DRAFT

SAMOA'S SECOND NATIONAL COMMUNICATION TO THE UNITED NATIONS FRAMEOWRK CONVENTION ON CLIMATE CHANGE

Foreword

Minister for Environment

Acknowledgements

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- brief summary of key points made by the SNC, for each of the following headings:

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1 Background

This section is really aimed at the domestic audience. It is not a requirement under the UNFCCC, but will help to provide some context for other people who read the SNC, such as students, policy makers and the general public. Other countries (including NZ) include this section and it seems to work well.

1.1 Greenhouse Gases & Climate Change

- Brief summary of the climate change issue, including its cause and the changes occurring/ projected, as well as consequences for small island developing states such as Samoa

1.2 International Response: UNFCCC and Kyoto Protocol

- Brief overview of the UNFCCC and Kyoto Protocol

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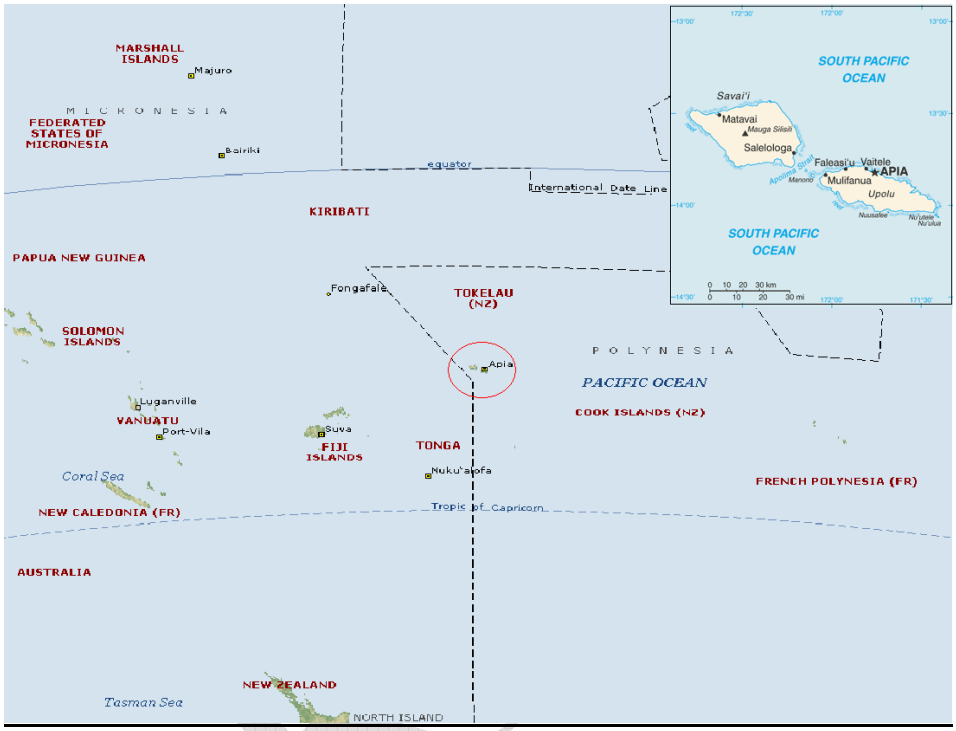
- brief explanation of the UNFCCC Reporting Requirements

NATIONAL CIRCUMSTANCES

2 National Circumstances

1.1 Geography and Geology

Samoa, a small island country in the South West Pacific comprises of four main inhabited islands and 6 smaller uninhabited islands (See figure 1).



The islands of Samoa lie between latitudes of 13°15°S to and longitudes of 168° - 173° W . The total land area is estimated to be around 2820 km^2 whereby Upolu holds 1115 km^2 and Savaii with 1700 km^2. The capital Apia is located on the northern part of Upolu and is approximately 130 km from Pago Pago, American Samoa, 3000 km from Auckland, New Zealand, 4500 km from Sydney Australia, and 4300 km from Honolulu, Hawaii. The neighboring countries are Tonga to the south, Wallis and Futuna to the west, Tokelau to the north and American Samoa to the east.

