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Abstract

The islands of St. Kitts and Nevis are part of a binary federation located within the northern Leeward Islands. Their landscapes are as much a result of their geological history as they are the manifestation of interactions of man and nature over time. From the central volcanic mountains draped with tropical rainforests, to the gently sloping pyroclastic fans that have provided rich soils for agriculture and land for settlement, to the coastline dominated by cliffs, to its variety of inshore and marine natural resources, the islands morphology is a key facet of its existence. The islands economy has always depended on the bounty of the land, first for agriculture and increasingly for a tourism product that is based largely on its natural environment.

Keywords

St. Kitts • Nevis • Volcanic • Environment

7.1 Introduction

The Federation of Saint Christopher (St. Kitts) and Nevis consists of three small islands: the inhabited islands of Saint Christopher (St. Kitts) and Nevis and the uninhabited Booby Island (Fig. 7.1). This Small Island Developing State is located in the northern section of the Leeward Islands and is part of the geo-political grouping called the Organization of Eastern Caribbean States.¹ Although there is only a small ocean channel (known as the “Narrows”) that physically separates the two islands, their separation is significant in terms of geo-political setting. Although provision is made

under the binary “Federation” for the two islands to officially operate as one, a special relationship exists between them, which means that they function together and separately at the same time.

The most dominant influence on the landscape of both islands has been their volcanic history, which has resulted in a combination of volcanic mountains, rain forests, and unspoiled beaches. The fact that both islands have an adequate supply of groundwater and an abundance of well-drained fields on gently sloping land (<10°) suitable for agriculture is to a large extent also due to the underlying geology. Single, young volcanic centers dominate each island, comprising the core of central volcanic mountains, which are densely vegetated by rainforest. These central mountains remain surrounded by gently sloping land that falls away uniformly toward the coastline in all directions (Fig. 7.2a).

St. Kitts is 176 km² (68 mi²) in area and roughly oval in shape with a narrow neck of land extending like a handle toward the southeast. It consists of a central mountain range dominated by Mt Liamuiga and surrounded by cultivated slopes, dissected by dry river valleys (ghauts) that drain into the sea. The southern sections of the central range enclose a

¹This is an inter-governmental organization dedicated to economic harmonization and integration, protection of human and legal rights, and the encouragement of good governance between countries and dependencies in the Eastern Caribbean. It also performs the role of spreading responsibility and liability in the event of natural disaster, such as a hurricane.

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ST. KITTS and NEVIS



Fig. 7.1 General physiographic map of St. Kitts and Nevis highlighting the islands' mountainous topographies and political parish boundaries. The waterway separating the two main islands, the Narrows, contains the small island of Booby Island. Cartography by K.M. Groom

spacious fertile valley that opens into the capital city of Basseterre. Although golden sandy beaches are common in the Southeast Peninsula, most of the beaches on the island are of gray and brown volcanic sand. Manifestations of

recent volcanic activity include active fumaroles in the crater of Mt Liamuiga (1156 m, where an ephemeral lake exists— see Fig. 7.2b) and past periods of intense earthquake activity associated with the volcano.

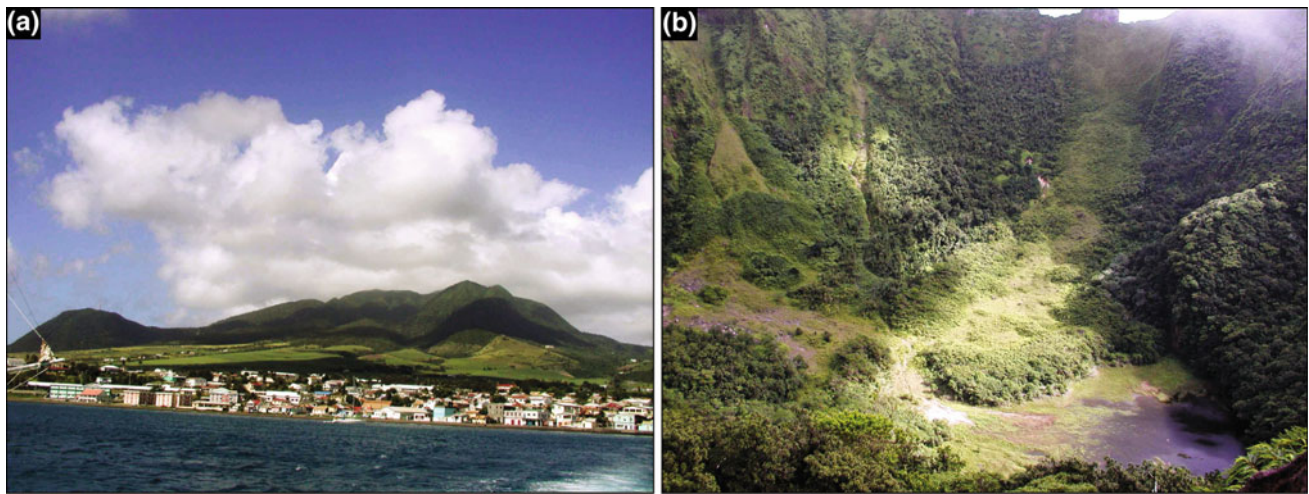


Fig. 7.2 Mountainous features of St. Kitts and Nevis. **a** Offshore view of St. Kitts showing its core of densely vegetated, central volcanic mountains (*left to right* are Brimstone Hill, Mt. Liamuiga, Middle Range, Southeast Range), surrounded by gentle cultivated slopes that drain to the sea. Basseterre, the capital of St. Kitts with its reclaimed waterfront area, is in the foreground. **b** The steep-walled summit crater

of Mt. Liamuiga volcano is a 900 m (width) × 244 m (depth) feature that contains low temperature fumaroles, a small ephemeral lake visible at the bottom of the image and a dense cover of mainly cloud forest. Photographs courtesy of R. Robertson, The UWI Seismic Research Centre

At 93 km², Nevis is also dominated by a central peak (Nevis Peak, 985 m) and dissected by deep ghaunts that run from the peak to the sea. No regular stream flow occurs in the ghaunts except during heavy rains, and the island has no significant bays, inlets, or cays, but has long stretches of golden, sandy beaches around most of the island. Vegetation cover is extensive but not dense, and many wetlands occur along the leeward coast.

