1. NATIONAL CIRCUMSTANCES 1994

The twin island Federation of St. Kitts and Nevis consists of two islands located in the northern part of the Lesser Antilles chain of islands in the Eastern Caribbean. St. Kitts is located at latitude 17^0 15' north and longitude $62^0$45' west and Nevis is located two miles (3 km) to the south-east, at 17^0 10' north and longitude $62^0$35' west.

First settled by the British in 1623, the islands became an associated state with full internal autonomy in 1967 as a tri-island state comprised of St. Kitts, Nevis and Anguilla. The island of Anguilla seceded in 1971.

Saint Kitts and Nevis achieved independence in 1983.

The Federation of St. Kitts & Nevis is a constitutional monarchy within the Commonwealth of Nations. Her Majesty, Queen Elizabeth II, is Head of State and is represented on the islands by a Governor-General.

The Government is run by an elected Prime Minister and comprised of eleven (11) elected representatives and three (3) appointed Senators.

1.1. PHYSICAL CHARACTERISTICS

1.1.1. Size

The Federation of St. Kitts and Nevis has a land area of 269 sq. km. (104 sq. miles).

The larger of the two islands, St. Kitts is 176 sq. km. (68 sq. mi.) in area. It is approximately 36.8 km (23 mi) long and is roughly oval in shape with a narrow neck of land extending like a handle from the southeastern end. Nevis has an area of 93 sq. km. (36 sq. mi), with a length of 12.3 km (7.64 mi) and a width of 9.6 km (5.96 mi) at its widest point.

1.1.2. Topography

(a) St. Kitts

The physical landscape of St. Kitts is characterised by three volcanic centres:

- the central northwest range, dominated by Mt. Liamuiga, which rises with a pronounced crater to 1,156 meters (3,792 ft). It is the Federation's highest peak.

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- the middle range, which consists of a number of irregular related peaks dominated by Vrechild's mountain at a height of 975 meters (3,200 ft). The slopes in this range are steeper and shorter towards the leeward coast.

- the southeast range, which consists of a number of irregular peaks, with the highest being 900 meters (2,953 feet) above mean sea level. Like the middle range, the

slopes here are steeper and shorter on the leeward side.

The middle and southeast ranges are separated by a broad gently sloping saddle of about 457 meters (1,500 feet) high, known as Phillips and Wingfield levels.

These ranges are complemented by the Canada hills on the northeastern part of the island, which rises to about 335 meters (1,100 feet) and are separated by a deep depression from the Morne and Conaree hills. The latter terminates in the neck of the South-east Peninsula (SEP).

The SEP is largely characterised by tied islands, about one third of a mile wide and with peaks of up to 183 – 213 meters (600 -700 feet). The southern extremity has hills with elevations up to 335 meters (1,100 feet).

The terrain from the central mountain ranges slopes down steeply from the peaks, flattening out to gentle slopes and low cliffs towards the coastal fringe. Minor domes protrude from these lower slopes at Brimstone Hill, Ottley's Mountain, Sandy Point Hill and Monkey Hill. The slopes are characterised by deeply incised ghauts with steep sides, which act as the primary channels for drainage.

Most flat or moderately sloped land occurs near the coast, and as a result, most urban and agricultural developments have occurred there.

The island's coastline largely consists of cliffs, some 15 – 30 meters (50 to 100 feet) high. Beaches at the foot of these cliffs are narrow and the sand is coarse and black, with many pebbles and boulders. Exceptions are in the northwest, where the cliffs are lower and some beaches have yellow sand and are wider. In Basseterre where there are cliffs, there is a narrow beach of grey sand. From Conaree, on to the southeast of the island, there are long stretches of fine yellow sand beaches.

(b) Nevis

Topographically, Nevis is approximately circular and dominated by the central Nevis Peak, 985 m (3,232 ft.) high. Windy Hill (309m) and Saddle Hill (381m) at the head and tail of the island, respectively, align with Nevis Peak to form a north-northwest/south-south-east trending spine comparable to the more pronounced spine of St. Kitts. To the east, the spine is thickened by the bulge of Butlers Mountain (478m). Slopes vary from almost zero near the sea, to over 40 percent in the vicinity of Saddle Hill, Butlers Mountain, Nevis Peak and Windy Hill.

1.1.3. Geology

(a) St. Kitts

The islands are the summits of a submerged mountain range that forms the eastern boundary of what is known as the Caribbean Tectonic Plate. The entire island archipelago is geologically young, having begun to form probably less than 50 million years ago, during the Miocene era. Volcanic activity occurred along the ridges of this arc during the

Miocene era and has continued since (*Lang and Caroll, 1964*).

St. Kitts has since undergone numerous and considerable changes in elevation but is now relatively stable. Newer volcanics rest on a basement of older rocks, now only exposed where the newer deposits have been denuded. Mt. Liamuiga, the most northerly volcano has a youthful appearance and was active in recent (geologic) time.

No obvious geologic faults can be observed, although several lineations have been noted which may be deeper faults masked by volcanic ejects. The island is composed almost exclusively of volcanic rocks of andesite or dacite mineralogy. Most of the deposits are pyroclastics and range in size from silt-sized particles to boulders several feet in diameter.

(b) Nevis

Although Nevis is primarily a volcanic island, the oldest rocks are of marine origin. On the southern slopes of Saddle Hill, an obscure outcrop of conglomerate yields blocks of recrystallised limestone that contain foraminiferids of mid-Eocene age. The next oldest rocks are volcanic, and much younger, being erupted during Pliocene time. The older volcanics crop out on the northwestern coast, while the youngest form Nevis Peak. Saddle Hill to the south is of intermediate age.

1.1.4. Soils

The soils of both islands have been studied and described in detail by Lang and Carroll (1966). Edaphic conditions have been greatly influenced by the islands' volcanic origins and soils of a given type are in most cases a product of the extent to which a given volcanic parent material has weathered.

(a) St. Kitts

Generally, the soils of St. Kitts can be placed into groups and types as shown in **Table 1.1.** Lang and Carroll (1966) grouped the soils according to the clay development and weathering of primary materials and defined seven broad groups.

Table 1.1. Soil Groups in St. Kitts

GROUP	STAGE OF DEVELOPMENT	WEATHERING STAGE
Protosols	Without clay development.	0
Young soils	Without marked clay development.	1
Smectoid Clay soils	Marked clay development.	0 - 3
Allophanoid Latosolics	Marked clay development.	2 - 5
Kandoid Latosolics	Marked clay development.	2 - 5
"Mixed clay" Latosolics	Marked clay development.	2 - 5
Kandoid Latosols	Marked clay development.	6 - 7

Source: Lang and Carroll (1966)

The soils of the lower slopes are developed in deep, coarse-textured and often gravely and bouldery volcanic ash. They are excessively well drained with low water holding capacities, and they have a low clay and organic matter content.

At about the 150 meter (500-foot) ash contour, the soils are wetter and show greater weathering and profile development. They have low clay content but higher contents of silt and fine sand. They have a higher water-holding capacity than the younger soils down slope, and are more leached but still have a high inherent nutrient level.

The soils of the mountains above the 300-meter (1000-foot) ash contour have the greatest profile development with high clay contents and bright reddish or brownish colours due to the presence of free iron oxides. They have finer textures and high water holding capacities. They are more leached than the soils down slope, but still appear to be moderately fertile with high levels of organic matter.

(b) Nevis

The three primary soil types of Nevis are as follows:

- A *Red-Brown Earth* at the summit of Nevis Peak. This soil is mature, but strongly acidic and of little agricultural importance.

- A *Brown-Yellow Earth*, which encircles the area of the Red-Brown Earth type. This is good agricultural soil but contains many boulders that limit mechanised methods of cultivation.

- A *"shoal" soil*, which occurs in low-lying areas. Lying on volcanigenic sediments, this soil is loamy by clayey and difficult to cultivate.

1.1.5. Forest

(a) St. Kitts

The vegetation of St. Kitts provides evidence of great disturbance by human activity. In the lowland areas, intensive land use has removed all vestiges of the natural vegetation. Although the mountain peaks are still covered by forest, they do not have virgin forest characteristics. Lower slopes are covered by secondary growth on abandoned farms. The vegetation, which comprises about 243 species of trees (*Beard, 1949*), supports wildlife.

Beard (1949), described five (5) forest type remnants of the original vegetative cover, viz:

- *Rain Forest* - dominated by the mountain cabbage palm, with large trees of gumlin (*Dacryodes excelsa)* and burrwood (*Solanea spp).* There are 600 - 700 acres of this formation in St. Kitts on either side of the Olivees range.

- *Dry Evergreen Forest* - secondary forest occupying the lower margins of the forest, usually on land thrown out of cultivation. This group includes the useful sweetwood (*Lauraceae spp.)* and small-leaf (*Myrtaceae spp.)* families. The undergrowth consists of densely growing shrubs and vines such as *Piper spp.* and various coffee type plants. The formation is of limited area.

- *Palm Brake* - covering land between an elevation of 1200 and 1800 feet. The forest

consists mainly of the mountain cabbage palm (*Euterpe globosa),* with a few tree-ferns and small trees.

- *Elfin Woodland* - appearing on peaks and ridges above 2000 feet. This is a low, tangled and windswept growth, loaded with epiphytes and mosses. This, together with Palm Brake, forms the vegetation of the summits of the ridges and peaks.

- *Dry Scrub Woodland* - of the SEP. Beard suggests that this type has been heavily impacted by the past. The SEP and its extension into the Canada Hills were probably once forested with deciduous seasonal forest, but now supports a xerophytic scrub of acacia, agave, columnar and Turk's Head cacti.

(b) Nevis

The vegetative zones of Nevis follow the pattern typical of small, volcanic Caribbean islands. Nevis has, according to Beard (1949), six vegetation zones. They are:

- *Rain Forest and Humid Forest* - The only substantial stand of tall trees is on the northwestern side of the mountain above Jessups. The dominant species are the mountain cabbage palm (*Euterpe globosa*), gumlin (*Dacryodes excelsa)* and burrwood (*Solanea spp).*

- *Elfin Woodland* - The summit of Nevis Peak is covered with low, gnarled tangled growth. This forest is usually under three metres high and laden with moss and epiphytes and matted with lianas.

- *Monthane Thicket* - A very thin belt located just above the rain forest on the west side of the mountain. This area is dominated by weedee (*Podocarpus coriceus*) and mountain cabbage palm.

- *Palm Brake* - This is a band of montane forest located on very steep slopes, or in areas exposed to high winds. This zone is dominated by mountain cabbage palm and the rest of the forest consists of tree ferns (*Cyathea arborea*).

- *Dry Scrub Woodland* - The low hills of Nevis (e.g. Round Hill and Saddle Hill) consist of a patchy, scrub woodland. The prominent trees are various species of acacia and cassia, together with century plant (*Agave americana*), prickly pear cactus (*Opuntia rubescens*) and pope's head or barrel cactus (*Euphorbia pulcherrima*). Most of the southern coast of the island from Baths Plain to Indian Castle consists of cactus scrub woodland.

- *Dry Evergreen Forest* - The lower slopes of Nevis Peak that extend north and east are covered with an evergreen forest of small trees. The most prominent trees are white cedar (*Tabebuia heterophylla*), black mast (*Diosyros ebenaster*) and loblolly (*Pisonia fragans*).

1.1.6. Coastal Ecosystems

(a) St. Kitts

The coastal and marine ecosystems in St. Kitts include coral reefs, sea grass beds, mangroves, salt ponds, diverse aquatic life and the coastline. As an island territory, St. Kitts has a fragile 78.1 km long coastline consisting of 34.7 km cliff (rocks), 10.8 km cobble, 6.3 km boulders and rocks, 13.1 km black volcanic sand, and 13.2 km golden sand.

Both coral reef and sea grass communities contribute to the following environmental processes:

- Provide habitat for commercially important fish species for example spiny lobster and queen conch depend upon both habitats at certain periods in their life cycles.

- Produce nutrients that are important in sustaining the life of fish species and other organisms.

The reefs also act as barriers during periods of heavy wave attack, and are important contributors to white sands.

Mangroves are not abundant. The main and most extensive mangrove habitat in St. Kitts occur in the SEP. Hawksbill and green sea turtles are found around the entire coast. In addition, there is a large number of resident and migratory birds that depend on the mangrove and pond communities for feeding and nesting.

(b) Nevis

Shoreline features of Nevis include sandy beaches, fresh water lagoons, rocky shores and massive sea cliffs. The most prominent sandy beach is a 4 km section of the coastline that stretches north from Charlestown to Cades Bay, called Pinneys Beach. It is composed of both coral fragments and terrestrial soils that give it a yellow appearance and is typical of a number of beaches found along the leeward coast of the island.