A rugged and mountainous topography characterizes the main islands (Taule'alo 1993a). Samoa is originated from volcanic activities, mainly from the Samoa – Uvea hotspot, the movement of continental plates over a thin, hot spot in the crust. However, this hotspot theory was challenged when Savaii erupted between 1905 and 1911. In Upolu, the central mountain range runs along the length of the island with some peaks rising more than 1000 metres above sea level with the highest peak being Mt. Fito at a height of 1000 metres (Curry 1955; Saileupolu 1985). Savaii on the other hand, contains a central core of volcanic peaks reaching the highest point of 1858 metres (Mt. Silisili). According to Kear, Camber and Brands (1979) the volcanic rocks common in Samoa are pictrite basalt, olivine basalt, and olivine dolerite. Most soils were derived from basaltic volcanic flows differing largely in age and type of deposit. The aa and pahoehoe lava types and scoria and

volcanic ash are the most common soil types in Samoa (Kear & Wood; 1959; 1963; ANZDEC 1990). A large portion of Samoa's soils are porous, shallow and clay in texture (Wright 1963; ANZDEC 1990)

Table 1: Soil Types of Samoa

Class	Description	Savaii	Upolu	Total
1	Soils of High Fertility	1,223	126	2,429
2	Soils of Moderate to High Fertility	19,696	1,777	20,473
3	Soils of Moderate Fertility	13,802	21,696	25,498
4	Soils of Moderate to Low Fertility	25,567	19,672	45,239
5	Soil of Low Fertility	21,033		34,333
6	Soils of Low to Very Low Fertility	56,826	13,300	81,583
7	Mineral Soils of Moderate Fertility	960	24,757	2,992
8	Peaty Soils of Low Fertility	32		52
9	Coastal Land of Moderate Fertility	567	2,032	2,296
10	Steep soils of Moderate, Moderate to Low, and Low to Very Low Fertility	14,790	1,729	4,3345
	Barren Lava	11,433	-	28,290
	Total	165,929	114,744	280,673

Source: Kear & Wood 1959

Most of the volcanic rocks are holocrystalline (coarse) and fine grained to porphyritic. Generally they are less to highly vesicular lava with very dark grey and almost black in appearance in most of the places. Phenocrysts phases are commonly pyroxene, plagioclase and olivine, phenocrysts sizes range from 0.5mm to 2cm.

1.2 Climate

Situated in the Tropical zone, Samoa is characterized by a distinct Wet and Warm (November - April) and Dry and Cool (May – October) seasons.

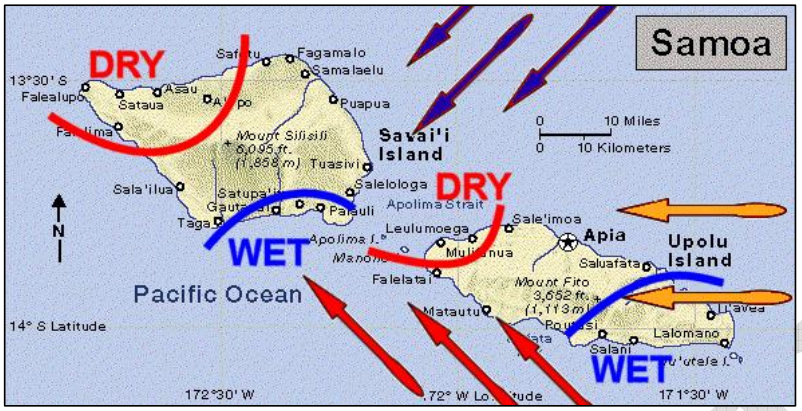
. These two seasons are characterized by small variations of rainfall and temperature seasonal trends. The highest temperature ever recorded in Samoa is 35°C and was recorded at the weather station in Apia. The lowest temperature is 10.5°C and was recorded at the weather station in Afiamalu, a weather station in the interior of Upolu.

Generally Samoa's climate can be summarized as having:

- A high rainfall and humidity
- A uniform temperature all year round
- Winds dominated by the south-easterly trade winds
- the occurrence of tropical cyclones during the southern hemisphere summer
- Long dry season

The topography of Samoa also affects the climate in terms of rainfall distribution. The mountain ranges determine the distribution of rainfall due to predominant easterly wind direction. Wet areas are generally those located at the south eastern areas and the relatively drier areas are located at the north western areas. Refer to figure 2 below.