Understanding and appreciation of the value of the landscape on both islands have spawned the creation of various organizations, policies, and practices in an attempt to manage the island's heritage resources. Institutionalized concern is reflected in extensive government policies and legislation as well as in such organizations as the National Conservations Commission, the St. Christopher Heritage Society, and the Nevis Historical and Conservation Society. The creation of national parks as well as the organization of various beautification and environmental management projects represents specific actions that focus on preservation of heritage resources.

7.2 Setting

Volcanic in origin, St. Kitts (17° 15' N, 62° 45' W) and Nevis (3 km to the southeast, at 17° 10' N, 62° 35' W), is located in the northern part of the Lesser Antilles chain of islands in the Eastern Caribbean, upon a submarine ridge that extends from St. Eustatius to just south of Nevis, covering an area of 80 km × 16 km. The coastal shelf widens slightly between both islands, and a total area of 595 km²

lies within the territorial waters of St. Kitts and Nevis (Island Resources Foundation 1991). The islands have a combined area of 269 km² and a population of approximately 46,000 persons (2010 census). With a Tropical Marine Climate that is strongly influenced by steady northeast trade winds and tropical oceanic cyclonic movements, the Federation experiences warm temperatures averaging about 28 °C, with small seasonal and diurnal variations. At high altitudes, temperatures can drop below 17 °C. Rainfall is mainly orographic, affected by a central mountain range that extends from Mt. Liamuiga (1156 m) to the Southeast Range (901 m). Precipitation increases in amount and frequency with altitude. The yearly average rainfall is 1620 mm, but it can range from ~1000 mm in coastal areas to ~3800 mm in the central mountains. Except for the Southeast Peninsula, which is very dry, rainfall is fairly well distributed throughout the island with a seasonal variation between the “wet” and “dry” season. The wet season extends from August to November, while the driest months are from January to April. Relative humidity is low in the dry season and high in the wet season with a mean value of 76%. The prevailing winds blow from the northeast (NE trade winds) with speeds ranging from 15 to 30 kph.

The volcanic landscape has resulted in beaches that consist of a variety of mostly volcanic materials ranging from black sand to cobbles, rocks, and boulders. In the Southeast Peninsula, south of Friar's Bay, beaches are comprised of marine sands consisting of coral and shell materials, and at Sandy Point, Dieppe Bay, and Conaree there is a mixture of land-based and marine sand (Island Resources Foundation 1991). In addition to the coral and

volcanic beaches, the coastal areas of St. Kitts and Nevis abound in shore and marine natural resources including coral reefs, mangroves, saltwater lagoons, and sea grass beds.

The increasing importance of tourism to the economy of both islands makes these coastal areas a vital asset that needs to be protected from the effects of human activities and the ravages of storms. The coastal zone has been affected by developments along the shore, including farming, quarrying (sand mining for construction), sewage disposal, and land reclamation. Human activities have placed tremendous stress on the ecological balance of coral reefs, sea grass beds, and mangroves leading to a rapid decline of marine ecosystems. Elevated nutrient levels in the coastal zone due to runoff from urban and agricultural areas along ghauts and storm drains has led to imbalances to the marine ecosystems (Williams 2013). Wetland infilling for residential homes and hotels due to development pressure and natural hazards is causing the islands to lose its coastal mangrove habitats.

7.3 Landforms

7.3.1 St. Kitts Landforms

7.3.1.1 Major Features

St. Kitts is an elongated island oriented NW–SE, 36.8 km (23 mi) long and roughly oval shaped with a narrow neck of land extending from the southeastern end (Fig. 7.3). It generally rises from the coastline toward its mountainous interior. The island is suspended on an underwater ridge which has a northwest to southeast axis from which Nevis also arises. The physical landscape of St. Kitts has a rugged backbone characterized by three volcanic centers dominated by Mt. Liamuiga, which rises with a pronounced crater to 1156 m.

Southeast of Mt. Liamuiga the Central Range and Southeast Range continue the trend after which the land descends into the Basseterre Valley. The Central and



Fig. 7.3 Elongated shape of St. Kitts with its rugged backbone of volcanic centers that trend NW–SE is clearly seen on a largely cloudless day from Nevis Peak, Nevis. The contrasting morphology of the youthful Mt Liamuiga volcano (*upper left*) to the older dissected

domes of the Salt Pond Peninsula (*mid-center*) is well illustrated in the photograph. The lush slopes of Nevis Peak occupy the foreground of the image. Photograph courtesy of R. Robertson, The UWI Seismic Research Centre

Southeast Range consist of a number of irregular peaks; the highest of which is Verchild's mountain at 975 m (3200 ft). The slopes in these ranges are generally steeper and shorter toward the leeward coast. The main mountainous interior blends downslope into a gradually sloping coastal plain that is interrupted by minor domes at Brimstone Hill, Ottley's Mountain, Sandy Point Hill, and Monkey Hill. Most of the flat and moderately sloping land occurs in these areas near the coast, which as a result, has been the areas used for urban and agricultural development.

7.3.1.2 Volcanic Centers

Although the core of St. Kitts is comprised of older (possibly Eocene) volcanic material, three younger volcanic centers encompass most of the island: the Southeast Range, the Middle Range, and Central Range dominated by Mt. Liamuiga (Martin-Kaye 1959). These are Pliocene to Pleistocene in age and become progressively younger toward the northwest (Hovey 1903, 1905; Sapper 1904; Davis 1924; Martin-Kaye 1959; Fels 1903; Earle 1925). The Salt Pond Peninsula is an old dissected landscape that consists of many low, rounded hills that comprise the topographic highs and reach a maximum height of 319 m, with flat, low-lying areas, and salt ponds comprising the topographic lows. Geologically, this area consists of lava domes and volcanoclastic deposits, which may have originally been pyroclastic flows and lahars from past eruptions. The oldest rocks exposed on the island (2.77 ± 0.3 Ma, Baker 1969) are found in this region (Fig. 7.4). Lang and Carroll (1966) suggested that the St. Anthony's Peak, the highest point on the Peninsula, might have been the site of a volcanic crater.

Younger Pleistocene volcanic centers (Southeast Range, Middle Range, and Mt. Liamuiga) that consist mainly of andesitic pyroclastic deposits are found along the island's central spine. They occur as ash, reworked sands and gravels, cobbles, and boulders. The Southeast Range rises up to 900 m and is a younger volcanic center made up of lava flows and volcanoclastic deposits. Due to poor exposures, little is known about its past eruptive history, but Baker (1985) obtained an age of 1 million years for a lava flow on its southern slopes. The Middle Range is heavily forested with few outcrops of hard rock and with difficult access to exposures of its geology. It has a summit lake and youthful appearance, but no age dates have been obtained and so it is difficult to make any conclusions about its eruptive history.