Another feature associated with the leeward coastline of Nevis is its system of freshwater lagoons. These may be the result of either mountain ghaut run-off, as is the case for the Pinneys Estate lagoons, or underground springs as evidenced at Nelson Springs in Cotton Ground.

Rocky shores are often associated with an impressive array of marine life from algae and snails to juvenile fishes of all description. Sea cliffs are found where strong wave energy undercuts rocky ledges and erodes soil from agglomerate and unconsolidated rock. These rugged habitats can be found on the southern and eastern coasts of Nevis.

Three coastal habitats -- freshwater lagoons, coral reefs, and seagrass beds -- are of critical importance to the nearshore tropical marine ecosystems of Nevis. There are many direct and indirect links between the productivity of these habitats and the health of inshore fisheries.

All of these linked ecosystems are presently being stressed by a variety of externalities, viz:

- Excessive sediments and agro-chemicals in run-off waters are altering food chains and reducing water quality.

- The draining and filling of coastal lagoons is upsetting the flow of nutrients from the terrestrial ecosystem into the adjacent coral reefs and seagrass system.

- Landfill of lagoon habitats is eliminating important nursery areas for fishes, crustaceans and avian species.

1.2 CLIMATE

The climate of the Federation of St. Kitts and Nevis is classified as tropical marine. Generally, it is influenced by steady northeast trade winds and tropical oceanic and cyclonic movements.

1.2.1 Humidity

The relative humidity is fairly high all year round - approximately 75% - 80%. It is usually low in the dry season and high in the wet season. The mean value is 76%, but it ranges from 70% in March, to 78% in September, October and November.

1.2.2 Rainfall

Rainfall is mainly cyclonic and orographic and increases in amount and frequency with altitude. Mean annual rainfall ranges from about 890 – 1000 mm (35 - 40 inches) in the coastal areas, to about 2500 – 3800 mm (100 - 150 inches) in the central mountain ranges. The rainfall is unevenly distributed between years and between months, but there is a reliable wet period from August to September and a dry period from January - April.

1.2.3 Temperature

Temperatures average approximately 27^0 Celsius. Seasonal and diurnal variations in temperature are small.

1.2.4 Hurricanes and Other Natural Hazards

(a) Hurricanes

The Federation is particularly vulnerable to damage from tropical storms. Since 1989, eight storms have affected the country - Hugo, Felix, Gilbert, Iris, Luis, Marilyn, Bertha and Georges. Damage from Hurricane Hugo (1989) has been estimated at E.C. $117 million (US$43 M), from Hurricane Luis and Marilyn (1995) at E.C. $149 million (US$55M), and from Hurricane Georges (1998) at E.C. $200 million (US$74M).

These costs underestimate the actual magnitude of the economic impacts, as they do not

account for private expenditures, as when private insurance claims are paid, or restoration and repairs are done with insurance. Nor do they account for repairs that are not done, as when buildings are left abandoned and derelict. They also do not account for the revenues lost to business, or lost tourist dollars, and they do not reflect the costs in human suffering and grief that accompany major storms.

(b) Earthquakes

Earthquakes in the Federation are derived directly from the tectonic interaction of the Caribbean and Atlantic Plates, and indirectly from volcanic activity also associated with these tectonic plates. A secondary concern is that of earthquake (and volcanic) driven tsunamis ("tidal waves"), which could cause considerable damage and loss of life in low lying, densely populated coastal areas.

(c) Volcanic Activity

There is no historic record of major volcanic eruption with attendant loss of property and life. Nevertheless, the islands are geologically young, and experience minor activity at their Mt. Liamuiga and Nevis Peak outlets.

1.3 SOCIAL CHARACTERISTICS

1.3.1 Human Settlements

(a) St. Kitts

The settlement pattern in St. Kitts consists of a series of small villages along the island main road, which passes very close to the coastline. There is a concentration in the Basseterre capital region, where about 40% of the population resides. There is a general preference for living near the coastline, primarily because most of the upland interior land is very rugged and steep with some sections being under the forest reserve and the remaining areas are intensely cultivated with sugar cane.

The rural landscape is dominated by sugar cane plantations, with settlements interspersed in between. The increasing demand for agricultural land has, in recent decades, resulted in many small farmers clearing forested land in the upper slopes for farming. Such encroachment results in deforestation, soil erosion, and pollution of stream rivers and coastal waters.

The rural areas are characterized by ribbon developments, none of which can be said to have occurred as part of a planned physical development strategy, although there are a handful of locations where planned developments have been implemented.

The major urban areas are Basseterre - the capital city, Sandy Point and Cayon. The drift from rural to urban areas over the past two decades has led to Basseterre becoming over-crowded. Sandy Point and Cayon are also experiencing expansion related problems.

The city centre is, for the most part, well planned, being laid out on a grid-iron pattern. Near to the city centre, there are some other areas of well-planned low-to medium-density suburbs (Shadwell, Wades Garden, Ponds Pasture and Fortlands). Interspersed amongst these, are a few areas of high density residential developments.

In recent years, the city centre has become increasingly congested and its infrastructure is approaching saturation levels. There is scope however to expand outwards, with the availability of 10 hectares (25 acres) of land newly reclaimed from the sea and the construction of a new sea port (Port Zante) in the close vicinity.

In the last 10 years, Basseterre has experienced significant growth of dormitory suburbs at Mattingley, Bird Rock and Earl Morne. In addition, it is also experiencing commercial and industrial expansion on the margins of the town. The traditional suburbs of the capital, Mc Knight, Irish Town and Newtown, where the great majority of the city's population live, are for the most part poorly planned and present formidable challenges in terms of adequate housing, services and infrastructure provision. Urban renewal programmes appear to be necessary in these areas.

Other major land uses in the urban zone include:

- the Robert L. Bradshaw Airport, which lies close to the urban area;
- a variety of social infrastructure and institutions including schools, hospitals and churches;
- significant areas of urban open spaces including park, square, playing fields;
- cemeteries; and
- major infrastructure installations, including the power station.

(b) Nevis

Like St. Kitts, the population is concentrated in the capital, Charlestown. Most villages follow ribbon-style development along the island main road.

There is more evidence of dispersed settlement patterns than in St. Kitts, primarily due to the construction of large homes on large land plots mostly by the expatriate community.

1.3.2 Population Dynamics

(a) Size

The population of the Federation in 1994 was 43,050. It has been relatively stable over the last 100 years, primarily as a result of migration – **Table 1.2.** Most of this migration was to final destinations outside the country, with citizens migrating to the Bermuda dockyards, the United States, the cane fields of the Dominican Republic, the United Kingdom, Aruba, Curacao, U.S. Virgin Islands and Canada in the early part of the century (*St. Kitts and*

Nevis Country Environmental Profile (CEP), 1991) and to North America and the United Kingdom since the 1960's.

In the 1970's, direct migration to North America continued, though movements to the United Kingdom were greatly reduced from the levels of previous decade. From the early 1970's to the present, there has been an increase in intra-regional migration, with the majority of migrants moving to other Caribbean Islands, such as the Virgin Islands, Puerto Rico and St. Maarten.

Table 1.2. Intercensal Population Estimates

Census Year	Total Population At End Of Interval	Total Growth	Intercensal Change (%)	Annual Rate Of Change (%)
1871	39,872			
1881	41,001	1,129	2.83	0.28
1891	43,963	2,962	7.22	0.70
1901	42,556	(1,407)	(3.20)	(0.32)
1911	39,228	(3,328)	(7.82)	(0.81)
1921	33,984	(5,244)	(13.37)	(1.42)
1946	41,206	7,222	21.25	0.77
1960	50,883	9,677	23.48	1.52
1970	44,884	(5,999)	(11.79)	(1.25)
1980	43,309	(1,575)	(3.51)	(0.36)
1991	40,618	(2,691)	(6.21)	(0.58)

Source: GOSKN

The effect of this net migration has been supported by a decline in the crude birth rate since the 1970's in the face of a relatively stable death rate – **Table 1.3.**

The recent demographic estimates in **Table 1.4** indicate that the population has grown marginally in the decade of the nineties.

Table 1.3. Crude Birth/Death Rates

YEAR	Crude Birth Rate	Crude Death Rate
1980	27.0	11.4
1985	23.3	10.0
1990	23.1	10.8
1991	22.3	9.7
1992	19.7	9.1
1993	19.5	9.0
1994	***21.9***	***9.3***
1995	18.3	9.7
1996	19.7	11.2
1997	21.5	9.7
1998	21.6	9.7

Source: GOSKN

(b) Age Profile

The population is a relatively young one. In 1999, an estimated 47.4% of the population was under the age of 25 and 29.3% under age 15.

The highest percentages in terms of population distribution are in the 0-4 range (10%), the 5-9 age range (9.8%), 10-14 (9.5%) and the 15-19 age range (9.4%).

Table 1.4.
Mid- Year Population

Year	Population Estimate
1990	41,870
1991	41,000
1992	42,670
1993	43,520
1994	***43,050***
1995	43,530
1996	42,280
1997	40,740
1998	40,130
1999	42,460

Source: GOSKN

The age cohort of 65 and over consists of approximately 8.9% of the population. Though the proportion is still small, there are signs that the relative aging of the population has begun.

(c) Gender Distribution

Approximately 50.3% of the population in 1999 was males, while the remaining 49.7% were females. It was only in the age range 65 and over, that females outnumbered men. This is reflective of the longer life expectancy of females.

(d) Household Size

Mean household size has been decreasing for the past 25 years. In 1970, it was 3.9 persons, by 1980 it had reached 3.7 persons, whilst in 1991 the mean household size was 3.4 persons. The current trend therefore is for smaller, but more numerous, households.

(e) Ethnicity

The population of St. Kitts and Nevis is largely of African descent. The 1991 Population Census indicated that 95% of the population was of African descent, 3% was mixed and 1.4% white. More recently, there has been some change in the ethnic mix of the population. This has been due in part to the influx of a number of Guyanese of East India descent, as well as Hispanics from the Dominican Republic.

1.3.3. Health Services

Health services are provided by both the public and the private sectors.

At the primary health care level, there are ten (10) government-owned health centers in St. Kitts which are located at: Basseterre (2), Old Road, Sandy Point, St. Paul, Dieppe Bay, Saddlers, Tabernacle, Cayon and St. Peters. Nevis also has a number of health centers which cater to the primary health needs of communities in maternal and child health care, family life education, diabetic and hypertension monitoring, dental health, mental health and home visitation for disease surveillance.

Secondary level health services are provided by two (2) district hospitals in St. Kitts -- Pogson Hospital in Sandy Point and Mary Charles Hospital in Molineux.

Tertiary level services are centralised in the two capital cities and are provided by Joseph Nathaniel France (JNF) Hospital in Basseterre and the Alexandra Hospital in Charlestown. These hospitals provide in-patient and outpatient services, together with a wide range of specialist services as well. The present capacity is 268 beds. At the time of this writing, the JNF Hospital in St. Kitts is undergoing extensive upgrading.

1.3.4. Life Expectancy

Average life expectancy in 1994 was 68.9 years, with females having a higher life expectancy (70.35) than men (67.41) – **Table 1.5.**

The increase in life expectancy since the early 1980's has been due to general improvements in the quality of life of the citizens and to an improvement in the delivery of health care systems.

Table 1.5. – Life Expectancy

PERIOD	MALE	FEMALE
1982	64.10	68.46
1985	65.99	69.67
1990	66.11	70.58
1991	65.10	70.08
1992	67.24	72.10
1993	67.86	71.14
1994	*67.41*	*70.35*
1995	67.87	72.96
1996	68.23	71.61
1997	67.67	71.10
1997	68.21	70.66

Source: GOSKN

1.3.5. Education

The GOSKN offers education at the following levels - day-care, nursery, primary, secondary, tertiary and adult.

(a) Nursery

While many children attend nursery schools prior to the age of five (5), early childhood education is almost entirely in the hands of the private sector. In 1998, there were sixty-two (62) early childhood development centers, of which fifty were privately owned and twelve were government-owned.

(b) Primary

There were twenty-three (23) primary schools on St. Kitts. Of the total number, sixteen (16) were government-owned and seven (7) were privately owned.

Over the period 1981- 96, the average teacher-pupil ratio declined from 1:25 to 1:21, whereby the total enrollment (in public primary schools) decreased by 12% from 5,409 in 1981 - 82 to 4,782 in 1995 - 96. The total number of schools decreased from nineteen (19) to sixteen (16) and the number of teachers increased from 216 to 228, an increase of 6%.

(c) Secondary

There were six (6) secondary schools on St. Kitts and two (2) on Nevis. All of the schools except the Convent Secondary were government-owned.

