Based on information in Basile 1941; Chester et al. 1985; Dazzi 2007)

Altitudinal Zones, Principal Crops and Pastoralism	Location on Etna	Notes
Regione piedmontese (sea level to 1000 m)		
Citrus Fruits (mostly lemons, oranges, but also tangerines, and limes)	From sea level to ca. 550 m, the upper limit is defined by temperature. The upper limit is lower on the eastern flank because of lower temperatures. Citrus needs more irrigation in the south-western sector because of lower rainfall and is absent from the northern, north-western and western flanks because of low temperatures	a. An ideal crop for peasant cultivation because it produces a high cash return from a small area b. Intolerant of frost c. A labor intensive crop on the terraced lands of the eastern flank d. Lemons were a major export crop of Sicily. In the 1940s, 90% of Italian production was from Sicily, with 2/3 being from the Provinces of Catania and Messina
Vines	Located above the citrus belt and, with the exception of the western, north-western and northern flanks where conditions are too arid, vines are found on all sectors of the volcano. Altitudinal limits 300–900 m	a. Not drought resistant. b. Needs a chilling period before the growing season c. Very labor intensive, requiring head pruning and the use of the hoe on the terraced lands of the eastern flank
Olives	Similar altitudinal range to the vine, but more common on the drier western and south-western sectors. Specialized olive groves are found on south-western and western flanks	a. Requires low humidity for proper fruiting and is more drought resistant than the vine. Long, hot summers are essential b. Will not tolerate frost for very long
Other crops Apples, almond, apricots, avocados, cherries, figs, loquats, peach, pears, pistachio, pomegranate, quince and strawberry	Grown throughout the regione piedmontese, but areas of specialization, for example: apples—south-western flanks; cherries—east coast and pistachio—western slopes	
Hazelnut, carob, cotton, mulberry, sugar cane	Diffuse distribution	
Aubergine, broccoli, cauliflower, fennel, lettuce, pepper, spinach and tomato	Diffuse distribution, but concentrated on the south-western sector	Often cultivated in winter throughout the eastern; south-eastern; southern and south western sectors
Cereals	Diffuse distribution throughout the region and often grown beneath tree crops. Much more common on the north-western flank than in other parts of the volcano	a. Far less important than in the rest of Sicily. b. On the north-western flank, rye is rotated with wheat and beans
Animals	Mostly confined to historic lava flows, which have not weathered sufficiently to produce soils able to support cropping	Throughout the region many farmers integrate cultivation with small number of animals to produce manure for the land and milk and other products for family use
Regione boscara (1000–2000 m)		
Forest Main species—oak, (various species), beech, chestnut, pine and poplar	Sweet chestnut (*Castanea sativa*) is common on the southern and eastern flanks, where it is often managed (coppiced), with its nuts being harvested as a tree crop. The Laricio pine (*Pinus nigra ssp. Calabrica*) has a pioneer role on lava flows	The altitudinal limits and sectoral distribution of different trees were related to: environmental conditions (especially climate); and practices of felling and re-planting

Table 15.2 (continued)

Altitudinal Zones, Principal Crops and Pastoralism	Location on Etna	Notes
Grazing	Major pastoral zone, with sheep and goats grazing both on open pasture and within woodlands	a. Often large flocks (500–2000) where involved, whose ownership was split between members of the same family and/or extended family b. Frequently combined with other farming activities c. Often under the control of large landowners (including the Church) and leased for the growing season
Regione deserta (above 2000 m approximate tree-line to the summit)	Not well named because Alpine vegetation occurs. Some low intensity grazing towards the lower altitudinal limit of the zone	

Rochefort 1961; Pecora 1968; Clapperton 1972; King 1973a; Duncan et al. 1981; Chester et al. 1985; Dazzi 2007).

A full discussion of climate and hydrology of Etna is beyond the scope of this chapter (Chester et al. 1985), but its essential features are: an increase in precipitation with height, to over 1200 mm in the summit zone; a steep environmental lapse rate of temperature, so that heavy snowfall is a feature of winter months; a temperature contrast between the warmer northern, north-western, western and other sectors of the volcano; the occurrence of a volcanic plume driven by the prevailing westerly winds, with a concomitant rainfall enhancement and slight temperature depression on the eastern and south-eastern sectors of the volcano, in comparison with the more arid northern and north-western flanks; and high irrigation potential. With regards to the latter, aquifers are recharged by winter rainfall and snow melt, and since Roman times have been exploited for irrigation (Table 15.1).

On a volcano with such strong altitudinal and sectoral variations in climate, it is hardly surprising that at first sight the link between climate/hydrology and land use appears to be a deterministic one, with much more intensive cultivation, usually under irrigation, occurring in the eastern, south-eastern, southern and south-western sectors, within the so-called 'regione piedmontese' (mountain foot (piedmont) region), which stretches from sea level to 1000 m (Fig. 15.4; Table 15.2). In reality the relationship was more complex because the northern and north-western sectors of the volcano were isolated from Catania, the major city and market center of the region, and from the principal export ports of the east coast (Fig. 15.1). Land-use intensity declined with increasing distance along all principal routes linking Catania to other parts of the Etna region. Variations in land-use intensity were striking and, based on the land below 2000 m and the percentages utilized for the cultivation of vines, orchards and other plantation crops, in the final years of the pre-industrial era intensity varied from 3% in the northwest, through 23%, 27% and 41%, respectively, on the western, northern and north-eastern flanks, to 52% in the south; 63% in the east, 67% in the south-west and 69% in the southeast (Chester et al. 1985).