Located on the northwestern most mountain and being the youngest volcanic center on the island, Mt. Liamuiga represents a typical stratovolcano, composed of alternating layers of andesitic and basaltic lava flows, agglomerates, and pyroclastics (Fig. 7.5a). The last eruption is estimated to have been about 1620 years before present (Baker 1985). Its young age, associated geothermal and seismic activity, suggests that it is a potentially active volcano that is likely to

erupt again in the future (Robertson 2005). There is a steep, summit crater ~ 900 m wide, and 244 m deep which contains a small ephemeral lake and has active low temperature (up to 100 °C) fumaroles along the crater walls (Robertson 2005). An old Carib legend suggests that Brimstone Hill, an andesite lava dome located on its lower flanks, grew out of the Mt. Liamuiga (Baker 1985), hinting that pre-Columbian peoples may have witnessed the growth of this dome.

7.3.1.3 Southeast Peninsula

The Southeast Peninsula is a cluster of seven older islands that have become linked by recent beach and saline marsh deposits. These were originally tombolos, which have widened into flat sedimentary plains and marshland linking the seven preexisting small islands/islets. The hills on the Peninsula are smoothly rounded with slightly convex peaks. The largest is St. Anthony's Peak at 319 m. Eight saline ponds that vary in size from 160 to 1.6 ha occur in the area.

The Peninsula consists of two distinct features (1) a narrow spit or bar that is slightly more than 0.5 km wide and about 4.5 km in length that extends in a southeasterly directly from Timothy Hill at Frigate Bay to Salt Pond Hill and (2) a larger, roughly triangular tombolo cluster surrounding the largest saline pond, 440 acre Great Salt Pond (Island Resources Foundation 1991).

7.3.1.4 Coastal Features

The coastline of St. Kitts consists largely of cliffs that range in height from 15 to 30 m. At Black Rocks, a basalt lava flow forms prominent distinctly black coastal cliffs (Fig. 7.5b). Narrow black sand beaches comprised of the eroded products from the volcanic hinterland occur at the base of most cliffs. In the northwest, the cliffs are lower, and some of the beaches are wider and comprised of yellow sand (Island Resources Foundation 1991). There are long stretches of fine yellow sand beaches extending from Conaree Beach on to the southeast of the island. Unfortunately, excessive sediment loads, biocide runoff, and other land-based sources of pollution continue to be the main causes of reef damage leading to coastal erosion across the islands (Island Resources Foundation 1991; Williams 2013).

7.3.2 Nevis Landforms

7.3.2.1 Major Features

Nevis is an oval-shaped island, 12.3 km long (7.64 mi) and 9.6 km (5.96 mi) wide at its widest part with its topography dominated by the central Nevis Peak. Although it is comprised of seven volcanic centers strung out SE–NW, the dominance of Nevis Peak on its topography is such that the peak overshadows all other topographic features, giving the island the appearance of a classic volcano-island. Windy Hill

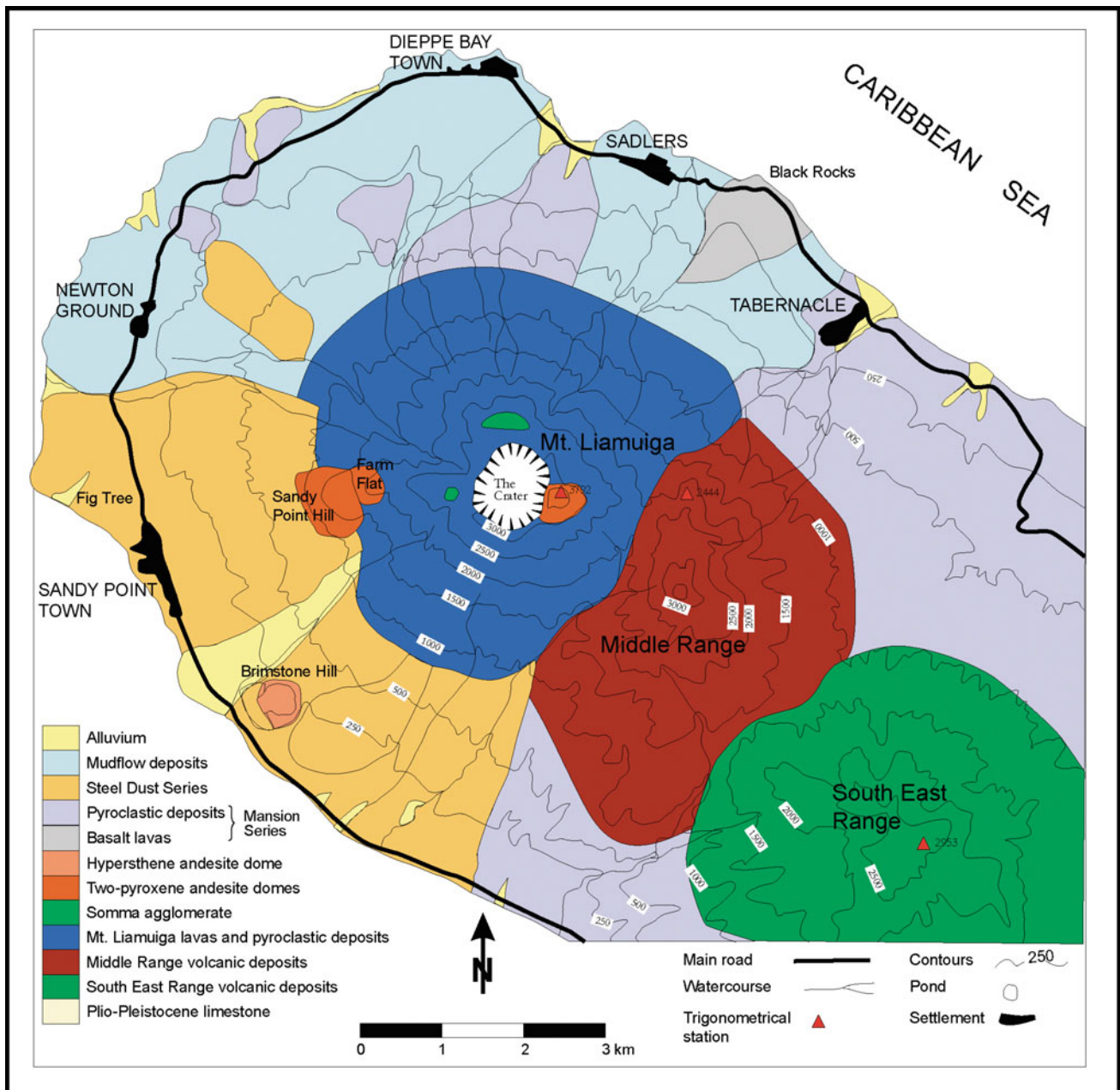


Fig. 7.4 Geological sketch map of the northwestern part of St. Kitts (adapted from Baker 1969) showing the main geological formations that make up the island. Note the different lava and pyroclastic flow

events that cover much of the island's landscape. Cartography by Shahiba Ali from the Volcanic Hazard Atlas of the Lesser Antilles (see Robertson 2005)