Over the period 1981 – 1996:

- the total number of public secondary schools increased from four (4) to five (5).
- the number of teachers increased from 195 to 268, a growth of 37%.
- the total enrollment increased by 16%.
- the teacher-pupil ratio declined from 1:17 to 1:14.

(d) Tertiary

There were three (3) tertiary education institutions, viz:

- the *Clarence Fitzroy Bryant College* - which is composed of the Divisions of Arts and Sciences, Teacher Education, Technical and Vocational Studies and Health Sciences.
- *Ross University* - which provides veterinary science studies.
- the *University of the West Indies* Center.

1.3.6. Adult Literacy

The Federation has a comprehensive education system that provides for "*Education for All*". Programmes are geared toward the achievement of high literacy rates and include early childhood to adult education strategies. As a result, literacy rates exceed 90%.

1.3.7. Poverty

(a) St. Kitts

The Poverty Assessment Report (2001) reported that 30.5 percent, or a little less than 1 in 3 individuals in St. Kitts are poor. This means that their monthly expenditure is less than the cost of meeting their minimal food and other basic requirements - the poverty line was estimated at EC $280.05 (US$103.72) per month for an individual.

11 percent, or slightly more than 1 in 10 individuals in the country, were found to be extremely poor or indigent - the indigence line was EC $177.94 (US$65.90) per month.

More than two-thirds of the poor (67.8%) are under 25 years of age. Males were 44 percent of the poor and women 56 percent. Twenty-nine percent of males were poor and 32 percent of women are poor.

(b) Nevis

On Nevis, 32 percent or a little less than 1 in 3 individuals are poor. This means that their monthly expenditure is less than the cost of meeting minimal food and other basic requirements or less than E.C. $328.40 (US$121.63).

17 percent of all individual are extremely poor or indigent, and do not have the E.C. $204.40 (US$75.70) necessary to meet their dietary needs.

Fifty-eight percent of the poor are under the age of 25. Males make up 37 percent of the poor and females 63 percent. Twenty-six percent of males are poor and females account for 36 percent of the poor.

1.4 ECONOMIC CHARACTERISTICS

1.4.1. Gross Domestic Product (GDP)

The economy of the Federation of St. Kitts and Nevis experienced positive GDP growth for the decade of the nineties. In 1994, the GDP was US$156.3 M[1] and this had grown to US$192.6M by 1999.

1.4.2. Main Economic Sectors

The major economic sectors in 1994 (**Fig 1.1.**) were:

- Government Services – 16.53%
- Wholesale and Retail Trade – 14%
- Construction – 12.65%
- Manufacturing – 11.45%
- Banks and Insurance – 10.04%.

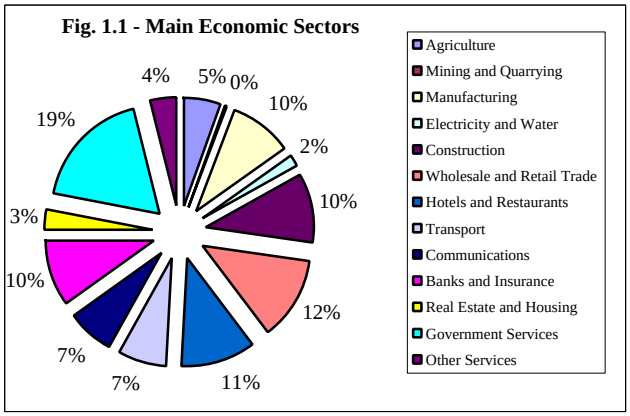
During the 1995 – 2000 period, there were some changes in this sectoral contribution with significant growth occurring in the contribution of the construction sectors and declines in Government Services, Hotels and Restaurants and Agriculture -**Table 1.7**.

Table 1.6 – Table of National Circumstances

CRITERIA	1994
Population	43,050
Relevant areas (square kilometres)	269
GDP (1994 USM$)*	$156.3
GDP per capita (1994 US$)**	$4,350
Estimated share of the informal sector in the economy in GDP (percentage)	Not Available
Share of industry in GDP (percentage)***	25.45 (23.20^{+})
Share of services in GDP (percentage)***	68.12 (71.02^{+})
Share of agriculture in GDP (percentage)***	6.42 (5.78^{+})
Land area used for agricultural purposes (square kilometres)	70.01
Urban population as percentage of total population	44.7
Livestock population (Total) - **Cattle** - **Sheep** - **Goat** - **Pigs**	42,050 2,050 18,000 17,500 4,500
Forest area (square kilometre, define as appropriate)	84
Population in absolute poverty	5,033
Life expectancy at birth (years)	68.9
Literacy rate	90%

* *Base data for constant or Real GDP in 1990 prices*
** *GDP per capita expressed as current (inflation not considered)*
*** *Constant or Real GDP based on 1990 prices*
$^{+}$ *Current GDP*

Fig. 1.1 - Main Economic Sectors



[1] *GDP at factor cost in constant 1990 prices*

Table 1.7 - Percentage Contribution to GDP of Selected Sectors 1995 - 2000

SECTOR	1995	1996	1997	1998	1999	2000
Agriculture	5.86	6.08	6.84	5.98	5.24	4.52
Manufacturing	11.21	11.14	11.55	11.33	11.79	12.15
Construction	13.63	13.51	13.35	14.14	15.35	18.65
Wholesale and Retail	14.80	14.8	14.56	15.01	15.01	14.85
Hotels And Restaurants	6.92	7.13	6.99	7.08	5.96	4.98
Transport	8.20	7.91	7.86	7.75	7.60	7.45
Communications	9.41	9.90	9.74	9.73	10.32	9.58
Banking and Insurance	11.38	11.74	12.33	12.2	12.16	12.63
Government Services	16.20	15.95	15.32	15.88	15.72	14.98

Source: Statistics Department, Planning Unit

1.4.3. Macro-economic Indicators

(a) Per Capita Income

The per capita income in 1994 was US$4,350. By 1998, it had risen to US$6,184.

(b) Employment

The labour market is characterised by relatively low unemployment. Unemployment estimates are not undertaken regularly, but an Organisation of American States financed study estimated the unemployment rate at between 4.3% and 11.3% in 1994.

Most of the unemployment that existed appeared to be structural and could be addressed by retraining. The St. Kitts Sugar Manufacturing Company (SSMC) has had to import labour in order to relieve shortages that are generated by the divergence between the wages and working conditions existent in the sugar industry and those desired by the labour available domestically.

There are signs that tourism's rapid growth is forcing labour market changes. It has pulled up wages in the construction and tourism related sectors, creating wage disparities and causing labour shortages in the traditional sectors of agriculture and low-skilled manufacturing.

These pressures appear to be particularly evident in Nevis, where the opening of a major resort in 1992 has reversed inter-island migration patterns within the Federation. Most wage rates are above the minimum levels, which were last revised upwards in October 1994.

(c) Inflation

Inflation, as measured by changes in the Consumer Price Index (CPI), ranged between 1.5% and 5.4% per year during 1990-99.

(d) Public Debt

The public debt was in 1994 was 46.4% of GDP. By the end of 1999, it had risen to 69.6% of GDP.

A significant portion of the increased borrowing had been on commercial terms. This increase in commercial borrowing resulted in a rise in the effective interest rate on the debt from 4.4% in 1995 to 5.9% by 1999. Consequently, debt service climbed from 15.6% of current revenue in 1995, to 25.9% in 1999.

(f) Exchange Rates

The Federation shares a common currency with the rest of the Organisation of Eastern Caribbean States (OECS) – the Eastern Caribbean dollar (EC$). The EC exchange rate is set by the Eastern Caribbean Central Bank (ECCB) and has been pegged to the United States dollar (US$) at a rate of US$1.00 to EC$2.70, since 1983.

1.5. INFRASTRUCTURE

1.5.1. Roads

(a) St. Kitts

St. Kitts has approximately 99.1km of paved roads, 40.1km of unpaved roads and 60.0km of track (*SEP Land Use Development Plan*). The island is served by an island ring main road that is the principal artery for the island's transport network. There are a number of secondary roads that feed into communities and residential areas. Most of these are paved and in fairly good condition, but there are still a number of dirt and unpaved roads within some communities.

There are also a number of feeder roads that were designed to facilitate access to farmlands and are used primarily by the farming communities.

(b) Nevis

On Nevis, the road network consists of 93km of paved roads and 45km of unpaved roads. There is also an island main ring road, with a number of secondary roads linking the communities.

1.5.2. Ports

(a) Airport

The Federation is served by two airports – an international airport in St. Kitts and a smaller domestic airport in Nevis.

(b) Sea Ports

There are two Seaports on St. Kitts, viz:

- The *Deep Water Port*, which serves a dual purpose, that of cargo handling and the docking of cruise ships; and

- Port Zante, which was designed mainly for cruise ships.

The recently constructed Long Point Pier on Nevis is used mainly for cargo handling while the seaport in Charlestown is used chiefly for cargo and passenger movement between both islands and other OECS countries.

2. GREENHOUSE GAS INVENTORY

This Inventory of Net Anthropogenic Emissions by Sources and Removals by Sinks of Greenhouse Gases (GHG's) and related gases, was undertaken in compliance with Articles 4 and 12 of the United Nations Framework Convention on Climate Change (UNFCCC) and in accordance with Inter-Governmental Panel on Climate Change (IPCC) Revised (1996) Guidelines.

The Reference Year was 1994.

2.1. METHODOLOGY

The Inventory of the following main Greenhouse Gases (GHG's) was conducted for the Federation of St. Kitts and Nevis: Carbon Dioxide (CO_2), Methane (CH_4) and Nitrous Oxide (N_2O). Other gases that contribute to Tropospheric Ozone (O_3) formation, such as Non-Methane Volatile Organic Compounds (NMVOC), Carbon Monoxide (CO) and Nitrogen Oxides (NO_x) were also included in the inventory.

The IPCC Revised 1996 Guidelines for National Greenhouse Gas Inventories (*Volumes 1, 2 and 3*) together with the accompanying Software in Microsoft Excel was used as the basis for undertaking the necessary calculations on GHG Emissions by sources and Removals by sinks.

The GHG Inventory was done on an individual sector basis for the Energy, Industrial Processes, Agriculture, Land Use Change and Forestry and Wastes Sectors. The Solvents Sector, for which the IPCC methodology is not yet available, was not undertaken.

In accordance with the Guidelines set out by the IPCC, Carbon Dioxide emissions from International Bunkers and burning of Biomass as an energy source are not included in the national totals, but they are reported separately as Memo Items.

For purposes of verification and transparency, the GHG Inventory has included, as Appendices, the completed relevant IPCC Worksheets for all Sectors, in addition to the Summary Report Sheets, used to prepare the Inventory Report (**See Appendices 1 to 9**).

Uncertainty is also addressed.

2.1.1. Energy Sector

Both the aggregate fuels supply top-down *Reference Approach* and the policy-oriented source categories bottom-up *Sectoral Approach* were used to calculate the GHG Inventory for the Energy Sector.

There is no production of primary and/or secondary fossil fuels in St. Kitts and Nevis. However, secondary liquid fuels including natural gas liquids, gasoline, jet and other (cooking) kerosene, gas oil/diesel, and LPG and small quantities of bitumen, lubricants and other (shale) oil are imported for local consumption – **Table 2.1**.

Table2.1
Supply (Import) of Fuels (kt)

Fuel Imports Categories	(kt)	%
Gasoline	9.02	31.5
Jet Kerosene	2.95	10.31
Other Kerosene	0.15	0.52
Gas / Diesel Oil	2.60	9.09
LPG	13.41	46.9
Bitumen	0.01	0.03
Lubricants	0.45	1.57
Other Oil	0.003	0.01
Total	**28.60**	**100**

CO2 emissions derive mainly from the combustion of these secondary fuels for use in the power-generating utilities, the transport sector, the manufacturing industries, the construction sector and in international bunkers (aviation).

Local activity data for the fuels imported and supplied were converted from barrels (bb) to an appropriate unit (kt) so as to facilitate the direct application of the IPCC Conversion Factor (TJ / kt) and in order to derive the Apparent Consumption in TJ.

In all cases, due to lack of country-specific data, the Default Values of the Conversion, Emission and Carbon Oxidation factors as furnished by the IPCC (1996), were used. Also, when available, default values were extracted from countries of similar characteristics, or from the same geographical area (Antigua and Barbuda, Dominica and St. Lucia).

2.1.2. Memo Items

The current IPCC methodology requires that emissions from International Bunkers and burning of Biomass as a fuel in the energy sector, be reported separately in the GHG Inventory.