The principal pre-industrial land uses of Etna are summarized in Fig. 15.4, 15.5, Table 15.2, but there are a number of additional points that are not fully captured by these illustrations. For instance, yields were maintained in areas of intensive cultivation by a combination of (a) inter-cropping of cereals and vegetables, usually sown beneath tree crops; (b) the creation and maintenance of elaborate lava-block terraces on steep slopes, that were well established in Sicily by the thirteenth century and which created flat land and also acted as an effective means of erosion control; (c) wood-mulch was widely used both to increase organic matter and reduce evaporation; (d) great care was taken over grafting, so as to maximize yields and reduce labor requirements; and (e) animals were closely integrated into the system of cropping. Animals not only produced meat and other products for both on-farm and local consumption, but also provided a vital source of manure.

Cultivars were carefully chosen for the particular conditions encountered on Etna and some, including the Nerello Mascalese and Carricante grapes, were used for many centuries, although additional varieties

Fig. 15.4 View of the Etna from Catania in the 1870s. The contrast between the intensively cultivated regione piedmontese and the barren upper slopes of Etna should be noted. (From Rodwell 1878)

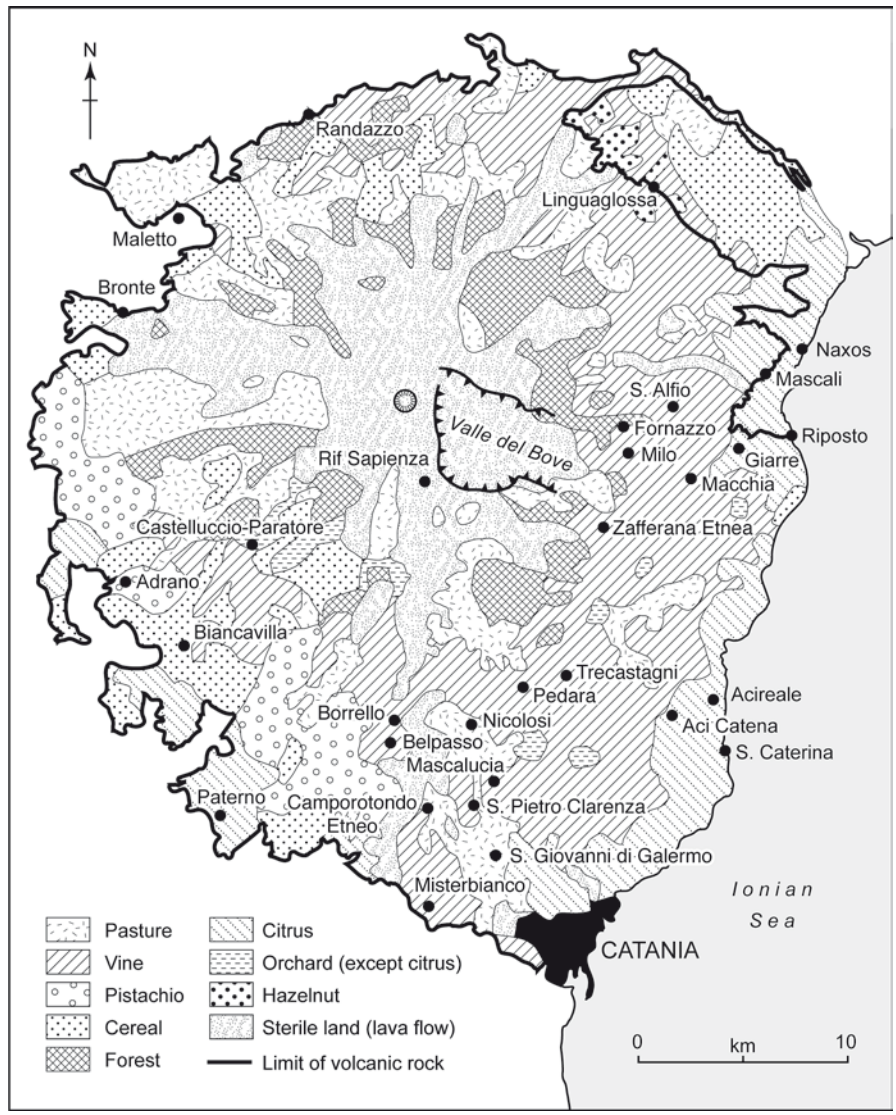

Fig. 15.5 The agricultural land-use of Etna. (After Rochefort 1961)

were introduced late in the pre-industrial era (Dazzi 2007).

Maintaining this system of agriculture demanded large drafts of family and extended family labor and by the close of pre-industrial times in the 1970s terraces abandoned from cultivation, but still in use for grazing, were a feature of the landscape. These bore witness to a reduction in the area being intensively worked especially towards the upper altitudinal limit of the regione piedmontese. This was due to a combination of: investment by the Italian State and the European Economic Communities in larger units, mechanization and more modern techniques of irrigation—so producing scale economies and spatial concentration; and to a reduction in the agricultural labor force, particularly sons and daughters of farmers who were increasingly unprepared to be employed tilling family-owned plots (King 1971; Chester et al. 1985).