(309 m) also called Round Hill in the northwest and Saddle Hill (381 m) in the southeast end of the island line up with Nevis Peak in the center to form a similar north-northwest to south-southeast trending trend as the more pronounced orientation of the mountains in St. Kitts.

7.3.2.2 Volcanic Centers

Seven volcanic centers have been identified on the island of Nevis: Hurricane Hill, Round Hill, Cades Bay, Saddles Hill,

Red Cliff, Butlers Mountain, and Nevis Peak, all considered to be the remains of lava domes that were created by quiet, effusive eruptions (Hutton 1965; Hutton and Nockolds 1978; Fig. 7.6). The oldest rocks are found in the northwest of the island at Round Hill (3.43 Ma) and the youngest are associated with Nevis Peak (0.10–0.98 Ma; Hutton and Nockolds 1978).

Nevis Peak, rising to 985 m and representing the island's highest point, is comprised of a central cone with flank

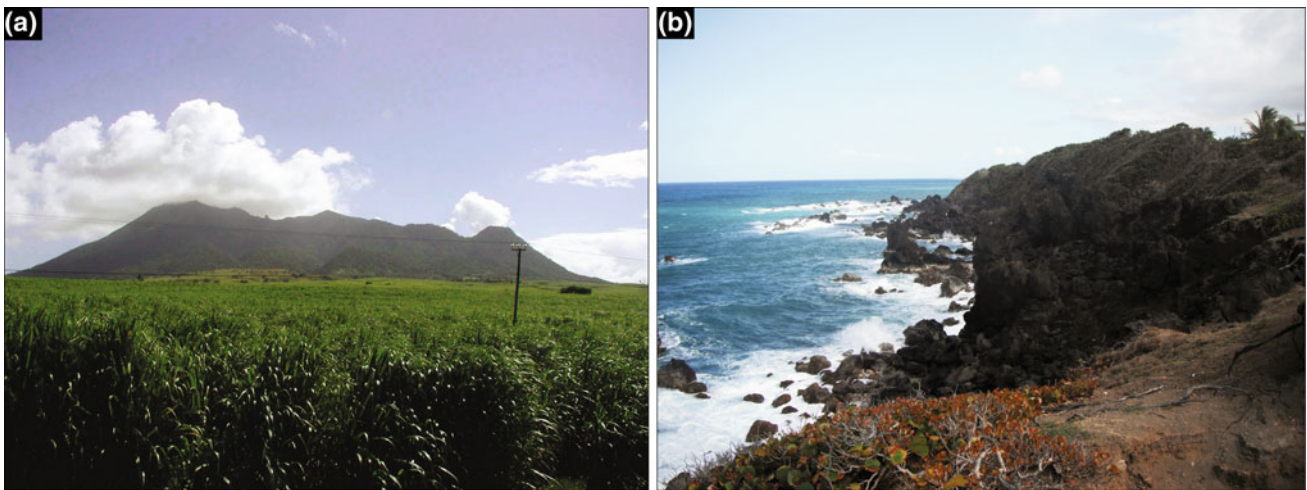


Fig. 7.5 Examples of volcanic landforms on St. Kitts. **a** Mt. Liamuiga volcano, which rises up to 3792 ft. (1156 m), the youngest volcanic center on the island of St. Kitts and its highest mountain. Its lower flanks are occupied by farmland and small villages but at higher elevations tropical rainforest and cloud forest takes over. **b** Black Rocks

(also called Black Stone), a notable rock formation that is an old lava flow from Mt. Liamuiga volcano, located on the northeastern coast of St. Kitts. This black basaltic rock was formed during the early evolution of Mt. Liamuiga volcano. Photographs courtesy of R. Robertson, The UWI Seismic Research Centre