(a) CO_2 Emissions from International Bunkers

Emissions from international bunkers are limited to emissions from jet kerosene sold to aircrafts that fly internationally. No fuels were sold to marine international bunkers in 1994.

CO_2 emissions from aviation international bunkers for the year 1994 were calculated using the IPCC Tier 1 approach.

(b) CO_2 Emissions from Biomass Fuels

The biomass fuels that are burned for energy are primarily firewood, charcoal and some agricultural waste.

In 1994, minimal consumption and emission of CO_2, resulted from the combustion of Solid Biomass, also considered as a Memo Item. This was primarily from charcoal firewood and agricultural residue, used for cooking in the residential sector.

2.1.3. Industrial Sector

The Federation does not have a strong Manufacturing or Industrial sector so that CO_2 and

non-CO_2 emissions from light manufacturing or heavy industries are minimal or non-existent. The Food and Beverage industry and Road Paving with Asphalt are the main emitters of non-CO_2 gases in the form of NMVOCs. Furthermore, the consumption and use of halocarbons for air-conditioning and refrigeration causes the release very small quantities of HFCs.

NMVOC emissions derive from bitumen used in road paving asphalt, the manufacture of alcoholic beverages (rum and beer mainly) and food production (bread and cakes, margarine and solid cooking fats and meat, fish and poultry).

HFC emissions, also reported under the Montreal Protocol, derive from the importation and consumption of halocarbons, including leakage and disposal, in refrigeration and air-conditioning activities.

All activity data are country-specific and were obtained from the Physical Planning Unit, Department of Statistics, Government of St. Kitts and Nevis. However, all emission factors were taken as Default Values from the IPCC Workbooks.

For purposes of the inventory, products covered under the Montreal Protocol are not included. Emissions are only calculated for HFC Consumption and Refrigeration Assembly, Operation and Disposal for 1994.

2.1.4. Agriculture Sector

The agriculture sector focuses on sugarcane, vegetables, root and citrus crops, cotton and breadfruit for local consumption.

Non-CO_2 gases, including methane (CH_4) and nitrous oxide (N_2O) are the only perceptible greenhouse gases emitted by the agriculture sector. CH_4 emissions are limited to emissions mainly from enteric fermentation and manure management from animal stocks.

N_2O Emissions derive from nitrogen-rich histosols, fertilizer application to cultivated soils, excretion from grazing animals, atmospheric deposition of NH_3 and NO_x and from leaching of agricultural soils.

Activity data on animal population according to species, for CH_4 and on agricultural soils for N_2O are country-specific and were obtained from the Ministry of Agriculture. Emission factors for enteric fermentation and manure management, in the case of CH_4, and for soil processes in the case of N_2O, were taken as default values from the IPCC Workbooks. Where this was not possible, as for instance emission factors for poultry, this was taken from other similar country reports (St. Lucia, Dominica).

2.1.5. Land Use and Forestry Sector

Since detailed data on Land-Use and Forestry are not available, limited data sets and expert estimations (*Forestry Department, Government of St. Kitts and Nevis*) place total forest acreage, that is anthropogenically-impacted at 8.6 kilohectares, consisting mainly of:

- Mixed Softwoods (2.69 kilohectares)
- Mixed Hardwoods (0.92 kilohectares)
- Other Forests-Moist (0.92 kilohectares)
- Other Forests-Dry (1.03 kilohectares)
- Other Forests and Shrubs (2.55 kilohectares).

The number of Non- Forest Trees could not be accurately estimated, but expert judgment by the Forestry Department estimated the number to be 130,000 trees. Furthermore, based on local expert judgment, changes in these acreages over the last 20 years have been minimal.

Activity data on species and areas (hectares) of forest/biomass stocks, on annual growth rate (t dm/ha) of forests and other trees and savannas and on commercial harvest (m^3) are country-specific and were obtained from the Forestry Division, Government of St. Kitts and Nevis and to a limited extent from the FAO Statistical Yearbook.

Conversion and Emission factors relating to carbon fraction, biomass conversion/expansion and fraction of biomass oxidized were taken as default values from the IPCC Workbooks. Furthermore, where published data was lacking, as for instance fraction of biomass burned on-site and off-site, these were estimated from comparisons with other countries in the region (St. Lucia, Dominica).

2.1.6. Waste Sector

In the Waste sector, greenhouse gas emissions are limited to Methane (CH_4) from Solid Waste Disposal Sites (SWDS) and to indirect Nitrous Oxide (N_2O) emissions from Human Sewage. There were some amount of wastewater treatment at some of the hotels and the hospital that led to the emissions of small amounts of CH_4.

(a) Solid Waste Disposal on Land

Solid Waste Disposal on Land is limited to two (2) sanitary landfills located at Conaree and Roundhole in St. Kitts and at Lowground and Gingerland in Nevis. A large part of the waste is buried for decomposition. Also, there are small, uncontrolled open dumps scattered in the rural areas. The volumes involved are very small and are not included in the Inventory.

Activity data pertaining to Municipal Solid Waste (MSW) disposed to SWDSs are country-specific data obtained from St. Kitts and Nevis Solid Waste Management Authority. Per capita waste generation rates were determined based upon estimated waste arrivals recorded at the landfill. Wastewater treatment data was obtained from the J.N. France Hospital, the Four Seasons Hotel and the Frigate Bay Development Corporation. This was supplemented by estimates based on expert judgment.

The IPCC Default values for methane correction factor, fraction of DOC in MSW, fraction of DOC which degrades and fraction of carbon released as methane were used for the estimation of methane emissions from solid waste disposal and wastewater treatment systems.

(b) Industrial and Domestic Wastewater Handling

Because of the small population of the country, the limited number of industries and commercial activities, the treatment of commercial and domestic wastewater takes place to a limited extent. Treatment and disposal of industrial wastewater is more or less non-existent. There is little or no anaerobic treatment of wastewater.

(c) Indirect Nitrous Oxide Emissions from Human Sewage

In St. Kitts and Nevis, municipal sewage is generally stored in septic tanks sent via conduit soakaways into the ground. In 1994, approximately 40% of the population was estimated to use septic tanks and the remainder (60 %) used pit latrines.

Nitrous oxide (N_2O) emissions from Human Sewage were estimated from country-specific data on Population and Per Capita Protein Consumption (kg/person/yr) as obtained from the Planning Unit, Department of Statistics, Government of St. Kitts and Nevis.

The IPCC Default factors for Fraction of Nitrogen in Protein and Emission of N_2O were used to estimate the emissions of N_2O from Human Sewage.

2.2. GREENHOUSE GAS INVENTORY RESULTS

2.2.1. Reference Approach

The use of the Reference Approach to determine the carbon dioxide emissions from the energy sector produced total emissions of 76.94 Gg of CO_2.

2.2.2. Sectoral Approach

The use of the Sectoral Approach to determine the carbon dioxide emissions from the energy sector produced total emissions of 70.89 Gg of CO_2.

This compares favourably with the 76.94 Gg calculated using the Reference approach – a difference of less than 8.5% - **Table 2.2**.

Table 2.2
Sectoral/Reference Approaches

METHOD	Gg
Reference Approach	76.94
Sectoral Approach	70.89
Difference (Gg)	6.05
Difference (%)	8.5

2.2.3. Primary Emission Sources

(a) Carbon Dioxide (CO_2)

Table 2.3
CO_2 Emissions from Energy Sources and Fuel Combustion Categories

FUEL	Gg CO2	%
Gasoline	27.73	36.04
Jet Kerosene	0.00	0.00
Other Kerosene	0.48	0.62
Gas / Diesel Oil	8.25	10.72
LPG	39.81	51.74
Bitumen	0.00	0.00
Lubricants	0.66	0.86
Other Oil	0.00	0.00
Total	**76.94**	**100**
MEMO ITEMS		
International Bunkers	9.00	100
Solid Biomass	0.00	0.00

Of the fuels imported for energy and related uses, the greatest proportions of CO_2 emissions result from:

- the combustion of liquefied petroleum gas (LPG) (51.74 % in 1994), that is used almost exclusively for cooking purposes in the residential and commercial sub-sectors; and
- from gasoline (36.04 % in 1994) used mainly for vehicular road transport.

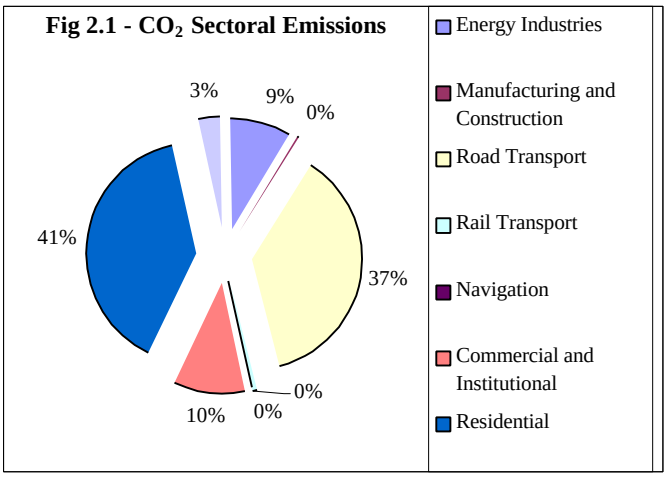
Other significant amounts derive from gas/diesel oil (10.72%), used in the energy industries sub-sector for the production of electricity, and from jet kerosene, a memo item.

Smaller amounts of CO_2 emissions also result from other kerosene use (0.62 % in 1994) and lubricants (0.86 % in 1994).

The contribution to CO_2 emissions by the sub-sectors within the energy sector utilising the Sectoral approach, is presented in **Fig 2.1**.

The key sources of carbon dioxide emissions in 1994 were:

- The Residential Sector – 39.8%
- Road Transport – 36.5%
- Commercial and Institutional Uses – 10.34%
- Energy Industries – 9.1%.



There were no significant CO_2 emissions from the Industrial Processes, Agricultural and Waste Sectors.

Total CO_2 emissions from the Forestry and Land Use Sector were 2.93 Gg consisting mainly of Forest and Grassland Conversion.

These emissions of carbon dioxide are mitigated by removals from changes in forest and

other woody biomass stock and from the abandonment of sugarcane fields. The total removals of CO_2 for The Federation in 1994 were 92.72 Gg. This consisted of 85.62 Gg of CO_2 from changes in forest and other woody biomass stocks and 7.10 Gg of CO_2 from carbon uptake from the abandonment of managed lands.

This resulted in a net CO_2 removal of 18.9 Gg when all sources and sinks were taken into consideration.

(b) Other Greenhouse Gases

There were also perceptible emissions of four (4) other greenhouse gases, viz:

- *Methane* – 2.83 Gg from solid waste disposal on land, enteric fermentation and manure management.

- *Non-methane Volatile Organic Compounds* – 1.19 Gg from road paving asphalt, food production and the production of alcoholic beverages.

- *Nitrous Oxide* – 0.11 Gg from cultivation of histosols, leaching of agricultural fields and indirect atmospheric deposition.

- *Carbon Monoxide* – 0.07 Gg from fuel combustion.

Table 2.4 provides a national summary of the Greenhouse Gas Inventory, with the data disaggregated on a sectoral basis.

Table 2.4: Initial National Greenhouse Gas Inventories Of Anthropogenic Emissions By Sources And Removals By Sinks Of All Greenhouse Gases Not Controlled By The Montreal Protocol - 1994

Greenhouse Gas Source and Sink Categories	CO2	CH4	N2O	NMVOC	CO
Total (Net) National Emission (Gigagrams per year)	**(18.9)**	**2.83**	**0.11**	**1.19**	**0.07**
1. All Energy	**70.89**	**-**	**0.01**	**0.01**	**0.07**
Fuel Combustion	*70.89*		*0.01*	*0.01*	*0.07*
Energy and transformation industries	6.45				
Industry	0.16				
Transport (Road, Rail and Navigation)	26.27				
Commercial-Institutional	7.35				
Residential	28.19				
Agriculture, Forestry, Fishing	2.41				
Biomass burned for energy					
Fugitive Fuel Emission					
Oil and natural gas systems	n.a.				
Coal mining	n.a.				
2. Industrial Processes				**1.18**	
Road paving asphalt				*0.89*	
Alcoholic beverages				*0.03*	
Food production				*0.26*	
3. Agriculture		**0.69**	**0.09**		
Enteric fermentation		*0.65*			
Leaching of agricultural fields			*0.02*		
Cultivation of histosols			*0.03*		
Manure management		*0.04*			
Indirect Atmospheric Deposition			*0.04*		
4. Land Use Change and Forestry		**0.0002**			
Changes in Forestry and other woody biomass Stock	(85.62)				
Forest and Grassland Conversion	2.93	0.0002	0.0001		
Abandonment of Managed Lands	(7.10)				
Carbon release from agriculturally impacted soils					
5. Other Sources as appropriate and to the extent possible		**2.1423**	**0.01**		
Solid Waste disposal on land		2.14			
Sewage		0.0023	0.01		

n.a. – not applicable

2.3. UNCERTAINTIES

The calculations of sources and sinks of GHG's for the different sectors incorporate several levels of uncertainty with respect to both the country activity data and the various conversion and emission factors. The ratings of these uncertainties are provided in **Table 8A** of the IPCC methodology (Revised1996) which is found in **Appendix 9**.