15.2.2 Adjustments to Hazards

The terms pre-industrial and industrial are not only used to portray societies at different levels of economic development, but also to describe responses to disasters caused by extreme natural events (White 1973). The nature of these two characteristic forms of response are summarized in Table 15.3, and for most of historical time societies throughout the world have had to respond "pre-industrially" when having to cope with disasters. Many inhabitants of economically less developed countries continue to do so even in the early years of the twenty-first century. In pre-industrial societies losses are accepted on an involuntary basis by individuals, families and isolated regions, but as the process of economic development takes place the burden shifts to the State and in large catastrophes to the international community, involving loss-sharing by means of aid transfers, insurance and the State assuming a central role, both as an aid provider, and as an agency seeking to reduce the impact of subsequent events (White 1973). This is known as an industrial or modern technological response. In Sicily there were few industrial features of responses evident until a hundred years ago, when in 1909 the State played a leading role in providing aid following the Messina earthquake. In the twentieth and twenty-first centuries major eruptions of Etna have occurred in 1910, 1911, 1923, 1928, 1950–1951, 1971, 1979, 1981, 1983, 1991–1993, 2001 and 2002–2003 and, albeit with some exceptions, this sequence has coincided with a progressively greater State involvement in managing the impact of volcano-related losses. Although from the Classical era until ca. 1900 there are a few historical examples of State involvement during and following eruptions of Etna (Chester et al. 2005), the best recorded examples were after 122 BC when inhabitants of Catania were granted a ten year tax moratorium by the Roman authorities (Rodwell 1878), and in 1669 AD when the Spanish Viceroy deployed troops and sent monetary aid to the region (Mack-Smith 1968). The dominant coping strategy until 1900 was typically pre-industrial, it included the features listed in Table 15.3 and reflected a fine adjustment of people to the Etnean environment. Although it is reported that troops were deployed during eruptions in 1874, 1879, 1883, and 1892, this was principally for the mainte-

Table 15.3 Responses to hazards in contrasting pre-industrial and industrial societies. (Based on White (1973) and Chester et al. (2005))

Pre-Industrial Society	Industrial Society
A wide range of adjustment	A restricted range of adjustment
Action by individuals or small groups	Action requires co-ordination by the authorities
Emphasis on harmonization with, rather than technological control over, nature	Emphasis is placed on technological control over nature, rather than harmonization with nature
Low capital requirements	High capital requirements
Responses vary over short distances	Responses mostly uniform
Responses are flexible and were easily abandoned if unsuccessful	Responses are inflexible and are difficult to change
Losses are perceived as inevitable. The 'mindset' of many inhabitants is strongly influenced by notions of supernatural punishment, vengeance and the need to appease divine wrath	Losses may be managed by government action, technology, economic development and science
Responses continue over time scales ranging from hundreds to thousands of years	Not commonly observed until the mid-nineteenth century and not widespread until the mid-twentieth century

nance of law and order. In 1883 troops played a limited role and were deployed to prevent the population seeking shelter in churches because of the risk of a major loss of life caused by volcanic earthquakes, whilst in 1892 soldiers distributed bread and the very limited financial aid provided by the Italian State.

In addition to the altitudinally fluctuating frontier of cultivation produced by temporal changes in economic and demographic pressures (see Sect. 15.2.1), throughout history and prehistory the cultivated area has not only been reduced by lava invasions, but also increased by the re-colonization of lava flows and associated volcanoclastics (Figs. 15.3, 15.5). In the case of incursions the distress caused to the population has been documented by many writers (Rodwell 1878; Hyde 1916; Chester et al. 1985). Dealing with just those eruptions that have occurred since the fifteenth century, when the records became reasonably complete: the villages of Trecastagni and Pedara were destroyed in 1404; in 1537 Nicolosi was devastated; in 1646 several small villages on the north flank of the volcano were reported to have been obliterated; the 1669 eruption, the largest historical event, wiped out Belpasso, S. Pietro Clarenza, Mascalucia, Comporotondo, S. Giovanni de Gelermo, Misterbianco, fourteen smaller settlements, and most of Catania; and a number of small villages were razed in the vicinity of Macchia in 1689 (Fig. 15.1). In pre-industrial times, the outskirts of towns and villages often comprised a corona, a roughly circular rim of particularly productive agriculture, and losses within such areas were recorded following eruptions in: 1371 (possibly ~1160) and 1444, in Catania; 1536, in Randazzo; 1566, in Linguaglossa; 1595 (possibly 1062); 1607 (possibly 1610), in Adrano; 1651–53, in Bronte; 1792, in Zafferana; 1810, in Milo; 1832 and 1843, in Bronte; 1852/3, in Zafferana; 1879, in Passopisciaro (located between Randazzo and Linguaglossa); and 1883, in Nicolosi. It has been calculated that between 1500 and 1900, some 8% of the total land area of the regione piedmontese was sterilized by lava flows (Chester et al. 2005).

It is often assumed that people panic when disaster strikes, but research across a range of disasters throughout the world shows that this rarely occurs. It was certainly not the case on Etna during the pre-industrial era because, although fearfulness and apprehension are noted in some accounts, the vast majority of reports bear witness to the fact that people remained calm, normal day-to-day activities continued unabated, people still farmed their land and continued with their trades. A strong sense of solidarity is evident as family and community coped with and recovered from lava incursions in a variety of ways. On Etna, eruptions of lava affecting settlements and agricultural land often occurred several times a century, inhabitants were familiar with the risks they faced and were able to adapt to them. People whose homes were under threat frequently made use of family and extended family relationships, leaving their villages to live with relatives. For instance, in the 1883 eruption it is reported that some of the threatened population in the villages of Belpasso, Biancavilla, Borello, and Nicolosi were forced to live in makeshift accommodation, in tents or in the fields, but in fact most people merely left their homes on a temporary basis to live with their families in other villages. Almost everybody returned once the emergency ended because only the village of Nicolosi was badly affected. Spontaneous evacuations also occurred during eruptions in 1843 and 1886. Even the tent and field dwellers were not invariably the marginalized poor as many nineteenth century press accounts imply, because many farmers owned permanent shelters on family plots that were normally used for a daily siesta in the hot summer months or for storage of tools and fodder, but could be easily converted into temporary family accommodation. In 1892 relief committees are also known to have been formed in several villages.