Figure 2: Orographic Effect on Samoa



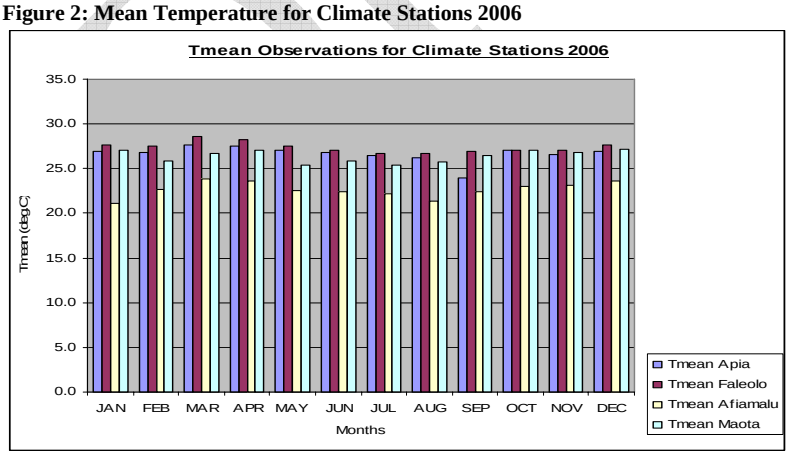
Source : Meteorology Division MNRE

The most striking feature of Samoa's surface winds is the dominance of the South-Easterlies. These winds are directly associated with the meridional migration of the SPCZ (Saifaleupolu 1985). The SPCZ is generally located further north of the Samoan Group in winter but moves southward to Samoa's latitudes during the summer. Therefore, the south-easterlies prevail in winter months while the wind direction becomes more variable during summer. The close proximity of the SPCZ to the Samoan islands during summer results in the winds being generally stronger than in winter. Heavy rainfall throughout the country and strong winds characterize these periods.

The annual rainfall is about 3000 mm (varying from 2500 mm in the North West parts of the main islands to over 6000 mm in the highlands of Savaii) with about 75% of the precipitation occurring during November to February.

The average mean temperature from all stations was near normal (1971 – 2000), with a 2% above normal from Apia and 6% below normal from Afiamalu. The average mean from all Climate stations is approximately 26°C.

Figure 2: Mean Temperature for Climate Stations 2006



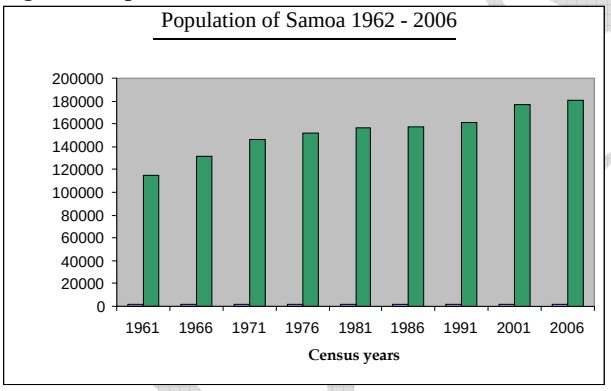
Source: Samoa Meteorology Division, Ministry of Natural Resources and Environment

Air pressures are relatively stable with a maximum in August of 1012 mbs and a minimum in January of 1008 mbs. Rainfall, humidity and temperatures are generally high and uniform throughout the year and is commonly affected by tropical cyclones during the wet season, especially during the months of December to February. Samoa is also vulnerable to anomalously long dry spells that coincide with the El Nino Southern Oscillation (ENSO).

1.3 Population

The 2006 census (November) enumerated a total of 180,741 persons in Samoa, (76% residing in Upolu and 21% in Savaii) which is a 2.2% increase from the last census in 2001 (an additional 4031 persons). According to the Statistics Department, 52% of the population are male and 48% are females. The population is estimated to be growing in a rate of 0.3 – 0.9% per annum over 1971 – 2007. The three major events which control the growth of population are births, deaths and migration. Since 1962 (Independence) the outflow of migration to New Zealand, Australia, USA, American Samoa and other countries reduced the population. The New Zealand quota scheme is another contributing factor to the increasing number of emigrants and the decreasing number of local population. The net migration rate estimated for Samoa is 1.6 – 2.2% per annum.

Figure 4: Population of Samoa 1962 - 2006



Source: Statistics Department, Ministry of Finance

TABLE 6: ANNUAL POPULATION GROWTH RATES 1961-2006

CENSUS YEARS	TOTAL POPULATION	PERIOD	ANNUAL GROWTH RATES (%)
1961	114427	-	-
1966	131377	1961-1966	3.0
1971	146647	1966-1971	2.2
1976	151983	1971-1976	0.7
1981	156349	1976-1981	0.6
1986	157408	1981-1986	0.1
1991	161298	1986-1991	0.5
2001	176710	1991-2001	1.0
2006	180741	2001-2006	0.5

Source: Population Census 2006, Statistics Department, MOF

The Samoan population is divided into four statistical regions, AUA (Apia Urban Area), NWU (North West Upolu), ROU (Rest of Upolu including Manono and Apolima) and Savaii. According to the Statistics department the NWU region has the highest population and the highest growth rate. This is probably because rural populations have purchased land within Vailele and Vaitele fou, regions in which the Government has sold to the public in a very cheap price.