2.3.1. Energy Sector

The main source of uncertainty is the partitioning of the total fuels used in the different sub-sectors. This limits the results of the Sectoral Approach. However, for the Reference Approach, where the total fuels used are lumped together, there is lesser, or very little uncertainty. All activity data have been sourced locally from the Planning Unit,

Department of Statistics, Government of St. Kitts and Nevis, which produces the annual energy balance.

Another source of uncertainty in the Energy Sector, regarding activity data, is with respect to the Memo items. For International Marine Bunkers, for instance, uncertainties exist since no proper data is available despite the presence of this activity. Also, country statistics on charcoal and firewood (Biomass) burning were estimated. As for the emission factors for the various greenhouse and other gases (CO_2, CH_4, N_2O, NO_x, CO, NMVOC) the IPCC default values (mostly Tier 1) were used in almost all instances, since country-specific measurements are not available.

2.3.2. Industrial Sector

Greenhouse gas emissions in this sector are restricted to:

- NMVOC in the Road Paving and Alcoholic Beverages and Food Production industries; and to

- HFCs emission from refrigeration and air-conditioning systems.

Activity data for these were obtained primarily from the Planning Unit, Department of Statistics, Government of St. Kitts and Nevis, so that uncertainties are minimal.

The NMVOC emission factors used are based on the IPCC default values and these may be unrepresentative based on the age and condition of the factories. Country specific conversion factors are not available.

2.3.3. Agriculture Sector

Several areas of uncertainty were encountered for this sector. Government Statistics and expert judgment were used to obtain estimates of some animal populations since national data did not address all types of livestock.

2.3.4. Land Use Change and Forestry

There are a number of uncertainties relating to greenhouse gas emissions and removals in this sector. There was a difficulty in assessing the fraction of the forested area which was anthropogenically impacted.

Selective logging is done mainly for lumber and charcoal production and it was difficult to determine the actual area disturbed from logging operations. There was also a lack of data on the number of non-forested trees. This category of forest represents a significant area of the island, but could not be accurately captured due to lack of data and capacity to capture this data.

With regards to emission and conversion factors, the IPCC default values were used. Given the very general nature of these default values, country-specific values such as annual growth rate of forests may be quite different and may introduce significant uncertainty in

the GHG emissions and removals calculations.

Data on the abandonment of managed lands were sourced from the St. Kitts and Nevis Country Environmental Profile (CEP), 1991.

2.3.5. Waste Sector

The methodology utilizes population statistics for urban areas and this was used in the calculation of CH_4 emissions from solid waste disposal sites. Under worksheet 6-1C (Supplement) default values for Methane Correction Factor were used. There is also high uncertainty, since the actual amount of waste deposited in disposal sites was not used because there was no data available.

In the case of N_2O emissions from human sewage, the IPCC default values were used. This may not be applicable to St. Kitts and Nevis and is a source of uncertainty. Also, the per capita protein consumption value used was derived from Department of Statistics "Crude Estimates of Food Availability" which could be a source of uncertainty.

Furthermore, although there are both domestic and industrial sources of wastewater, CH_4 emissions were not calculated because there was no anaerobic treatment of wastewater.

2.3.6. Summary of Uncertainties

In summary, the GHG emissions and removals for the different sectors were calculated using available data and expert judgment. However, it must be cautioned that there are uncertainties in these estimates and the degree of uncertainty varies between sectors.

The Federation of St. Kitts and Nevis does not have the expertise or the resources to improve upon these uncertainties. However, with assistance from the UNFCCC, or other funding agencies, the capacity can be improved and studies can be initiated to address these uncertainties.

2.4. RECOMMENDATIONS FOR IMPROVING ACCURACY

Based on the problems encountered in the preparation of the GHG inventory, it is recommended that future efforts focus on training, research and data collection activities.

In this context, there is need for:

- Strengthening of local capacity to undertake future inventory compilations;
- Research in such areas as forest species coverage, using for instance, remote sensing coupled with GIS methods; and
- Obtaining local data on emission factors in the various sectors.

3. VULNERABILITY ANALYSIS

This vulnerability assessment will provide baseline information on the vulnerability of the Federation of St. Kitts and Nevis to the impacts of climate change.

As far as possible, the assessment has followed the guidelines for vulnerability and adaptation established by UNEP and IPCC. However, constraints imposed by data and time limitations means that the results are necessarily preliminary in nature and that more work is needed to achieve a more complete picture of the potential impacts of climate change, and potential for adaptation, in St. Kitts and Nevis.

It will use internationally accepted climate change scenarios and examine possible impacts on the Federation's forestry, coastal zone, water resources, human settlements, agriculture, tourism and human health.

It will also identify data gaps, capacity building needs and implementation requirements for conducting more in depth vulnerability and adaptation activities.

3.1. CLIMATE CHANGE SCENARIOS AND MODELS

Vulnerability is defined by the IPCC as " ***the extent to which climate change may damage or harm a system. It depends not only on a system's sensitivity but also on its ability to adapt to new climatic conditions***"(*IPCC, 1995*). Vulnerability to climate change can therefore be seen as a complex mixture of ecological, economic and societal factors.

Two different methods for identifying potential anthropogenically induced scenarios of climate change have been used for the climate change impact and adaptation assessment, viz:

- The first of these involves utilizing the widely recognized Australian (CSIRO) and UK (HADCM2) GCM's. These were used in the study of the agriculture, water resource, health, and tourism sectors.

- The second approach involves the use of the IPCC projections of 1.0 to 3.5 degrees Celsius for temperature increases and a sea level rise of 15cms to 95cms by 2100. Projections for greater alterations in extreme weather events, and for more variability in rainfall patterns were also adopted.

Specific climate change scenarios for 2030, 2050 and 2100 were derived from published transient experiments corresponding to the coupled general ocean / atmospheric circulation models, CSIRO and HADCM2. The Simple Climate Model (SCM) / General Circulation Model (GCM) combination of these two GCM's along with the climate model MAGICC was done using the greenhouse gases emission scenario IS92e with 2.5 C climate sensitivity. These climate change scenarios were available for temperature, precipitation, sea level and atmospheric CO_2 concentrations (*Centella, 2001*).

Annual mean increments for temperature, precipitation and sea level with respect to actual values, as well as carbon dioxide (CO_2), methane (CH4) and nitrous oxide (N2O) atmospheric concentrations, are shown in **Table 3.1** for both climate models and for the IS92e greenhouse gases emissions scenario.

Table 3.1. – Climate Change Scenarios

	2030	2050	2100
Temperature (HADCM2)	+ 0.9 C	+ 1.5 C	+ 3.0 C
Temperature (CSIRO)	+ 0.8 C	+ 1.3 C	+ 2.7 C
Precipitation (HADCM2)	(12.9) %	(20.6) %	(42.3)%
Precipitation (CSIRO)	+ 5.3%	+ 8.4%	+17.2%
CO2 (ppmv)	474.30	568	877.70
CH4 (ppmv)	2,474.30	2,965.50	3,941.20
N2O (ppmv)	349.80	373.90	421.70

Values for relative humidity, wind speed, global solar radiation and monthly number of rainy days were not available and were considered as invariants in all projected climates using the GCM tools.

The main impact model used in the agriculture assessment was the WOFOST 4.1 biophysical crop model (*Diepen et al., 1988*). This model has been used extensively in climate change impact assessment for various countries (*Rivero et al., 1998; Rivero, 2001 and 2001a*).

The WOFOST 4.1 model is a general one and it is not especially suited to any particular crop. For confirmation purposes, especially for rainfed crops, independent assessment of expected yields was done using the FAO procedure for estimating water influence on crop yields (*Doorenbos and Kassam, 1988*).

For the health, tourism and energy sectors certain human bioclimatic indexes (comfort indexes) were utilized that have been developed. These include Suffocant Heat Index, Equivalent Effective Temperature, and Oxygen Air Density

Actual climate conditions in St. Kitts, at least in low and middle lands surrounding the mountains ranges, correspond to seasonally wet forests. The forest ecosystem appropriate for this kind of climate is semi deciduous forest, and typical examples of this type of forest are seen in the island. As mountains peaks in St. Kitts in Nevis are often shrouded in clouds, it is very possible that rainfall amounts are much higher there and that some kind of wet non-seasonal forest occupies the higher regions of the island. Based on radiative index of dryness, the country's climate[2] lies somewhere between wet and dry forest, with a wet forest stage in Wingfield and a drier forest in Factory Pier.

Analysis of future scenarios utilizing the GCM models leads to the conclusion that, for climate change scenarios corresponding to the CSIRO model and IS92e greenhouse emissions scenario, climatic conditions will become wetter without reaching the wet forest stage and without losing its seasonality.

In contrast to the results from the CSIRO model, results predicted with the HADCM2 model point towards potentially catastrophic declines in rainfall. According to this scenario, climatic conditions in St Kitts and Nevis will evolve first toward a wet savanna and then dry savanna categorization by the 2020s. By the 2040s, the island's climate would become dry sub-humid, and would acquire semi-desert characteristics by the second half of

[2] Time and data constraints did not allow for comprehensive assessment of Nevis so that analysis of forest life-zones is based on data from St Kitts only.

the century. These changes will appear earlier in drier areas such as Factory Pier and later in areas like Wingfield where rainfall amounts are greater based on topographic conditions.

In the event that such a climate scenario was realized, it would be accompanied by the dieback of existing (secondary) forests and an intensification of desertification processes in the island. These processes will be exacerbated by the sea level rise expected and the salinisation of groundwater reserves.

3.2. VULNERABLE SECTORS

3.2.1. Forestry and Terrestrial Ecosystems

(a) Sectoral Characteristics

An estimated 37% of land area in St Kitts and 20% in Nevis are forested. Much of this occurs at higher elevations on both islands, though there are wetland and dryland forests occurring at various locations throughout the islands.

Hurricane damage, deforestation and land clearing, primarily for agriculture, have resulted in the loss of most of the islands primary forests. Traditionally, forestry management has been directed primarily towards watershed protection (such as at Nevis Peak) and soil stabilization. With the growth of tourism, the importance of forested areas as eco-tourism attractions has become increasingly significant. From a biodiversity perspective, the country's limited but productive forested areas provide habitats for a number of terrestrial species of flora and fauna.

Forests in St Kitts and Nevis continue to be of vital importance to sustainable development, particularly in relation to water supply, fuel-wood and the prevention of erosion and landslides.

Existing problems confronting the forests in St Kitts and Nevis include:

- Conversion to residential development.
- Wetland conversion for tourism development.
- Unsustainable harvesting of forest products (e.g. charcoal, wildlife and medicinal plants).

(b) Vulnerability to Climate Change

Climate change scenarios associated with the CSIRO model would appear to pose no major threats for the net primary productivity of forests and terrestrial ecosystems, since there would be a slight tendency to increased rainfall in the period to 2100. Productivity could even be enhanced by the effect of CO_2 fertilization.

Contrastingly, climate change scenarios associated with the HADCM2 model depict a

drastic progressive reduction in the productivity of terrestrial ecosystems as landscapes in the island evolve towards drier conditions. This would be accompanied by a reduction in Potential Biomass Density (PBD) of those ecosystems. Elementary calculations suggest that adverse effects on terrestrial ecosystems in the island would not be offset by the effect of CO_2 fertilization.

Decreases in forestry productivity will lead to scarcity of food for secondary (herbivorous) and tertiary (carnivorous) wildlife populations. This process would have an additional impact on biological diversity of natural populations already stressed by human actions such as hunting and habitat loss. For some species, this could result in population collapse.

In climate change scenarios derived from the HADCM2 model, the problem of forest fires can also be expected to increase with time. This would happen not only to forests but also to sugarcane plantations and to grasslands.

Wetland forests, such as those on the Southeast peninsula in St Kitts and at Pinneys in Nevis, also fulfill important ecological roles, including as nurseries for fisheries. These areas will be at risk to sea-level rise and storm surges arising out of climate change.