A remarkable feature of loss-bearing on Etna was that, although cities, towns and villages could be badly affected and even destroyed, they normally recovered rapidly. Nicolosi was, for instance, destroyed by lava in 1537, but was a prosperous settlement when an earthquake again badly affected the settlement in 1633 and was probably fully re-built by the time of the 1669 eruption (Fig. 15.1; Chester et al. 1985). This was not an isolated example and more than thirty nine towns and villages suffered losses between 1400 and 1900, some on more than one occasion, yet an area was never abandoned a settlement being either rebuilt on the same site or as close as possible to it (Table 15.4; Chester et al. 2005). Close to the vent of a high-effusion rate eruption, lava may travel at velocities of several kilometers per hour, but typically by the time flows reach inhabited areas they advance more slowly, normally at no more than tens of meters per hour. Residents knew in advance if and when their village and home was about to be destroyed and there is

Table 15.4 Urban responses to major flank eruptions 1400–1900. Ticks indicate that relocation or rebuilding on the same site featured in the response. The impact of eruptions on Catania are discussed in the text and locations are shown in Fig. 15.1 (After Chester et al. 2005). The dates of historic lavas are from Tanguy et al. (2007)

Eruption	Towns/Villages effected	Relocation	Rebuilding on same site	Subsequent expansion of the settlement over the lava flow
1408	Trecastagni and Pedara were destroyed	✓		
1536	Lava approached close to Randazzo			A small settlement was built on the flow
1537	Nicolosi was destroyed		✓	
1566	Lava approached close to Linguaglossa.			Village expanded
1595 (or 1062?)	Lava approached close to Adrano			Little later urban expansion on the flow
1607 (or 1610)	Lava approached close to Adrano			Little later urban expansion on the flow
1646	Affected several villages on the northern flank			The village of Passopisciaro was built on the flow
1651–53	Lava approached close to Bronte			Village expanded
1669	Nicolosi was destroyed by a volcanic earthquake		✓	
	Belpasso was destroyed by lava	Rebuilt on a new site and called Mezzo-campo, but the air is reported to have been unhealthy and the present site, 1 km from the flow was selected in 1695		
	S. Pietro Clarenza was destroyed by lava	✓		
	Mascalucia was destroyed by lava	✓		
	Camporotondo was destroyed by lava	✓		
	S. Giovanni di Gelermo was destroyed by lava	✓		
	Misterbianco was destroyed by lava	✓		
	Fourteen small villages on the southern and south-eastern flanks were destroyed	✓		
1689	Macchia area. Several small housing clusters were destroyed on the outskirts of the village			Village expanded and the lava flow is now densely settled
1792	The outskirts of Zafferana were destroyed			Little urban expansion on the flow
1811	Lava approached close to Milo			Little urban expansion on the flow
1832	Lava approached close to Bronte			Little urban expansion on the flow
1843	Lava approached close to Bronte			Little urban expansion on the flow
1852/3	Lava approached close to Zafferana			Village expanded
1879	Lava approached close to Passopisciaro and adjacent smaller villages			Village expanded
1886	Lava approached close to Nicolosi			Little urban expansion on the flow
1892	Lava approached close to Nicolosi			Little urban expansion on the flow

good historical evidence that people salvaged all they could (Chester et al. 2005). Salvage included furniture and personal possessions, but newsreel films of the slightly later 1928 eruption show that the removal of tiles, windows and doors was a well established practice (Duncan et al. 1996; Chester et al. 1999).

Despite being devastated so many times by earthquakes and eruptions the city of Catania was never fully destroyed. It always remained functional both as a city and port, was still the focus of inland transport and, even in its ruined state, held far more locational advantages than any possible rival (Chester et al. 1985). Lava flows in contrast to earthquakes, sterilized the land over which they moved for hundreds of years and it could take several months before a flow had cooled sufficiently to allow site clearance to begin. Lavas from the 1669 eruption took over eight months to cool (Rodwell 1878). In the decades following each lava inundation, the urban area of Catania expanded over sterilized land, a policy of hazard adjustment that had the twin advantage that building sites were cheap and reconstruction did not have to compete with high-value agriculture. A similar expansion, but on a smaller scale, frequently occurred as villages spead over sterile land following episodes of lava inundation (Table 15.4).

All peasant agriculture involves maximizing family security over profit and one feature throughout Sicily is that cultivation plots are often owned in different localities. On Etna, parcels of land may be as small as 2 ha, but a family normally either rents or owns plots in several localities so that a single eruption is unlikely to wipe out all a farmer's property (Clapperton 1972). Pastoralism also provided a means of increasing security and, although high altitude pastoralism has declined in recent decades, in pre-industrial times this was far more important and provided a valuable additional source of income especially in times of distress (Chester et al. 2005). High level pastures could be leased on a seasonal basis from large landowners, including the church, by members of an extended family.