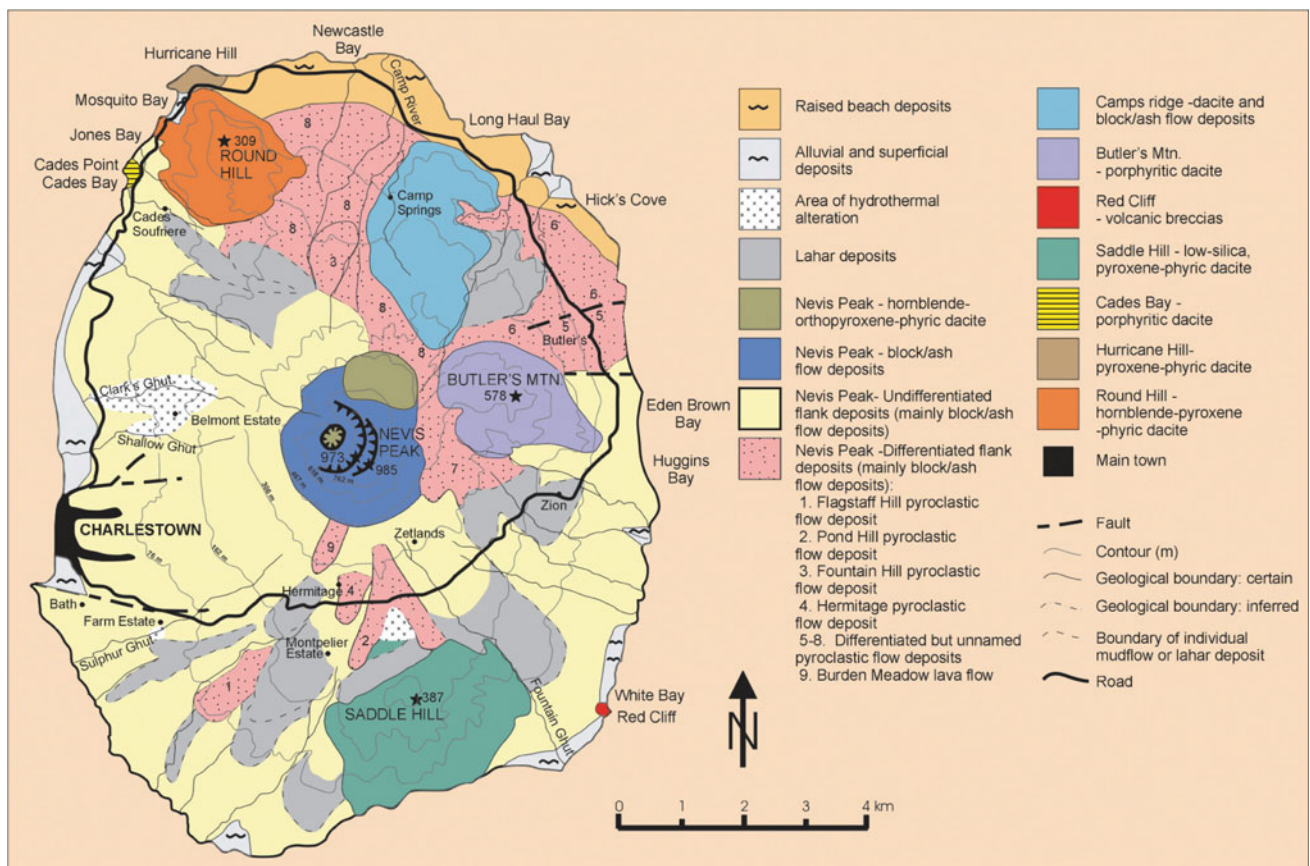


Fig. 7.6 Generalized geological map of Nevis Island (modified from Hutton and Nockolds 1978) showing all the major geologic features on the island. Cartography by Shahiba Ali from the Volcanic Hazard Atlas of the Lesser Antilles (see Simpson 2005)

deposits radiating outward toward the sea and two younger lava domes. Past eruptions have produced lava domes and associated volcanoclastic deposits that range in compositions from andesite to dacite (58–65% SiO₂; Hutton and Nockolds 1978).

Although there are large areas of hydrothermally altered rocks found throughout the island, only two localities exist with focused fumarolic activity: Cades Bay and Farm Estate. These are relatively low-temperature (53–100 °C) fumaroles characterized by warm, hydrothermally altered ground, small boiling pools, and weakly steaming vents (Robertson 2005). Geothermal activity on Nevis is also exhibited at a number of hot springs—the hottest being Bath Estate and Cades Bay beach. At these locations, the emission of hot gases under water provides a “champagne” effect.

7.3.2.3 Microclimates and Drainage

The presence of several peaks on Nevis results in a range of microclimates that vary greatly with height, location, and orientation. Possibly due to the lower elevation of its central mountain, the average rainfall is lower than on St. Kitts with considerable variation from year to year and month to month. Rain falling on the elevated mountain core of St. Kitts drains toward the sea by way of river valleys (called ghauts) that are mostly dry. Many of the streams are fed from springs and their overland flow disappears underground at about the 250 m contour. The only two rivers that flow consistently to the sea for most of the wet season are the relatively large Wingfield and Canyon Rivers.

On Nevis, the dominance of Nevis Peak as the major topographic feature on the island results in a radial drainage pattern, which is only disrupted by the smaller volcanic cones of Hurricane, Saddle, and Round Hills. Like St. Kitts drainage is via dry ghauts, which develop as deep, steep sided ravines on the flanks of Nevis Peak. There are no lakes or ponds on the island and only intermittent streams. Most of the ghauts are ephemeral and only Bath and Camps Rivers, which are fed from springs located close to the shoreline (<1.6 km), actually flow into the sea.

7.4 Landscape and History

7.4.1 Biogeography and Landscape

The biogeographical face of the country is as much a result of nature as it is interaction with people over time. Centuries of successful sugar cultivation have left an aesthetically pleasing, orderly, well-proportioned rural landscape on St. Kitts. In contrast, the long, less successful experience with sugar (until the 1950s) in Nevis and later free-grazing goats, sheep, cattle, and pigs has scarred and ravaged the landscape. Lack of this protective vegetation cover has resulted

in greater erosive impact of wind and water erosion and sediment flow downslope that impact coastal areas and reefs (Island Resources Foundation 1991). The human-environment impact on Nevis differs significantly from that on St. Kitts.

Vegetation coverage on both islands comprises a variation of Rainforest, Dry Evergreen Forest, Dry Scrub Land, Palm Break, Elfin Woodland, and Disturbed lowlands that resulted from farming (Ministry of Sustainable Development 2014). The dominant influence on vegetation distribution on both islands is the effect of moisture-laden trade winds forced upwards by their prominent central peaks. Cooling of the moisture-laden air results in rain that falls more consistently on the upper slopes and leads to differential distribution between the windward and leeward side of the island. This has led to the development of classic island vegetation: Elfin Woodland and Palm Brake in the highest areas, giving way to rain forest on lower slopes, then seasonal and dry evergreen forests, and finally transitioning to littoral and mangrove along the coast. An upland forest belt occupies the steeper part of the central mountainous interior that comprises the northwest, central, and southeast ranges. This forest blends downslope into a gradually sloping coastal plain that flows gracefully toward the sea. It is an area that was traditionally occupied by sugarcane plantation but has increasingly become occupied by diversified agricultural crops and pastureland.

7.4.2 Anthropogenic Impacts

The vegetation on St. Kitts and Nevis has been greatly disturbed by human activity. Intensive land use in the lowland areas has removed all semblance of the natural vegetation, and agricultural crops dominate most areas not currently urbanized (Island Resources Foundation 1991). Although the mountains are still largely covered by forest, it is unlikely that any of this is still virgin forest. The lower reaches of forested areas (244–457 m), where the land has been under cultivation (with sugar, cotton, ground provisions) for a long period of time, are now occupied by secondary growth of dry evergreen forest of small trees (15–18 m in height) on abandoned farms. The resident vegetation consists of about 243 species of trees (Beard 1949).