3.2.2. Coastal Ecosystems

(a) Sectoral Characteristics

The coastal zone constitutes a rich and unique habitat. The islands abound in shore and marine resources including coral and volcanic beaches, coral reefs, mangroves, freshwater lagoons and sea-grass beds. Biodiversity is particularly rich in the marine and coastal areas and includes a number of endemic and threatened/endangered species. These coastal resources provide the basis for a range of economic and social activity including the important tourism and fishing industries. There are also strong cultural attachments to coastal resources and their uses.

A number of human activities are already affecting the sustainability of resources in the coastal zone. These include improper shoreline development, sand mining, land-based pollution, over-fishing, and destruction of reefs. Certain areas of the Federation, notably along the important tourism area of Pinneys Beach in Nevis, have experienced dramatic rates of coastal erosion with considerable economic costs to owners and the national economy. Nevertheless significant areas, particularly on the South-East Peninsula in St Kitts, remain relatively pristine and are targeted for tourism and other development.

(b) Vulnerability to Climate Change

Major coastal impacts can be expected from sea-level rise and other effects of climate change. These effects will include an intensification of present patterns of coastal erosion, saline intrusion, and sea flooding.

These will impose additional stresses on several already impacted resources such as beaches and coral reefs and will also have serious economic and social consequences. As an example, the storm surge associated with Hurricane Georges in 1998 had a tremendous

adverse impact on the tourism infrastructure in St Kitts (cruise ship facilities) and in Nevis (hotel properties).

In general the experience of hurricane and sea-level rise induced impacts would suggest that these will have negative effects on natural resources and man-made structures. Areas at particular risk from climate change would include low-lying wetland areas on the South-East Peninsula in St. Kitts and west coast in Nevis.

The fisheries sector in St Kitts and Nevis is also vulnerable to climate change impacts. It is largely artisinal and exploits near-shore fisheries, including lobster and conch for local and export markets. It is also an important source of employment and nutrition.

These fisheries resources are also likely to be impacted by climate change. The potential negative impacts will occur on the principal fisheries habitats such as mangroves and coral reefs as a result of increasing sea temperatures, shifts in tidal patterns, intensified hurricane activity and sea-level rise. In many instances, these will place additional stresses on fisheries that are already stressed from over-fishing and habitat loss.

3.2.3. Water Resources

(a) Sectoral Characteristics

On both islands, the mountainous central areas provide the sources for the streams or "ghauts" that drain rainfall to the sea. While springs and surface water have historically been the main source of water for potable and agricultural uses, there is increasing reliance on groundwater. In both islands, water intakes are vulnerable to hurricane damage and flooding.

Estimates of the availability of freshwater resources on St Kitts indicate that the island has considerable underground resources as well as significant surface water, particularly springs.

Nevis is somewhat drier than St Kitts with over half the island receiving less than 1300mm (50 inches) and approximately 80% of the water supply coming from underground sources. In Nevis, rainwater harvesting from roofs is also an important source of domestic water supply. Prolonged periods of dry weather already present stresses to the water supply, especially in Nevis.

Owing to morphological and geological structures in the island, it can be said that the greatest quantity of available water on both islands is groundwater and can be expected to remain so in the future. At the same time, demands for water are likely to continue to increase as a result of expanding populations and demand in the tourism, agricultural and residential sectors.

(b) Vulnerability to Climate Change

The amount and quality of available water in the islands will be affected by at least three (3) factors associated with climate change. These are:

- an increase in temperature leading to higher evaporation and evapotranspiration rates;
- changes in the quantity and timing of precipitation events; and
- the progressive rise in sea level.

Climate change scenarios associated with the CSIRO model demonstrate a substantial increase in water availability over the islands. In spite of this positive impact, it should be taken into account that higher precipitation amounts could lead to higher erosion rates. Besides this, higher precipitation amounts will lead also to the problem of rising water tables that will be accentuated by the concomitant sea level rise. At the same time, higher air surface temperatures associated with global warming will also result in increased evaporation.

A completely different situation will occur if the actual climate evolves as predicted by the HADCM2 model. As a response to higher evaporation rates and lower precipitation amounts, water availability will decrease drastically and progressively in the future, possibly leading to a situation in which available water will not be enough to sustain the projected human population in the islands.

This condition would be worsened by sea level rise, increasing saline intrusion in aquifers and deterioration of water quality. Terrestrial ecosystems and agriculture would be affected by increasing salinisation of soils and additional reductions in primary productivity. Reduced availability of freshwater will have negative repercussions for all sectors notably agriculture, health, and tourism.

Any intensification of hurricane activity, whether in terms of frequency or strength, will also have serious negative implications for water supply, particularly in terms of impacts on water production and distribution infrastructure.

3.2.4. Human Settlements

(a) Sectoral Characteristics

The pattern of human settlements reflects the geographical and historical circumstances of the country. In St Kitts, inland areas are largely dominated by intensive sugar cane cultivation, forcing settlements onto coastal areas. Similarly in Nevis, spatial distribution of settlements and supporting infrastructure are also primarily located in areas at or near the coastline.

In an analysis of both islands conducted by the Organisation of American States (OAS)[3] it is shown that the majority of public infrastructure is located within two kilometers from the coast, including such facilities as hospitals, clinics, major highways, and schools. This

[3] OAS Post George Disaster Mitigation assessment, OAS, 2001. Available at OAS website

makes such facilities particularly at risk to sea-level rise and storm surge even under existing conditions.

(b) Vulnerability to Climate Change

The experience of recent extreme weather events has highlighted the vulnerability of the major settlements to hurricanes and flooding events. In particular, the passage of a number of major hurricane systems has drastically affected housing, tourism, commercial and public buildings and facilities.

One consequence of this has been to affect the availability and cost of insurance for property owners in the islands. In some cases, particularly for very vulnerable coastal developments, insurance coverage has either become unavailable, or available only at prohibitive rates. This has implications for commercial and tourism development since financiers are unlikely to risk investments in properties that cannot be adequately insured. Recent experience indicates that tourism sector structure and facilities are at particularly high risk to damage associated with extreme weather events – hurricanes and storm surge.

Data from the OAS assessment also reveals that most public buildings have been built to withstand hurricane force winds of 160 kph (100 mph), and in some cases up to 240 kph (150 mph). However, it is unclear to what extent such facilities will be able to meaningfully stand up to the type of intensified hurricane force winds projected as a result of climate change and perhaps foreshadowed in hurricanes such as hurricanes Mitch in 1998 and Michelle in 2001.

The costs of protecting the shoreline and other infrastructure will vary, depending on the kind of protection needed, the length of area to be protected, design specifications to be adopted, and the availability of construction materials. There is concern, however, that the overall costs of infrastructure protection will be beyond the financial means of a small developing economy such as St Kitts and Nevis. Vulnerability studies conducted for selected small islands, including of Nevis, suggest that the costs of coastal protection ("hard" options) would be a significant proportion of the country's GNP (see IPCC 1996, WG II, Table 9-3).

3.2.5. Agriculture

(a) Sectoral Characteristics

The agricultural sector has long been dominated by plantation cultivation of sugar cane on St Kitts. Historically, this was accompanied by cotton cultivation and garden production of fruits and vegetables in Nevis. More recent years have seen efforts to diversify agricultural production to non-sugar crops including for regional, extra-regional and tourism markets and to diversify sugar cane production to include rum and other non-sugar products. In both islands, most crops are grown under rain-fed conditions.

In St Kitts, the natural environment has benefited to some extent from the generally benign impact of the uninterrupted propagation of sugar cane for some three hundred years by reducing the effects of soil erosion and maintaining green cover. Existing problems facing

the sector in St Kitts and Nevis include rainfall variability and destructive impacts from hurricanes. In 1995, hurricanes Luis and Marilyn are estimated to have resulted in a reduction in agricultural production.

On Nevis, a variety of environmental, economic and social factors have combined to hinder the development of agriculture. Low and unreliable rainfall and extended periods of drought make moisture the most critical factor limiting agricultural productivity and availability of an adequate water supply remains a considerable obstacle to agricultural development. Soil erosion, given the island's topography, is also a concern exacerbated by foraging from feral goats and other livestock.

(b) Vulnerability to Climate Change

Under the CSIRO model projections, utilizing the FAO WOFOST 4.1 biophysical model, there is slight decrease in sugarcane yields through to 2100. While it is possible that potential yield could increase with irrigation under this scenario, inter-annual variations in rainfall are likely to be so significant as to adversely impact profitability.

The situation is even more severe in the climate change scenarios utilizing the HADCM2 model. Results from that model suggest that climatic conditions by the second quarter of the century would be too dry for rain-fed agriculture, with yields being below economically viable levels. In this model, sugarcane cultivation would only be possible in irrigated management conditions for which, the same model suggests, there would be inadequate water. *In view of the ecological and economic significance of sugar cane to St Kitts, additional research is urgently required into the impacts of climate change on sugar cane cultivation.*

The Government has identified agricultural diversification as a priority, with emphasis on such areas as livestock and fruit and vegetable crops. Projections under both the CSIRO and HADCM2 models would appear to have potentially devastating impacts on the prospects for cultivation of these agricultural products. Experience from present extreme weather events, particularly hurricanes, suggests that any intensification of these phenomena will also have significant adverse economic and environmental impacts.

In Nevis, rising sea levels are likely to lead to salinization of agricultural soils in lowland areas.

In both islands, salinization of coastal aquifers will negatively affect availability of water for agriculture.

3.2.6. Tourism

(a) Sectoral Characteristics

The tourism sector is now the dominant engine for economic growth and is the principal source of foreign exchange and employment. The country's tourism industry is based on a combination of natural and historic attractions, notably the islands' coastal and marine environment and rich historical heritage. Future development plans highlight sustainable

tourism development, including on the spectacular South East Peninsula area of St Kitts where a virtually untouched coastal and marine environment provides numerous attractions – wetlands, wildlife, and beaches – for international tourism development.

In addition to stay-over visitors arriving by air, the country is also dependent on the increasingly important cruise ship sector for its visitor arrivals.

(b) Vulnerability to Climate Change

The tourism sector will be probably one of the most affected by climate change. This will be so because tourism will be affected in many apparently unrelated ways. Climate change impacts on the tourism sector are likely to include the following:

- Flooding of coastal areas, increasing beach erosion, rising water tables and higher wave energy as consequence of sea level rise. These will increase costs and cause damage to the tourism infrastructure in coastal areas.

- Damage to coastal ecosystems and reefs as a consequence of sea level rise, hurricane/tropical storm activity and increased seawater temperature.

- Decrease in freshwater availability and increased related costs in scenarios derived from the HADCM2 model.

- Deterioration of outdoors comfort conditions in all scenarios leading to a decrease in outdoor activities participation from tourists.

- Deterioration of indoor comfort conditions leading to an increase of energy demand and associated costs for air conditioning purposes.

- Deterioration of landscapes because of aridity and droughty conditions in scenarios derived from the HADCM2 model and because of rising water tables and accentuated land erosion in those scenarios derived from the CSIRO model.

- Increasing shortages of foods and consequently increased costs of foods in scenarios derived from the HADCM2 model.

- Deterioration to historic sites from increasing humidity and changes in tropical storm and rainfall regimes.

Added to this, is the uncertainty surrounding the impact of warmer winters in northern latitudes on the desire of tourists from North America and Europe, the country's main markets for air and cruise arrivals. This desire may be adversely affected by the warmer climates at home and the deterioration in comfort levels likely in the Caribbean as a result of global warming.

The impact on the tourism infrastructure will be particularly significant, as a major proportion is located in coastal and marine areas and is therefore likely to feel the brunt of

factors associated with increasing sea-levels and enhanced storm surges arising from climate change.

The effects of these events are in fact already being felt in some locations - notably in Nevis along the heavily developed Pinneys Beach where a significant section of that island's tourism infrastructure is located. At that location, some properties have already had to undertake costly beach protection and nourishment measures, often with only short term ameliorative benefits and with negative impacts on other coastal processes and uses.

Public infrastructure in this sector is also already at risk to climate variability, including cruise ship facilities in St Kitts and the airport in Nevis. Such vulnerability is likely to increase with accelerated coastal erosion, hurricane activity, and storm surges associated with climate change.

The extent of vulnerability has also been demonstrated by the experience of hurricane impacts during the 1990s. Tourism arrivals by both air and sea have been negatively affected by the passage of hurricanes Luis and Marilyn (1995), Georges (1998) and Jose (1999).

St Kitts and Nevis, like most eastern Caribbean destinations, is already a relatively high cost travel destination arising from the high investment and operational costs associated with hotel and tourism management in such small import dependent countries. The potential impacts of climate change could have the effect of increasing already high operational costs, with negative implications for the development of the industry.