Field work and the analysis of aerial photographs have shown that even on the relatively well-watered southern, eastern and south-eastern flanks of the volcano centuries may pass before cropping can recommence (Chester et al. 1985; James et al. 2000). When studied in the early 1990s, the 1928 lava flow, which destroyed the town of Mascali, only supported low-intensity rough grazing and in the few places where vegetation succession had not been influenced by humans, the lava was only covered with a ground flora comprising lichens, mosses, and some small trees where soil and moisture have been concentrated in depressions (Duncan et al. 1996). Left on their own lavas will be re-colonized by natural processes and soils will develop. It is not surprising that, given the complexity in the interplay between geology, relief and climate, and in terms of the mix of its soils and their spatial extent, Etna is striking as the most distinctive region of Sicily (Fierotti et al. 1988). Five soil associations are mapped for the volcano the pattern shows a broad relationship to elevation (Table 15.5). In terms of agricultural quality, apart from lava rock outcrop, the poorest soils of Mt Etna are Lithosols (Leptosols according to the WRB Classification; Deckers et al. 2002), young or eroded, shallow soils of minimal development in weathering lava. Eutric refers to the relative richness in basic elements, but the quality of Lithosols is limited by shallowness and the generally rugged terrain. Regosols are weakly developed soils in loose substrates, particularly tephra, but may be cultivated. Of greater pedogenetic development and agricultural value are the eutric Cambisols and Luvisols, well developed brown soils of good depth. On generally well drained and commonly glassy volcanic ashes and pyroclastics, Fierotti et al. (1988) describe these as having the distinctive andic properties of volcanic soils, namely low bulk density, high water retention and porosity, and relatively high organic matter and nutrient content. These soils are of greatest extent on the eastern, south-eastern, southern, and south-western lower flanks of the volcano.

The broad distribution of soils on Etna is controlled primarily by climatic variation with sector and elevation, yet at many localities soil quality is related to the nature, depth, and age of soil-forming materials and varies spatially across distances as small as a few meters. Thus a local pattern of soils is likely to reflect age and morphology of lava, and the age and depth of tephra deposited across lava surfaces. Soil depth is critical in a region where it is highly variable and often limited. In agricultural terraces, soil depth is built up artificially. The authors find that terrace-soils, which were formerly cultivated but are now grazed, comprise tephra little altered by pedogenesis: the black tephra is coarse, loose and rich in little-altered volcanic glass (a soil property described as vitric), the only visible pedogenetic horizon being an organic-rich and shal-

Table 15.5 Soil associations mapped and described for Mt Etna by Fierotti et al. (1988). Soils in associations 5, 15 and 10 may have andic properties that confer low bulk density, high porosity, high water retention and good drainage. They are relatively rich in organic matter and nutrients

Soil Association[a]	Distribution on Mt Etna (see Fig. 15.1)	Land morphology	Soil character	Agricultural value
5. Lithosols; Rock outcrop (lava flows); Eutric Cambisols. Andosols as inclusions.	Restricted to lower slopes on the northern and western flanks	Sloping and moderately steep	Shallow, but Andosols may be of medium depth	Low. Some soils are capable of being cultivated
15. Eutric Regosols; eutric Cambisols; Orthic Luvisols	Extensive; particularly on eastern, south-eastern, southern and south-western flanks	Gently sloping to very steep	Shallow to moderately deep. Cambisols and Luvisols are well developed	Modest. Vineyards, orchards, citrus groves, woodland and grassland. These are the principal agricultural soils of Mt Etna.
10. Eutric Regosols; Lithosols; Eutric Cambisols. Andosols as inclusions	Between sea level and 1750 m	Fairly steep.	Shallow to moderately deep. Shallow Regosols are developed in tephra	From mediocre to good. Woodland and grassland
1. Rock outcrop (lava flows); Lithosols		On younger lava flows, mostly between ca. 500 m and the summit	Very shallow	Almost none
24. Eutric Cambisols; Eutric Fluvisols	Restricted to the base of the Eastern flanks	Level to sloping; on alluvium and the volcaniclastic fan to the south of Riposto (Fig. 15.1)	Moderately deep to deep	Good. Vineyards, orchards, citrus groves and other crops

[a] Numbers refer to the associations defined by Fierotti et al. (1988). The soil classification follows that of FAO-UNESCO (1974)

low topsoil. The importance of soil depth in relation to other factors in soil fertility may apply to relatively young soils, but the soils of the oldest flows on the lower slopes of Mt Etna are markedly more developed, being finer-textured, brown Cambisols and sometimes Luvisols. These soils, associated with mature landscapes, are also terraced and carry a rich variety of more demanding crops. The patchwork of Etna's geomorphology and soils, which occurs between very local and regional/sector scales, accounts in part for the great ecological and agricultural diversity of the volcano.

Tephra is the major constituent of many of Mt Etna's soils, and its periodic deposition rejuvenates them. During the 2002–2003 eruption, 10 cm of tephra accumulated 5 km from the source. Citrus fruits and vegetables were badly affected and grapes had to be washed to remove ash; washing machinery could not be used because of damage by the abrasive ash, and oranges could not be processed economically for juice (Dazzi 2007).

Although in the absence of human interference lava will be re-colonized by natural processes, there is evidence that farmers both understood weathering and re-colonization and assisted it to a limited degree. By comparing geological maps and aerial photographs it is possible to see that farmers had an accurate perception of re-colonization potential. Etna generates relatively little pyroclastic ash, but where it occurs mature soils are produced far more quickly than on lava flows. Around the village of Nicolosi (Fig. 15.1), located on the south-eastern flank at a height of 700 m, vines have been established for a considerable time on Andosols developed from the pyroclastic ashes of the 1669 eruption, whereas adjacent lavas of the same age only support the low intensity grazing of livestock. King (1973a) also makes the point that farmers often encouraged natural weathering and processes of soil formation, with the prickly pear cactus (*Opuntia ficus-indica*) being introduced from South America so that the plant's powerful roots could assist in the breakup of lava flows.