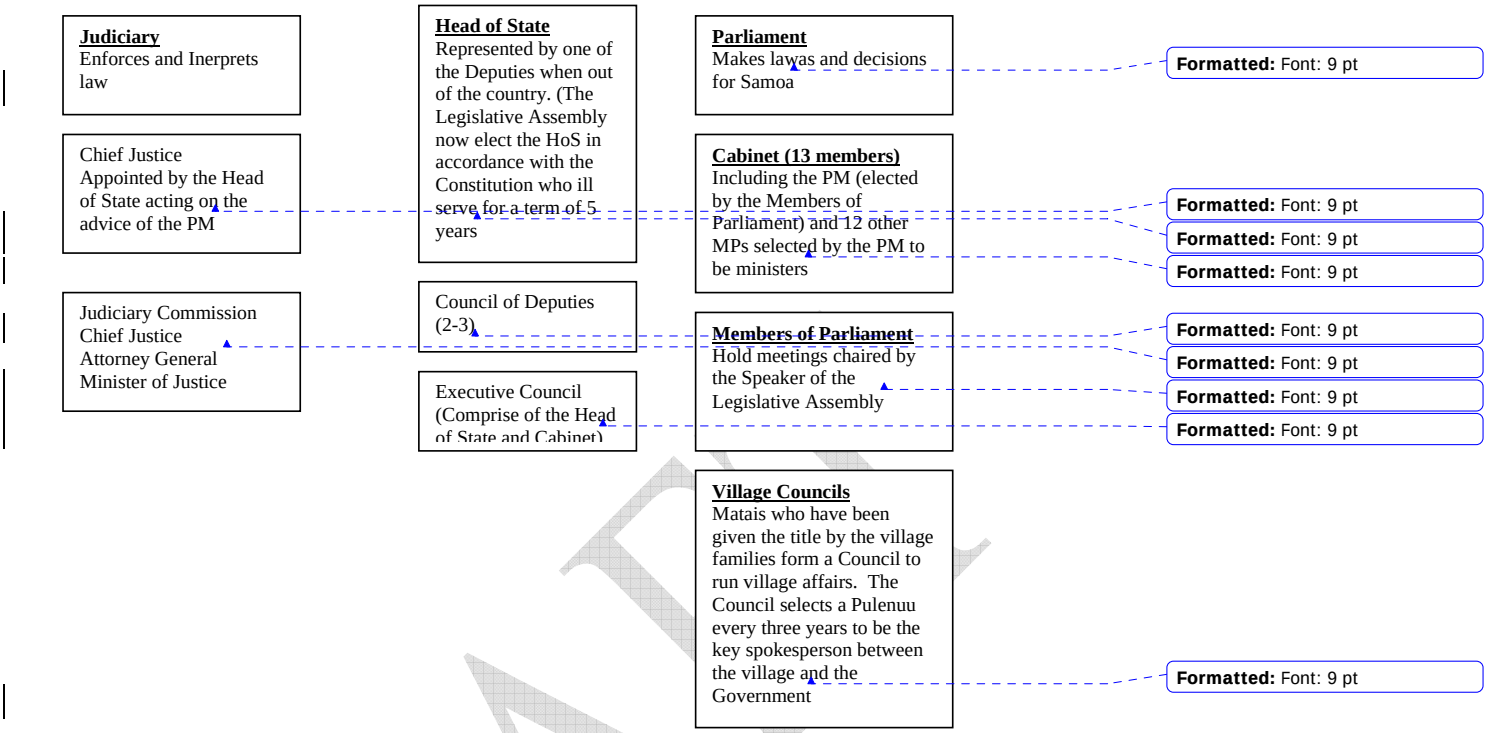
Generally the most densely populated area is AUA and NWU. People prefer to reside in these areas because of the closeness to facilities and a better life. There is a large number of young population (high birth rate) and a low mortality as population ages. In terms of age composition, male dominates younger age groups and female dominates ages 50 and over. Generally, women live longer then men

The working age group is 15 to 64 years and the dependent age group is 0 to 14 years and 65 years and over.