3.2.7. Human Health

(a) Sectoral Characteristics

St Kitts and Nevis has been able to attain significant achievements in health care with the principal sources of mortality arising primarily from non-communicable chronic diseases. Nevertheless weather and climate influenced health care problems continue to constitute major sources of morbidity including gastrointestinal diseases, dengue and influenza. Additionally health care facilities, particularly the country's main hospital on St Kitts, have received major structural damage and interruptions to operations from hurricane activity since 1995.

(b) Vulnerability to Climate Change

Health problems related to climate change can be expected to arise under CSIRO and HADCM2 scenarios. For scenarios related to the CSIRO model, these will be related to higher temperatures and precipitation that will create favorable conditions for the thriving of vectors associated to transmissible diseases (rodents and insects). Additionally, rising water tables can be expected to lead to deterioration of hygienic conditions and to the development and diffusion of water borne diseases.

In scenarios associated with the HADCM2 model, the increasing temperatures will be associated with increasing aridity and periods of drought. These can be expected to result

in deterioration of water quality with resultant impacts on diarrhea and other water related diseases.

In the case of scenarios related to the HADCM2 and to a lesser extent the CSIRO models, all these impacts could be exacerbated by a decrease in local food production and consequent effects on nutritional status.

The *aedes aegypti* mosquito that is the carrier of the dengue disease is endemic to St Kitts and Nevis. Globally, dengue is expected to be one of the diseases likely to increase in prevalence as a result of climate change. The projections from the CSIRO and HADCM2 models suggest that enhanced conditions for breeding of the vector can be expected. This will exacerbate existing morbidity and mortality associated with dengue and place additional strains on already stressed health care facilities.

Other existing health care priorities are also likely to be aggravated by climate change. For example heart diseases presently constitute close to 25% of mortality and can be expected to intensify with increased air temperatures.

4. INSTITUTIONAL FRAMEWORK

4.1. INSTITUTIONAL RESPONSIBILITIES

A number of Governmental institutions and statutory bodies currently undertake sustainable development functions in the Federation – **Table 4.1**.

Table 4.1. Key Agencies/Ministries with Environmental Responsibilities

INSTITUTION	DIVISION	RESPONSIBILITY
Ministry of Agriculture, Lands, and Housing	Forestry	Protection and Management of forest and wildlife and watershed management
	Fisheries Division	Management and development of fisheries; protection and management of marine reserves.
	Pesticide Board	Enforcement of Pesticides Act and Regulation
	SSMC	Management of Sugar Cane Lands.
	Building Board	Evaluate structural designs and boundary setbacks, inspect and monitor construction activities for compliance of regulation
	Department of Lands and Housing	Surveying of Government lands
	National Housing Corporation (NHC)	Housing supply
Ministry of Finance, Development and Planning	Physical Planning Unit	Implementation of Planning Legislation
	South East Peninsula Land Development and Conservation Board	Development, management and conservation of the South East Peninsula
	Technical Committee	Technical Advisory Board to Cabinet. Evaluate development applications
Ministry of Health and Environment	Public Health Department	Maintenance of environmental health, pollution control, waste management
	Department of Environment	Implementation of National Conservation Environmental Protection Act (NCEPA)
Ministry of Com. Works and Public Utilities	Water Department	Supply of piped water, watershed management
Ministry of Tourism and Culture	Urban Development Corporation	Management of Port Zante.
	Frigate Bay Development Corporation	Regulating Development in the Frigate Bay Area
St. Christopher and Nevis Solid Waste Corporation		Management of Solid Waste

These agencies do not fall under the same administrative umbrella. For the most part, they operate along traditional sector lines (e.g. agriculture, fisheries, health, and the like), with little effective communication or coordination across sectors. As a result, there is an ad hoc

and uncoordinated approach to issues involving the environment.

In addition to these government ministries and agencies, two (2) Non Governmental Organizations (NGO's), namely the St. Christopher Heritage Society (SCHS) and the Nevis Historical and Conservation Society (NHCS) have actively been involved in environmental matters. They are chiefly concerned with protecting and preserving of the environment including the historical, cultural and natural heritage of the islands.

The Chamber of Industry and Commerce has also been assisting in the preservation of the environment through its "Beautiful Basseterre" programme. This programme, among other things, aims to improve the city through the preservation of the old architecture within the city.

4.2. ENVIRONMENTAL LEGISLATION

Over the years a number of laws have been passed to provide for the management, development and protection of the natural environment. A number of them have been subsequently revised to ensure that development proceeds in a manner that ensures long term sustainability – **Table 4.2**.

Table 4.2 - Principal Environmental Laws

YEAR	LEGISLATION	RESPONSIBLE AGENCY	SCOPE
1949	Water Courses and Water Act	Water Department	Control Water Supply and Management
1949	Town and Country Planning Act		Establish National Planning and Land Development
1960	Land Development Act		Control Land Development
1969	Public Health Act	Public Health Department	Maintain Environmental Health Control Pollution and waste
1972	Frigate Bay Development Corporation Act	Frigate Bay Corporation	Control the Development of the Frigate Bay Area
1973	Pesticides Act	Department of Agriculture	Control the Use of Pesticides, including labeling and storage
1984	Fisheries Act	Fisheries Division	Manage Fisheries and Marine Reserves
1986	South East Peninsula Land Development and Conservation Act	South East Peninsula Board	Control the development, conservation and management of the South East Peninsula
1987	National Conservation and Environmental Protection Act	National Conservation Commission	Control Management and development of Historic and natural resources.
1988	Nevis Housing and Land Development Act	NIA	Control Land Development
1989	Litter Act	Public Health Department	Restrict the deposit of litter in public and private places.
1996	Solid Waste Management Act		
2000	The Development Control and Planning Act		Provides for the orderly and progressive development of land and for the protection of the environment and improvement of amenities.

Source: St. Kitts and Nevis National Environmental Action Plan

Among the various laws, the National Conservation and Environmental Protection Act of 1987 gives the most comprehensive guidelines for the management and development of the natural and historical resources in the Federation. Among other things, it provides for the establishment of protected areas, forestry, soil and water conservation, protection of soils, beaches and coastal zones. This act vested powers of environmental protection and conservation in the National Conservation Commission.

4.3. INTERNATIONAL CONVENTIONS AND AGREEMENTS

The Federation is a party to a number of Conventions on the environment, including:

- *The MARPOL Convention 73/78* - This relates to the International Marine Pollution Convention as ratified in 1973 and amended in 1978. Among other things, it provides regulation for improving maritime safety and the prevention of sea and land pollution from ships. The Federation benefited from a number of regional training workshops provided under this convention. The focal point for this convention is the St. Christopher Air and Sea Port Authority.

- *The Cartagena Convention* - This is the convention for the protection and development of the marine environment of the wider Caribbean region and a protocol in combating oil spills. This convention was adopted in 1983. The convention also has a protocol on specially protected areas and wildlife (SPAW).

- *The United Nations Convention on Biological Diversity* - This was adopted in Brazil in 1993. The preparation of the Biodiversity National Action Plan is one of the activities undertaken under this convention. This program is being implemented by UNEP.

- *The Convention on International Trade in Endangered and Wild Life Species of Fauna and Flora* - This was ratified in 1994. At present no projects are ongoing under this programme.

- *The United Nations Convention to Combat Diversification* - This convention was adopted in 1994 and ratified in 1997. To date no projects have been implemented under this programme.

- *The United Nations Framework Convention on Climate Change* adopted in 1992 and ratified in 1993. There are ten components of the Caribbean Planning for Adaptation to Global Change Project (CPACC). Presently components 3, 4, and 8 are ongoing in the Federation. These involve the establishment of a database and the design of a policy framework.

- *The Montreal Protocol* on Substances that deplete the Ozone Layer. This was ratified in 1992. There are two components to this project, the refrigeration management plan and the institutional strengthening component. To date there has been one training workshop for refrigeration technicians. Planning for the second workshop is ongoing. A public awareness programme has been launched and a

national ozone unit has been established under the institutional strengthening component.

4.4. COORDINATION OF CLIMATE CHANGE AND UNFCCC ACTIVITIES

A Steering Committee, hosted by the Department of Environment, has been established to overseer and guide UNFCC activities. This committee comprises membership from a number of relevant government agencies, the private sector and NGO community. The Steering Committee is mandated to review policies and programmes that will guide GOSKN national priorities, in the context of UNFCCC activities.

5. NATIONAL RESPONSE MEASURES

5.1. SUSTAINABLE DEVELOPMENT STRATEGY

5.1.1. Vision

The vision for the future development of The Federation of St. Kitts and Nevis requires that sustainable development policies be applied to all sectors. The primary goals are:

- to improve the quality of life by securing social and economic benefits for the national community from the rational development of the country's natural resources;

- to ensure environmentally sound economic activity by encouraging private and public sector organisations to fully consider environmental consequences and opportunities in the formulation, planning, development, implementation and evaluation of their activities; and

- to promote public awareness of the benefits of environmentally sound and sustainable economic development thereby ensuring a change in attitudes and behaviour.

With a view to ensuring the country's state of readiness for adaptation to climate change, these primary goals have been detailed into specific and measurable sectoral objectives. These objectives provide GOSKN with operational criteria for policy formulation. The objectives, targets and strategies are outlined in the following sections.

5.1.2. Objectives

The main objectives are:

- to protect natural systems, maintain the genetic diversity of species, and preserve the resilience and productivity of the ecological system.

- to provide long-term prosperity with lasting and secure livelihoods that minimise resource depletion, environmental degradation, cultural disruption and protect human health.

- to reduce the country's reliance on scarce energy resources through the encouragement of conservation, efficiency, substitution and the adoption of new and appropriate technologies.

- to encourage the development of information systems and analytical techniques that facilitate sound environmental management.

- to disseminate knowledge of environment-economy linkages throughout the public and private sectors as well as the general public.

- to establish a system of human settlement which promotes balanced development amongst districts, an efficient system of settlements, optimum use of natural resources and conservation of the dominant scale and character of the natural environment.

5.1.3. Targets

The set targets include, *inter alia*:

- the reduction of chemical and particulate air pollution by 50% by the year 2020.
- the reversal of deforestation, desertification and other land degradation by the year 2020.
- the achievement of sustainable exploitation of forest resources as well as their protection.
- an increase in the use of renewable energy sources.
- a decrease in the use of chemical fertilisers.
- improvements in the quality of potable water and the air around us.

5.1.4. Strategies

Strategies to be adopted are:

- the building of human potential and capacity, and the strengthening of institutions as essential elements for sustained growth and development of the economy.
- establish an appropriate legal and institutional framework and mechanisms to facilitate the integration of economic development and environment.
- revise and harmonise national planning and environmental legislation to reflect the current consideration of environmental concerns necessary to achieve sustainable development.
- encourage the adoption of more effective environmental management practices and technologies.
- ensure compliance with all environmental, planning and infrastructure guidelines, standards and regulations.
- apply the “polluter pays principle” to halt irresponsible environmental destruction.
- promote regional and international co-operation in matters of the environment.

5.2. RESPONDING TO CLIMATE CHANGE

5.2.1. Principles

The Federation of St. Kitts and Nevis joined the international response to climate change when it ratified the United Nations Framework Convention on Climate Change (UNFCCC).

This Initial National Communication represents the start of the national process of responding to climate change, within the framework agreed upon by the Conference of Parties (COP).

In developing this national response strategy, the Federation is guided by the principles of Article 4 of the Convention, and subsequent COP decisions, wherein the developed country parties have committed to assisting the developing country parties in the implementation of response measures to combat the negative effects of climate change.

The preceding sectoral analyses indicate the wide-ranging nature of the potential adverse impacts that anthropogenic climate change can have on the Federation, notwithstanding the high levels of uncertainty as to the timing, nature and extent of these possible changes in climate parameters and consequently their impacts.

The Federation however fully subscribes to the Precautionary Principle enshrined in the Convention and does not believe that one has to await full scientific certainty before initiating measures to combat climate change.

Given the scarcity of resources however, the national approach will not be based on climate change considerations only. The measures to address the likely, or potential, impacts of climate change would be linked to wider considerations and would be directed in the first instance, towards reducing existing vulnerabilities and risks to present day weather and climate variability, as well as advancing wider development objectives.

The measures will address all the main aspects of climate change i.e.

- Reduction in emission of greenhouse gases.
- Adaptation to the many sources of vulnerability that have been identified.

It must be noted however that given the low levels of greenhouse gas emissions, the emphasis will be placed on the adaptation aspects, as this is the area where the Federation will experience the most serious adverse impacts.

5.2.2. Mitigation of Greenhouse Gas Emissions

Based on the results of the GHG Inventory, the focus on mitigation activities will be on those sectors that are responsible for the most significant emissions - the residential sector, the transport sector and the energy industries sub-sectors within the energy sector, which together are responsible for 86% of the carbon dioxide emissions.