Although the perception that disasters are caused by supernatural forces in order to punish sinful humanity is not confined to pre-industrial societies and, indeed, transcends culture, time and religious tradition (Chester and Duncan 2010), generally in southern Italy and particularly on Etna (Chester et al. 2008) this attitude played a particularly prominent role in the ways in which people reacted to catastrophes caused by volcanic and tectonic processes. The tradition that Etna has a divine status is long-established and in fact may be traced back to before the period of Hellenic influence, with Maniscalco (2005) noting that the Sikel god, Hybla, was associated with a mud volcano at Paterno on the south-western flank of the volcano (Fig. 15.1). Later in the Classical Era the view emerged that the only course of action that people could take when threatened by the effects of an eruption was divine appeasement, with Lucilius Junior (first century AD) recording that the people offered incense to the gods who were thought to control the mountain and its eruptions (Hyde 1916). In the Christian tradition, theodicy is defined as any attempt to reconcile the notion of a loving God with the existence of human suffering, and southern Italian popular Catholicism modified the pre-Christian tradition to maintain that losses had to be accepted because they were a legitimate expression of a vengeful God's punishment of a sinful people (Chester et al. 2008). All the inhabitants of Etna could do in response was to appeal to God in prayer and supplication, to try and propitiate wrath by liturgical actions and, in planning recovery from the disaster, resolve to live better lives. In the eighteenth century and strongly influenced by enlightenment thinking, alternative models of theodicy were given prominence especially by the philosopher Gottfreid Wilhelm Leibniz, but rural Sicilian Catholicism remained wedded to notions of punishment, with the only positive feature of a disaster—what theologians term the greater good—being found in the virtues of self-sacrifice, public service and social cohesion (Chester et al. 2005).

Given the manner in which the greater good was defined in Sicily, it is hardly surprising that from the earliest times heroic acts became the stuff of legend. Seneca, for instance, records the story of Anapias and Amphinomus—the so-called 'Fratelli pii' or pious brothers—who rescued their parents from a major conflagration in Catania, lava opening in front of them like the Biblical Red Sea and so allowing escape, whereas much later in 1669 Diego Pappalardo a local leader and some fellow citizens of Catania attempted to divert a flow which threatened their city, a course of action which caused a riot since the diverted lava now put Paterno at risk. Following this and for the rest of the pre-industrial era, attempted diversion of lava was made illegal (Chester et al. 2005).

A widely-held theodicy of punishment meant that eruptions became associated with liturgies of divine appeasement. Although intercession through the agency of the Madonna and the saints was an established part of mainstream catholic teaching, in the form of popular Catholicism practiced on Etna this was expressed in a distinctive and extreme manner, with saintly relics, statues and other votive objects supposedly having the ability to prevent disasters (Chester et al. 2008). As early as 252 AD when lava approached Catania, the inhabitants processed the veil of the recently martyred St. Agatha at the flow front which it was claimed was immediately halted. Following this early success the veil and objects associated with saints were used on numerous occasions: in 1669 it was asserted that Agatha's veil prevented all Catania being destroyed; and as late as 1886 the veil was claimed to have been responsible for lava passing close to, but not destroying, the village of Nicolosi (Chester et al. 2005). The rural landscape of the Etna region was dotted with roadside shrines to saints and martyrs and an important part of the traditional way of life of each village was a festival (*festa*) dedicated to the local patron saint.

In pre-industrial times on Etna there was a marked psychological tension caused by an inconsistency between beliefs and actions. Sometimes called cognitive dissonance or parallel practice (Dibben 1999) the people of Etna, while on the one hand accepting that disasters were manifestations of divine wrath, on the other had no difficulties in reducing their risk exposure through, for example, exploiting extended family networks, having cultivation plots in different areas, and forming self-help committees. What is more from the eighteenth century some of the early geologists who studied Etna from a scientific perspective were priests, most notably the German Jesuit Athanasius Kircher and the Sicilian Canon Giuseppe Recupero who assisted the pioneer volcanologist Sir William Hamilton (Chester et al. 1985). This influence, however, did not displace or modify the indigenous popular Catholicism of the Etna region, with its emphasis on the supposed power of relics and votive objects and the efficacy of

village patron saints and the Madonna to intercede for divine protection (Chester et al. 2008).