The range and abundance of flora and fauna on St. Kitts and Nevis have also been adversely affected by human settlement particularly with the coming of the Europeans who replaced the indigenous Caribs and Arawaks. Modification, and in some cases elimination, of habitats and their associated wildlife followed the wholesale clearing of vegetation and changes to the landscape for estate development (sugarcane cultivation) and infrastructure development. Europeans civilization also introduced exotic animal species such

as cats, dogs, rats, pigs, and mongoose that significantly affected native habitats and local populations of wildlife species such as ground-dwelling birds, beach-nesting sea turtles, agouti, and iguanas. The relatively inaccessible central mountainous backbone of St. Kitts (extending from Mt. Liamuiga to Olivees) and the island's largely remote Southeast Peninsula are areas where wildlife has been largely untouched and preserved. On Nevis, the combination of Nevis Peak and lower population densities has served to moderate the loss of wildlife.

Located along the island's coastal belt, the wetlands represent St. Kitts' most important habitat for migratory and marine avian species. The best example of a mangrove swamp on the island, Greatheeds Pond, resides on the Windward coast at Conaree, just below the Canada Hills. Other wetland habitats are found at Friar's Bay, Frigate Bay, and the pond system of the Southeast Peninsula. The island is among the few in the Eastern Caribbean to have large pond systems, and certainly unique in having one large pond (Salt Pond) that attracts a large number of shorebirds.

7.4.3 Historical Impacts

When St. Kitts and Nevis was first sighted and named by Columbus in 1493, Carib Indians inhabited the island. They called the island "Liamuiga" (fertile land) and were the last of several Amerindian migrations from South America during the prehistoric period. These included the hunter-gathering people called the Siboney who arrived around 4500 BP, followed by the agriculturally based Arawaks who arrived around 2000 BP. Archaeological investigations by Goodwin (1979, 1980) indicate that Amerindian land use at this time was often high. Centuries of slash and burn agriculture destroyed much of the primary forest on both islands well before European arrival.

On Nevis, preceramic people occupied the island as far back as 4000 BP. The island was affected by similar migrations of indigenous peoples from South America, but its written history did not begin until the arrival of Columbus in 1493. The Caribs called the island "Oualie" (land of beautiful water), but the island's current name was derived from the Spanish "Nuestra Senora de las Nieves" (Our Lady of the Snows), so called due to the ubiquitous and continual cloud cover that encircles Nevis Peak (Fig. 7.7).

Columbus claimed both islands in the name of Spain, but since the Spanish focused more on the large islands in the region, they made little effort to colonize the two islands. This enabled the Caribs to remain unchallenged on the island until the early seventeenth century when land-hungry northern Europeans descended on the Eastern Caribbean. The first permanent European settlement on the island occurred in 1624 when Thomas Warner landed with a small

party of British men (Island Resources Foundation 1991). The Caribs allowed him to establish a settlement near their village at Old Road. The French, led by Pierre Belain, arrived a few months after and were also welcomed by the Caribs. As was the practice at the time, French and British settlers began to enslave (and in some cases massacre) their indigenous hosts by 1626. Thereafter the island was divided between the two nations who maintained a peaceful co-existence since they had to guard against attacks by the Spanish. In 1628, the British expanded to Nevis when a group led by Anthony Hilton moved there and established a settlement named Jamestown.

In the early parts of the seventeenth century, St. Kitts was used as a base by the two colonial powers to expand their influence in the region with the French occupying Guadeloupe and Martinique, and the British expanding to Antigua and Montserrat. St. Kitts soon developed a reputation as one of the most fertile sugar colonies although intermittent colonial warfare between 1666 and 1708 prevented its emergence as a full-fledged sugar monoculture. During this period, the French and British attacked and seized each other's territory on St. Kitts and twice the French overran Nevis. The British eventually gained control, and in 1713, France ceded its portion of St. Kitts. The sugar industry expanded rapidly thereafter, and between 1715 and 1735, sugar monoculture supported by African slave labor replaced the preexisting diversified economy of the island. The island's population expanded significantly after this period as well, giving St. Kitts one of the highest population densities in the Caribbean by the middle of the eighteenth century (Island Resources Foundation 1991).

The main reason for colonization of the islands by the British was for sugar and Sea Island cotton export. Sugar has dominated the economic life of the two islands from colonial times until recently, when the focus has turned to tourism. All of this activity depends heavily on, and is affected by, the environment—all of which remains dominated by the volcanic landscape. Prior to the 1970s, most of St. Kitts' water needs were satisfied by surface springs and streams. Since then, there has been increasing focus on the island's groundwater resources as a source of supply to meet growing demand and ensure greater reliability. Still, on St. Kitts, springs, rather than groundwater, continue to provide the largest proportion of the total water supply. On Nevis, all water needs (domestic, agricultural, and industrial) are met by a combination of surface, rain, and groundwater sources, with groundwater providing the largest proportion of their public piped water supply.

Despite over 300 hundred years of continuous and intensive use for agriculture, St. Kitts' and Nevis' soils have generally stood up well. This is largely a result of the beneficial properties (chemical and physical qualities) resulting



Fig. 7.7 View of Nevis Peak from the ferry between St. Kitts and Nevis. A 3232 ft. (985 m) high stratovolcano, Nevis Peak is the highest point on the island of Nevis. Its central cone rises up behind the capital Charlestown and flank deposits radiate outward toward the sea in all

directions. On days when the peak is completely free of clouds, there are remarkable views from its summit of the surrounding islands. Photograph courtesy of R. Robertson, The UWI Seismic Research Centre

from recent volcanism on the islands, since fresh volcanic materials can give rise to fertile soils up to 20 years after deposition (Hardy 1939). Rapid soil formation resulting from the abundance of fragmentary volcanic ejecta has also reduced the impact of soil erosion on cultivated slopes on both islands.

7.4.4 Geothermal Resources

The relatively young volcanic geology of St. Kitts and Nevis has provided it with significant untapped high-temperature geothermal resources with the potential for the development of geothermal power. Given that renewable energy resources (wind and solar) provide only 5.7% to their total installed power capacity of 56.4 MW, development of these resources has the potential to dramatically alter the energy balance of these islands (Alexander et al. 2015). Investigations undertaken by Energy and Climate Partnership for the Americas on a potential interconnection between St. Kitts and Nevis and Puerto Rico concluded that such an interconnection

could simultaneously reduce oil and natural gas use on the islands and promote geothermal development (Alexander et al. 2015).