Mitigation activities for the non-carbon dioxide emissions are not considered, as the quantities emitted are minimal.

(a) Residential Sector[4]

Mitigation of greenhouse gases in this sector will be premised on the creation and promotion of an enabling financial and fiscal environment for the adoption of appropriate energy efficient and renewable technologies in the buildings sector.

Within this context, the following measures will receive priority consideration:

- the introduction of tax concessions for the adoption of energy efficient and renewable technologies.
- the sensitization of financial institutions to the environmental and other benefits of these technologies.
- regulatory measures relating to mandatory energy-efficiency standards, within the context a national building code.
- utility demand side management (DSM) that would provide incentives for the purchase of energy-efficient products.
- manufacturer incentive programs that would reward companies for the development and commercialization of high-efficiency low-energy-use products may be implemented
- procurement programs, where large purchases may make the acquisition of energy-efficient products affordable and the adoption of cost-effective energy efficiency measures in exchange for technical support and marketing assistance

(b) Transport Sector

Mitigation of greenhouse gases in this sector will be approached in the context of a comprehensive transportation plan aimed at regularizing and minimizing traffic flow and consequently reducing the greenhouse gas emissions.

Some of the initiatives that will be considered include:

- incentives, through licensing fees for instance, to encourage the purchase of energy efficient vehicles.
- incentives, such as price control, to encourage the use of alternative fuels, such as natural gas or bio-fuels, that are less polluting.
- legislation of fuel economy standards, including compulsory fitting of speed

[4] Also applicable to commercial and institutional buildings

limiters.

- the mandatory installation of pollution removal devices such as catalytic converters in vehicular exhaust emission systems, in the context of strong legislation relating to exhaust emissions.

- the restriction of the importation of older foreign used vehicles. Ideally, the first approach to controlling or reducing CO_2 emissions from tail pipes is to restrict the age of the vehicles on the roads to those that may meet better emission standards. In this context, policy directed at discouraging the importation of foreign-used cars and heavy vehicles more than 5 years old would be put in place. Such measures will provide much needed control to the increasing population of older vehicles on the roadways.

- policies that encourage wider use of public transportation such as more comfortable and safer buses and non-motorized systems such as bicycles and push-carts, together with supporting infrastructure such as dedicated lanes and improved signaling. This will be accompanied by public education to the environmental benefits of public transportation.

- special fiscal and licensing incentives to encourage people to keep their cars for longer periods, since resale and purchase of another car, very likely new, only increases the number of cars on the road with consequent increases in GHG emissions.

- energy use efficiency improvements, through the use of less carbon emitting fuels such as natural gas.

- greater use of some non-transport options such as overall land use planning, improved urban planning, and transport substitution using modern telecommunications options, which will lead to reduced vehicular trips and thus GHG reductions.

- the setting up of a clearinghouse to track new and emerging technologies that address energy efficiency improvements, including the transport sector.

(c) Energy Sector

The options that will be considered for emissions reduction in this sector include:

- the optimization of existing power plants for more efficient fuel use, and consequently lower emissions, by implementing a regime of preventative maintenance.

- the retro-fitting of existing plants with modern efficient technologies, such as decarbonization of flue gases and fuel.

- the use of less carbon-intensive fuels, such as switching from liquid fossil fuels to

natural gas, or simply the use of cleaner liquid fuels where costs can be justified.

- the greater use of renewable energy technologies for power generation such as solar and wind energy and the development of micro-scale hydro power plants.

- the provision of incentives for investment in renewable energy.

- the removal of policies that hinder the application and use of renewable energy.

- the development of human and institutional capacities, in the implementation and management of policies aimed at promoting renewable technologies, by for instance, providing information and training to key Government officials and local stakeholders; fostering joint research and technology development; promoting the assessment of the potential of renewables; and involving local communities, mainly in small-sized energy supply projects.

- The adoption of measures that facilitate the penetration of less carbon-intensive technologies, such as provisions for accelerated depreciation of new equipment and negotiated agreements with industry that favor the use modern and more efficient equipment.

- The institution of regulatory measures, voluntary agreements with the power generating utilities and infra-structural measures aimed at removing institutional barriers and the development of a comprehensive and efficient energy system planning.

(d) Other Sectors

Mitigation options have not been developed for the industrial, agricultural and waste sectors based on the insignificant levels of greenhouse gas emissions. It must be noted however, that in the medium to long term, new and emerging industries will be required to integrate greenhouse gas mitigation considerations into their planning.

5.2.3. Adaptation Measures

Future social and economic development in the Federation depends not only on climate change issues, but also on many others factors including political considerations.

This preliminary assessment of the adaptation options will therefore focus on measures and policies that are of the "*win-win*" or "*no-regret*" type. This means that these measures would be desirable and positive even in the case of no climate change.

It must be noted however, that more in-depth vulnerability analyses are urgently required, in order to ensure that the Federation develops a more rigorous response program to the potential negative impacts of climate change.

(a) Water Resources

Water resources are vulnerable to sea level rise and temperature increase leading to higher evaporation rates. In scenarios derived from the HADCM2 model water resources are additionally vulnerable to sizable reductions in precipitation levels. Given the centrality of ground water sources to the national water supply, the problem of water resources is primarily one of keeping and protecting the underground water resources.

This would include the following actions:

- Rational use of available water enforced by the national water authority;
- Controlled rate of pumping from aquifers;
- Conservation of protective forests that allows a high rate of infiltration of rainfall to the aquifers; and
- Protection of contamination of underground water from pollution sources - agricultural, human settlements and others.

The use of measures for minimizing runoff of freshwater to the ocean environment would have to be done in agreement with the requirements of the coastal ecosystems, which thrive on definite levels of salinity and organic sediments from land areas.

(b) Agriculture

The potentially adverse impacts of climate change on the agricultural sector requires that research and analysis be initiated into the potential for developing and introducing cultivars resistant to the projected climatic conditions.

(c) Tourism

Adaptation options for this sector include:

- Developing and enforcing environmental policies and regulations (including building regulations) for tourism activities that take into account the issues of sea level rise and climate change.
- Ensuring that the risks associated with sea level rise (coastal flooding, increased action of waves and coastal erosion, enhanced storm surges and rising water tables) are taken into consideration in the building and development of new tourism resorts.
- Redirecting tourism from activities that adversely impact on natural fragile ecosystems, toward more societal activities of historical, traditional and cultural nature that will not be associated with climate change issues.
- Encouraging tourism resorts to make greater use of locally-produced goods so as to

reduce costs.

(d) Human Health

Climate influences on health are most directly related with epidemiological issues and preventive medicine. This two features, epidemiological control and preventive medicine, should be enhanced in the country's health system.

Adaptation measures for this sector would include the following,

- The development of a Health Forecast System for acute respiratory, cardiovascular and many other diseases, for which weather and climate conditions constitute the triggering mechanism.
- Strengthening of data collection and reporting systems.
- Vaccination campaigns for all possible diseases.
- Sustained and improved sanitary conditions in human settlements.
- Sustained and improved disease vector control.
- Educational and promotional health related public campaigns.
- The promotion of a healthy way of living including a balanced diet and the avoidance of excessive quantities of allergenic and damaging kinds of foods. It is not enough to fight against smoking habits, drugs and alcoholism without paying attention to the excessive use of high cholesterol sources, noxious food additives and lactose-rich products.

(e) Institutional Framework

The measures required here are the establishment of a coordinating authority for the management of climate change and the institutionalization of climate change considerations into the policy making process.

- *Coordinating Authority* - A National Coordinating Authority is needed, as no institution has the responsibility of managing the process of adapting to climate change. The Steering Committee that is presently responsible for managing matters related to the UNFCCC needs to be upgraded into a formal institution with requisite authority and responsibility.
- *Policy Making* – It is necessary that climate change considerations be placed at the center of national development planning.

(f) Capacity Building

The human resource capacity in the Federation is deficient in the knowledge and skills

required for assessing and responding to the impact of climate change. It is therefore imperative that these deficiencies be redressed.

This requires upgrading at two levels:

- The development of a cadre of trained professionals who can provide technical leadership and guidance to the climate change process. Such training is usually obtained through formal university programs.

- The upgrading of the technical capacities of the management and technical personnel in the institutions and sectors that will be most affected by the impacts of climate change.

5.3. PRIORITY ACTION PLAN

It is not possible to immediately address the large number of response actions identified in this Initial National Communication. It is therefore necessary to identify key areas for the initiation of a structured response to climate change.

In this context, this priority action plan addresses certain core areas for attention, which can be expected to have multiplier effects. These are:

- Strengthened Institutional Capacity for Climate Change

- Public Awareness

- Coastal area management

- Improved Freshwater Management

5.3.1. Institutional Strengthening

GOSKN will upgrade the mandate of the Steering Committee responsible for UNFCCC activities such that it becomes a "*National Meteorological and Climatological Authority*".

Climatological data is generally dispersed between a number of agencies including the Robert L. Bradshaw airport, the Water Department, the Department of Agriculture and the St. Kitts Sugar Manufacturing Corporation. Much of that data is in handwritten form and no computerised database exists. Consequently, existing meteorological and climatological data is not in a form useful for practical applications.

Apart from resolving the issues related to database management of climatological time series, other climate change and adaptation responsibilities of the Authority would include:

- being a source of certified climatological data for governmental or private development and investment programmes.

- being a part of the institutions involved in the issuing of environmental permission and licensing.

- giving systematic specialised services to small farmers and agricultural institutions.

- creating and servicing a National Climate Forecast System with the capabilities of producing forecasts for periods of 1 - 12 months.

- creating and servicing a National Drought Surveillance System and a National Early Warning System for Agricultural Drought.

- ensuring that climate variability and climate change issues are included in all country development and planning actions.

- researching issues in the fields of climate variability, climate change, desertification and sustainable development.

This institutional strengthening will be accompanied by the provision of relevant training in climate change impacts and assessments, to technical and senior managerial personnel in the key institutions in all of the sectors that will be adversely impacted by climate change.

This training will include methodologies for data collection and analysis related to assessing and responding to the threat of climate change.

5.3.2. Public Awareness

Greater public awareness of climate change will be essential since actions will be required by stakeholders at all levels – individual, household, community, sectoral and national. This can only be possible when persons involved have a greater awareness of the problems associated with climate change.

This will require the education of agencies and organizations involved in public outreach and information dissemination (particularly the news media, NGOs, and community based organizations) on matters relating to climate change impacts and adaptations. This level of awareness will be targeted at the infusion of basic knowledge of climate change at the mass level.

It will also require the provision of specialized training and sensitization for decision-makers and resource managers to provide them with the information base they will need to advance sustainable development in their respective sectors.

The ultimate objective of these public awareness programmes would be to sensitize stakeholders as to the likely impacts of climate change and the measures that can be taken to ameliorate adverse impacts.

5.3.3. Coastal Area Management

Various hard and soft technologies exist for responding to IPCC projected scenarios of sea level rise and accelerated storm surge. These fall into a range of Retreat, Accommodation and Protection options. These types of responses are generally best accomplished within the framework of some sort of integrated coastal management framework. Action will therefore be taken to enhance coastal resource management, bearing in mind the need to incorporate climate change data and trends.

The uncertainties surrounding timing and extent of climate change and the existing stresses on the coastal and marine environment means that adaptation options adopted would be also targeted at promoting sustainable resource use in coastal and marine areas.

Sectoral beneficiaries will include the important tourism and fisheries sectors.

5.3.4. Improved Freshwater Resource Management

Model results from the CSIRO and HADCM2 climate models indicate fairly disparate analyses of the likely impacts of climate change on the Federation's rainfall regimes. Effects from both model scenarios however indicate the potential for adverse impacts on the water supply system particularly in Nevis where water resources are already stressed by regular droughts. Given the importance of freshwater supply to other sectors (health, agriculture, tourism) there is a need to work to ensure security of water supply.

The Federation presently depends exclusively on rain-fed surface water for its freshwater supply making it vulnerable to variations in rainfall. A combination of resource enhancement activities (reforestation, agro-forestry) and management measures (water conservation, land use policy, zoning) are required if sustainable approaches are to be achieved. The possibility of desalinization is an option that an increasing number of small island countries are also being forced to examine, despite the high costs involved.

Future measures to address freshwater management will therefore incorporate climate change considerations into forecasting and management planning.

5.3.5. Research

Additional research would be initiated into:

- A more in-depth analysis of the vulnerability of the various sectors in the Federation to the potential negative impacts of climate change.

- The potential for developing and introducing crop cultivars resistant to the projected climatic conditions.

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