15.3 Conclusion: Landscape and Hazard Response Today

Although most characteristics of pre-industrial loss bearing on Etna have not been in evidence for a hundred years, some elements have survived (Table 15.3). Most notable are liturgies of divine appeasement which are still carried out each time there is a major eruption. Since 1970 major flank eruptions have affected or threatened settlement on the volcano in 1971, 1974, 1981, 1983, 1991–1993, 2001 (Guest et al. 2003) and in 2002–2003, and during most of these events religious rites have been performed, showing a continuity with the situation before 1900. These liturgical actions still enjoy overwhelming popular support and in July 2001, Luigi Bommarito Archbishop of Catania, celebrated mass in the village of Belpasso (Fig. 15.1; Chester et al. 2008), hopefully to halt the lava that was threatening the village. It is estimated that between 7000 and 10,000 people attended this open-air mass, representing a wide cross-section of the inhabitants of the village including many well-educated professional people. A teacher is quoted as remarking local people still believe in miracles. "If human technology can't keep the lava back, the eternal father is our only salvation" (Kennedy 2001, p. 10). Furthermore, in detailed interviews carried out in the village of Trecastagni in the 1990s (Fig. 15.1), Dibben found that "for many (members of the public) religious beliefs play a significant role in their representation of the volcano" (Dibben 1999, p. 196). The parallel practice noted in pre-industrial times, of people accepting that disasters are manifestations of godly wrath which are only capable of being moderated through mechanisms of divine propitiation, yet at the same time fully embracing attempts to reduce risk and aid recovery through State supported actions, is still part of the psychological makeup of a large number of the inhabitants of Etna. Salvaging all that may be easily removed from a building before it is engulfed by lava has also remained an important means of coping. This well established tradition is probably not unrelated to the low take up of domestic property insurance which is both costly and of only limited availability (Chester et al. 1985). In spite of these exceptions, present day responses to periodic flank eruptions are industrial in character (Table 15.3), with emergencies being closely managed: by government, through the Ministry of Civil Protection (Dipartimento della Protezione Civile), and other scientific agencies, including the National Institute of Geophysics and Vulcanology (Istituto Nazionale di Geofisica e Vulcanologica INGV) in Catania; and by the use of technology and planning expertise, particularly hazard mapping, land-use zoning and geophysical monitoring. In this respect Etna differs little from volcanoes located in other parts of the economically more developed world (Chester et al. 2005) in terms of its hazard preparedness.

In introducing this chapter it was noted that many features of pre-industrial agriculture and the distinctive lifestyle of Sicilian agro-towns were still in evidence in the late 1960s and early 1970s. Over the past forty years poverty in Sicily has been reduced through aid and subsidies from the Italian State and the European Union, with the interior lands in particular benefiting from the programmes of land-reform which were introduced from the 1950s (King 1973a, 1973b). On Etna the regione piedmontese retains its agricultural distinctiveness and, though farmers now have access to machinery and subsidies, much of the traditional system of intensive irrigated agriculture described in Sect. 15.2.1 may still be recognized (Dazzi 2007). Since the 1970s, the policy towards concentrating investment in more environmentally favored and larger more easily worked and more accessible holdings within the regione piedmontese and on the plain of Catania has continued, and further abandonment from cultivation of more marginal land has taken place. The numbers employed in agriculture have fallen, those in service occupations have increased and many comuni, particularly those within easy driving distance of Catania, now serve as commuter settlements and contain many inhabitants who are far less aware of risks they face from the volcano than were their forebears four decades ago (Dibben 2008). The region is now a major tourist destination and since the early 1970s has attracted many second home owners. Especially in the settlements near Catania and adjacent to the coast, much of the traditional Sicilian way of life and the character of the agro-town has disappeared, though elements are still to be found in the more remote villages of the northern and north-western and western sectors of the volcano.

References

Ayala G, French C (2003) Holocene landscape dynamics in a Sicilian upland river valley. In: Howard Macklin Passmore (eds) Alluvial Archaeology in Europe. Swets and Zeitlinger, Rotterdam, pp 229–235

Ayala G, French C (2005) Erosion modeling of past land-use practices in the Fiume di Sotto di Troina River Valley, North Central Sicily. Geoarchaeology 20:149–167

Basile DG (1941) Agricultural Sicily. Economic Geography 17:109–120

Benjamin S (2006) Sicily: Three thousand years of human history. Steerforth Press, Hanover New Hampshire, 498 pp

Chester DK, Duncan AM (2010) Coping with disasters within the Christian tradition, with reference to volcanic eruptions and earthquakes. Religion 40 (2):85–95

Chester DK, Duncan AM, Dibben C, et al. (1999) Mascali, Mount Etna region Sicily: An example of Fascist planning during the 1928 eruption and its continuing legacy. Natural Hazards 19:29–46

Chester DK, Duncan AM, Dibben CJL (2008) The importance of religion in shaping volcanic perception in Italy, with special reference to Vesuvius and Etna. Journal of Volcanology and Geothermal Research 172:216–228

Chester DK., Duncan AM, Guest JE (2005) Responses to eruptions of Etna from the Classical Period to 1900. In: Balmuth MS, Chester DK, Johnston PA (eds) Cultural responses to volcanic landscape. Colloquia and Conference Papers 9, Archaeological Institute of America, Massachusetts, pp 93–107

Chester DK, Duncan AM, Guest JE, Kilburn CRJ (1985) Mount Etna: The anatomy of a volcano. Chapman and Hall, London, 404 pp

Chester DK, Duncan AM, Guest JE, et al. (2000) Human response to Etna during the classical period. In: McGuire WJ, Griffiths DR, Hancock PL, Stewart IS (eds) The archaeology of geological catastrophes. Geological Society Special Publication 171, London, pp 179–188

Clapperton CM (1972) Patterns of physical and human activity on Mount Etna. Scottish Geographical Magazine 88:160–167

CORINE (1994) Soil erosion risk and important land resources – in the southern regions of the European Community. European Environment Agency, Copenhagen. http://www.eea.europa.eu/publications/COR0-soil (accessed 24 March 2009)

Dazzi C (2007) Environmental features and land use of Etna. In: Arnalds O, Bartoli F, Buurman P, Oskarsson H, et al. (eds) Soils of Volcanic Regions in Europe. Springer, Berlin, pp 629–644

Demangeon A (1927) La géographie de l'habitat rurale. Annales de Géographie 36:1–23

Deckers J, Driessen P, Nachtergaele F, Spaargaren O (2002) World reference base for soil resources – in a nutshell. In: Micheli, E., et al. (eds) Soil Classification 2001. (EUR 20398 EN). Luxembourg: Office for Official Publications of the European Communities. European Soil Bureau, pp 173–181

Dibben CJL (1999) Looking beyond eruption for an explanation of volcanic disasters: vulnerability in volcanic environments. Unpublished Ph.D. thesis, University of Luton, Luton.