Investment and development plans have increased in recent years with exploratory drilling already completed in Nevis, and geothermal exploration exercises started in St. Kitts where consideration is being given to the generation of up to 20 MW for the initial phase. In both instances, however, plans for development have been challenged by political opponents and by lack of incentives for private sector participation (Alexander et al. 2015). On Nevis, the US Department of State and other partners in the USA are providing assistance.

St. Kitts and Nevis have separate utilities with exclusive rights to operate power systems on each island, and current developments demonstrate each island is utilizing different approaches to explore and develop their geothermal resources. Additionally, the high upfront capital needs, including the exploratory drilling, presents a major barrier to development of operational geothermal power. The relatively small power demand on both islands poses a challenge

to profitability and points to the need for regional interconnection, collaboration, and trade in development of these resources.

7.5 Heritage and Tourism

The uniqueness of St. Kitts and Nevis, which has helped to shape the national identity and public image, is derived in part from the country's distinctive, dramatic, and spacious profile—all a direct result of its geologic past (Island Resources Foundation 1991). Each island is dominated by a single, volcanic edifice surrounded by a wide expanse of gently sloping fertile land that uniformly spreads toward the sea in all directions. Unlike other volcanic islands in the Lesser Antilles Island Arc, there is no complex interior landscape rising abruptly from the coastline. The hinterland of both islands is clearly visible from the coastline, often in one continuous parade of microhabitat variation and altitudinally conditioned biodiversity (Island Resources Foundation 1991).

Over the past two decades, the Federation has been transitioning from a way of life that evolved over four centuries of sugarcane cultivation to a political economy influenced by investments in the development of tourism, the challenges of international trade, and an uncertain environmental future (Williams 2013; Fig. 7.8). The sustainable management of land is a critical issue for the economic and social well-being of the country (Williams 2013). Partly in response to this, the Government of St. Kitts and Nevis (GOSKN) has established a number of laws, regulations, guidelines, and standards designed to govern the Federation's sustainable use and exploitation of the terrestrial and coastal resources. Each of these provides policies and guidelines for dealing with environmental issues with the overall intention of promoting sustainable development of the island.

Over the past few decades, a number of laws have also been passed to provide for the management, development, and protection of the natural environment. The legislation requires the preparation of Environmental Impact Assessments for projects that are likely to impact natural resources. Although there is no specific legislation that deals with soil conservation, there are legislative provisions that cover forestry and land tenancy—issues often related to soil conservation. One of the key issues is the existence of “landless” livestock farmers who graze animals in unrestricted areas.

St. Kitts and Nevis is signatory to five, and Party to 41 international environmental agreements, of which 18 are deemed to be the most important (Williams 2013). The obligations of the twin-island federation under a number of these international agreements have been recognized in national law. Despite the number of policies and laws that

exists, Williams (2013) noted that outdated legislation and poor enforcement along with limited exposure of legal personnel to environmental issues and impacts are major weaknesses that minimize the effectiveness of the environmental regulations.

There are several designated national parks or protected areas on the islands. Brimstone Hill National Park Fortress (St. Kitts) and the Bath Hotel (Nevis) were two of the first, but recently the Central Forest Reserve National Park (CFRNP), the Royal Basseterre Valley Park (RBVP), St. Mary's Biosphere Reserve, and Frigate Bay Salt Pond have been declared protected. In addition, all land above the 300 m contour on Nevis is totally protected through administrative means and there are plans to establish a Nevis Peak Park to encompass this area.

Brimstone Hill Fortress National Park is a UNESCO World Heritage Site, and a key component of St. Kitts tourism product. Designed by British military engineers and constructed with skill, strength, and endurance of African slaves, it features great historical, cultural, and architectural significance. Although its primary focus is historical and cultural preservation, it also serves as an unofficial bird and monkey sanctuary. Alongside Brimstone Hill, the other early tourism draw for the Federation was the Bath Hotel, built in 1778 on a site overlooking Charlestown, the capital of Nevis, and adjacent to natural hot springs. Similar in function and style to its namesake in the UK, it first attracted many European travelers who would come for the hot springs.

The Central Forest Reserve National Park (CFRNP) is one of the largest protected areas on both islands encompassing 50 km² of cloud forest that provides habitat to a number of threatened birds and represents the last stand of undisturbed tropical rainforest on St. Kitts. The area is most important for its water resources, with an estimated 30% of St. Kitts' potable water supply originating from surface runoff within the Park. Heritage resources include scenic trails, as well as budge wood (*Myrtaceae*) for fish pots; bamboo, coconut, and calabash for traditional arts and crafts; and plants for traditional medicines.

The Basseterre Valley Park, at ~2 km² and immediately adjacent to the capital city Basseterre, houses an aquifer that provides 40% of the water supply for Basseterre. The water supply, however, is under threat from human-induced impacts such as fertilizer usage, sewage treatment and disposal, and storm water runoff along roadways. While still under development, plans have been put forth to provide a variety of development such as trails, parking lots, train station, and a large rainforest arboretum.

St. Mary's Biosphere Reserve and Frigate Bay Salt Pond are the most recently declared protected areas on the islands. Comprising cloud forests, mangroves, and coral reefs, St. Mary's Biosphere Reserve represents an important site in terms of biological diversity and is, in fact, one of the most



Fig. 7.8 Various tourism resources, both historic and geologic/geomorphologic, found on St. Kitts and Nevis. **a** Brimstone Hill Fortress National Park—a UNESCO World Heritage Site of historical, cultural, and architectural significance that is a prominent feature on the landscape of the island of St. Kitts. Its construction is a testimony to the ingenuity of British military engineers who designed it and to the skill, strength, and endurance of African slaves who built and maintained it. **b** The historic Church of Immaculate Conception located in Basseterre was built in or about 1856 and grew to become a beacon of Catholicism on St. Kitts during the ensuing years. Steeped in the history and traditions of Portuguese and Irish immigrants, the parish is one of two cathedrals in the Diocese of St. John's-Basseterre. **c** St. George's Anglican Church in Basseterre, one of the oldest surviving Anglican churches in the English-speaking Eastern Caribbean; a major

tourist attraction and landmark on the island of St. Kitts. Its history, which consists of significant impacts by natural hazards (the 1842 earthquake, 1843 hurricane, and several others since 1989), along with human impact (the Great Fire of 1867), is symbolic of the two key influences on the evolution of the landscape on the island. This Church was originally built by the French as a Catholic Church but was subsequently burnt by English soldiers and rebuilt. **d** A green clock tower and water fountain that is known as Piccadilly Circus, or The Circus marks the main square of Basseterre, the Capital City of St. Kitts. This area was once a slave market for African slaves, who were one of the driving forces in the modification of the landscape on the island. It is a memorial to the former president of the General Legislative Council, Thomas Berkeley courtesy of R. Robertson, The UWI Seismic Research Centre

diverse natural communities on St. Kitts. Frigate Bay Salt Pond is located in an area that supports a number of bird species and is linked to the breeding of three such species. There are plans for its rehabilitation and generation of eco-tourism and educational experiences.