Dibben CJL (2008) Leaving the city for the suburbs – The dominance of 'ordinary' decision making over volcanic risk perception in the production of volcanic risk on Mt. Etna, Sicily. Journal of Volcanology and Geothermal Research 172:288–299

Duncan AM, Chester DK, Guest JE (1981) Mount Etna volcano: Environmental impact and problems of eruption prediction. Geographical Journal 147:164–179

Duncan AM, Chester DK, Guest JE (1996) The 1928 eruption of Mount Etna Volcano Sicily, and the destruction of the town of Mascali. Disasters 20:1–20

Duncan AM, Chester DK, Guest JE (2005) Eruptive activity of Etna before A.D. 1600 with particular reference to the classical period. In: Balmuth MS, Chester DK, Johnston PA (eds) Cultural responses to volcanic landscape. Colloquia and Conference Papers 9, Archaeological Institute of America, Massachusetts, pp 57–69

FAO-UNESCO (1974) Soil map of the world, Vol. 1 Legend. United Nations Food and Agriculture Organization (FAO) and United Nations Educational, Scientific and Cultural Organization (UNESCO), Rome.

Fierotti, GF, Dazzi C, Raimondi S (1988) Carta dei suoli della Sicilia, 1: 250,000 (with report). Regione Siciliana Assessorato Territorio ed Ambiente and Univesita degli Studi di Palermo, Facoltà di Agraria, Istituto di Agronomia Generale, Cattedra di Pedologia, Palermo

Finley MI (1968) A history of Sicily: Ancient Sicily to the Arab conquest. Chatto and Windus, London, 222 pp

Grove AT, Rackham O (2001) The nature of Mediterranean Europe. An Ecological History. Yale University Press, New Haven, 524 pp

Guest JE, Murray JB (1979) An analysis of hazard from Mount Etna Volcano. Journal of the Geological Society of London 136:347–354

Guest JE, Cole PD, Duncan AM, Chester DK (2003) Volcanoes of southern Italy. Geological Society, London, 284 pp

Hyde, WW (1916) The volcanic history of Etna. Geographical Review 1:401–418

James P, Chester D, Duncan A (2000) Volcanic soils: their nature and significance for archaeology. In: McGuire WJ, Griffiths DR, Hancock PL, Stewart IS (eds) The archaeology of geological catastrophes. Geological Society Special Publication 171, London, pp 317–338

Kennedy F (2001) Sicilians pray as technology fails to stop lava. The Independent (London), 10 July, p 30

King R (1971) Mediterranean island in torment. Geographical Magazine 44:178–185

King R (1973a) Sicily. David and Charles, Newton Abbot, 208 pp

King R (1973b) Land Reform: The Italian experience. Butterworth, London 257 pp

King R, Strachan A (1978) Sicilian agro-towns. Erdkunde 32:110–123

Leighton R (1996) Early societies in Sicily. Accordia Research Centre University of London, London, 211 pp

Leighton R (1999) Sicily before history: an archaeological survey from the Palaeolithic to the Iron Age. Duckworth, London, 312 pp

Mack-Smith D (1968) A history of Sicily: Vol. 1 Medieval Sicily 800–1713; Vol. 2 Modern Sicily after 1713. Chatto and Windus, London, 559 pp

Maniscalco L (2005) The prehistoric settlement near Salinelle di San Marco (Paterno, Catania Province, Sicily). In: Balmuth MS, Chester DK, Johnston PA (eds), Cultural responses to volcanic landscape. Colloquia and Conference Papers 9, Archaeological Institute of America, Massachusetts, pp 127–142

Malone C, Stoddart S (2000) The historical geography of ancient Sicily: implications for genetics. Journal of Cultural Heritage 1: sup. 29–sup. 31

Milone F (1960) Sicilia: La natura e l'uomo. Paulo Boringhieri, Torino, 462 pp

Pecora A (1968) Sicilia: Le regione D'Italia, Vol. 17. Unione Tipografico Editice, Torinese, 644 pp

Rochefort R (1961) Le travail en Sicile. Étude de Géographie Sociale. Presses Universitaires de France, 363 pp

Rodwell GF (1878) Etna: A history of the mountain and its eruptions. C. Kegan Paul, London, 146 pp

Sadori L, Narcisi B (2001) The postglacial record of environmental history from Lago di Pergusa, Sicily. The Holocene 11:655–670

Sadori L, Zanchetta G, Giardini M (2008) Late glacial to Holocene palaeoenvironmental evolution at Lago di Pergusa (Sicily, Southern Italy) as inferred by pollen, microcharcoal, and stable isotopes. Quaternary International 181:4–14

Smolenaars JJL (2005) Earthquakes and volcanic rruptions in Latin literature: Reflections and emotional responses. In: Balmuth MS, Chester DK, Johnson PA (eds) Cultural responses to volcanic landscape. Colloquia and Conference Papers 9, Archaeological Institute of America, Massachusetts, pp 311–329

Tanguy JC, Condomines M, Le Goff M, et al. (2007) Mount Etna eruptions of the last 2759 years: revised chronology and location through archeomagnetic and ^{226}Ra-^{230}Th dating. Bulletin of Volcanology 70:55–83

White GF (1973) Natural hazards research. In: Chorley RJ (eds) Directions in Geography. Methuen, London, pp 193–212