Two key NGOs remain actively involved in projects related to heritage conservation, environmental management, and protection in St. Kitts and Nevis: the *Saint Christopher National Trust* (SCNT) and the *Nevis Historical and*

Conservation Society (NHCS). The SCNT evolved from the St. Christopher Heritage Society, which was incorporated as a private company in 1994. The Trust manages the National Museum in the Old Treasury Building in Basseterre and has as its key objective the protection, conservation, interpretation, and enhancement of the natural environment of St. Kitts, including its animals and plant life. The Trust provides a forum for the exchange of ideas, information, and knowledge on a range of issues related to conservation and

heritage. The NHCS, established in 1980 to conserve the natural, cultural, and historic resources of Nevis, and its adjacent marine areas have worked to institute projects and policies designed not only to preserve Nevis' unique history and environment, but also to make that heritage accessible and intelligible to locals and visitors to the island.

7.6 Hazards

St. Kitts and Nevis remain exposed to a wide range of hazards, similar to other islands in the Lesser Antilles: hurricanes, floods, droughts, landslides, earthquakes, and volcanic activity. An estimated 39% of the population is considered to be at risk from such hazards (GFDRR 2010). The islands are among the top 60 countries exposed to risk of mortality and within the top 40 who would suffer significant economic risk from two or more hazards (GFDRR 2010). Risk to GDP is estimated to be 65% (GFDRR 2010). Destruction caused by natural disasters has had a negative impact on tourist arrivals and as such affects an important foreign exchange service sector.

The principal hazards affecting both islands are those related to hydro-meteorological events (high winds and rainfall due to tropical storms and hurricanes). The tendency toward urbanization with its resulting increased exposure to wind damage makes the islands increasingly vulnerable to wind storms. In addition, tourism development, the main trust for the island's economic development, is focused in the coastal zone, which is exposed to hurricane and storm surge impacts. The islands' topography limits the areas prone to the flooding which invariably results from prolonged rainfall and storm surge events, resulting in relatively few flood-prone areas. Those places prone to flooding, however, are usually located in low-lying coastal areas (e.g., coastal fishing villages) and along stream passages, and given that the general preference on St. Kitts to live in low-lying areas close to the sea, vulnerability to flooding and related storm surges is high. This is less so in Nevis where the settlement pattern is more dispersed, due to its legacy farming practices. Areas used for tourism and port facilities, however, are particularly exposed to storm surge events since these are also located near the coastline.

Hurricanes have had the most devastating effect on the islands with over 20 named storms passing within 60 nautical miles of the Federation between 1995 and 2004 (Carter 2010). Nine of these (three in particular were Category 3 or higher) made landfall on the territory. Hurricane damage to St. Kitts and Nevis was estimated at 85 and 140% of GDP in 1995 and 1998, respectively—significantly impacting the economy. In 1998, damages of Hurricane George were estimated to be US\$445 million, including damage to 80% of the housing (GFDRR 2010). This hurricane significantly

impacted not only natural resources closely linked to economic activities, but also funds required for rebuilding infrastructure and provision of social services. In 2008, Hurricane Omar, a Category 4 storm, passed 150 km east of the islands, but still caused significant damage from wind and storm surge.

Perhaps the greatest hazard potential lies in St. Kitts' and Nevis' volcanic origins. Mt. Liamuiga, the active volcanic center on St. Kitts, is considered likely to erupt in the future despite not currently showing any signs of increased activity (Robertson 2005). Based on its history, future events are likely to be explosive magmatic eruptions accompanied by the formation of a lava dome. The most devastating volcanic hazards (pyroclastic density currents and lahars) are gravity controlled, and strongly affected by St. Kitts' topography, relegating these major impacts to river valleys and associated outwash plains. This will most directly affect the northern parts of the island, but thick ash fall deposits could extend as far as the southern parts of the island, posing a threat to aviation especially (Robertson 2005).

Nevis Peak represents the active center on Nevis and the most likely location of future eruptions for that island. Although there have been no recent signs of increased activity, frequent shallow earthquake swarms and hydrothermal activity indicate that this center is still volcanically active, and an increase in activity could occur in the future (Simpson 2005). Based on past eruptions, the most likely future event would be a lava dome-forming eruption from the summit of Nevis Peak. Given the size of the island and the potential impact of hazardous volcanic activity, a major volcanic eruption would require the evacuation of the entire island (Simpson 2005). The Southern Peninsula of St. Kitts could also be affected by ash fall from an eruption of Nevis Peak.

7.7 Conclusion

The Federation of St. Kitts and Nevis is unique in the region in terms of the openness of its landscape and the bifurcated nature of its governance. Its volcanic geology has imprinted itself on all aspects of the landscape with densely vegetated central volcanic mountains that help seed the islands water supply, surrounded by gently sloping pyroclastic fans that have provided rich soils for agriculture and land for settlement. This picturesque landscape has been able to withstand decades of mono-crop agriculture and remains supportive of continued farming, settlement, and infrastructure.

The island has a rich history beginning with settlement by migratory Amerindian peoples originating in South America to eventual and subsequent conquests by the Spanish, French, and British colonial powers. After several decades of relative neglect, the islands rose in importance to at one time being the base for French and British colonial expansion in

the region. With the onset of plantation agriculture built on African slave labor, the island was for many decades dominated by sugarcane cultivation, which left a lasting legacy on the landscape.

The interaction of people and the environment has also left its imprint on flora and fauna, to the point that very few untouched areas remain. With increasing realization of the importance of careful environmental management to help ensure sustainable development, there has been greater emphasis placed on implementation of policies and guidelines backed by laws to enforce a more careful management of the land. Like other Lesser Antillean countries, St. Kitts and Nevis continue to struggle with the challenges of Small Island Developing States, while seeking to develop to their fullest potential. The fundamental importance of its landscape and the impact of its geology on all facets of life on the island remain evident. Maintaining an appropriate balance between the demands of economic development while minimizing harmful impacts on the environment will continue to be a challenge well into the future.

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