Table 2.2a: Total Child and Old-Age Dependency Ratios by regions, 2006

SAMOA REGIONS	Total Population	0-14 (i)	15-64 (ii)	65+ (iii)	Not Stated	Child Dependency ratio [(i)/(ii)*100]	Old-Age Dependency ratio [(iii) / (ii) * 100]	Age Dependency ratio [(i)+(iii)] / (ii)*100]
SAMOA	180741	70937	100999	8747	58	70	9	79
AUA	37708	13398	22589	1708	13	59	8	67
NWU	56122	21993	31810	2307	12	69	7	76
ROU	43769	17562	23986	2217	4	73	13	82
SAVAII	43142	17984	22614	2515	29	80	14	91

1.4 Government Structure



1.5 Economy

Samoa's economy is relatively small and like any other less developed country, depends very much on natural resources for people's needs and economic expansion. The economy depends primarily on the primary sector, mainly agriculture and fisheries. Contribution from the secondary sector, including manufacturing, construction, electricity, water and the tertiary sector, hotels, restaurants, transport, communication, finance and business services is also acknowledged. However, Samoa's national income depends on international trade, remittances from overseas and aid flows. The GDP for Samoa as of 2006 is estimated to be SAT$1,248.7 million, an equivalent of US$455.7 million. The primary sector contributes 11.4% into the GDP, 26.6% from the secondary sector and 62.1% from the tertiary sector.

Table 7 : Annual Real GDP			
	2004	2005	2006
At constant 2002 prices	**($ Million)**		
Agriculture	63.3	73.13	68.28
Fishing	52.78	48.5	48.33
Food and Beverages Manufacturing	30.42	33.3	31.21
Other Manufacturing	106.61	100	89.32
Construction	74.28	84.45	87.71
Electricity and Water	43.09	44.46	46.49
Commerce	182.13	192.04	200.92
Hotels, Restaurants	24.15	26.49	34.1
Transport, Communication	120.84	126.9	132.06
Public Administrration	78.89	90.45	100.52
Finance and Business Services	90.45	94.35	99.29
Less: Enterprise share of FISIM	-11.59	-12.04	-12.27
Ownership of Dwelling Personal & Other Services	34.55	35.25	35.96
Personal & Other Services	53.04	53.43	53.49

Source: Treasury Department, Ministry of Finance

Agriculture has traditionally provided the bulk of Samoa's export. The main export commodities are coconut oil, coconut cream, bananas, taro, kava and fish. Export revenues valued at 11.19 million tala in 2007, an increase by 3.60 million tala from 2006. Exports are subject to a number of constraining factors, such as price in stability, high transport costs, lack of overseas markets and harsh weather conditions. Commodity prices are relatively poor, and a narrow economic base. Overall, Samoa has a poor economic performance and growth.

Contributing to these factors is the large amount of official external Government debts, which have accounted for $450.45 million tala in 2007.

Table 8: Annual Export Commodities			
	2004	**2005**	**2006**
	($ Million)		
Fish	13.52	11.58	15.45
Coconut Cream	2.56	2.28	2.39
Nonu Fruit	1.47	1.54	0.87
Nonu Juice	4.69	8.3	3.95
Beer	4.34	4.83	3.48
Taro	1.97	0.85	0.6
Others	4.58	3.12	2.01
Total	33.13	32.5	28.75

Source: Central Bank of Samoa

Samoa's Industrial Structure

Primary Industries: Agriculture and Fisheries

Agriculture production rebounded from a negative growth of 6.6% in 2006 to record an increase of 9% in 2007. This promising turnaround was translated into a positive .6% contribution to overall growth. The substantial increase in agricultural production was encouraging and consistent with Government's efforts of promoting agricultural food security as stipulated in the SDS 2005-2007.

However the vulnerability of the industry to unfavorable weather conditions. Therefore this situation does not provide assurance for favourable future prospects.
Fishing industry remained the leading exporter, comprising of 62% of domestic exports and contributed 16.3% to the overall increase of 15.2% in exports for 2007. In 2007, the industry generated a total value added of $74.5 million, a share of 5.4% of total GDP.

Secondary Industries: Manufacturing, Construction, Electricity and Water
Manufacturing value added in current prices for 2007 was 36.6 million, declined by 9.6% from 2006. The decline in performance was translated into its share to GDP dropped from an average of 3.4% in the past 5 years to 2.7% in 2007. The industry remains the third largest industry, despite its share of GDP declining significantly from 13.4% as in 2003 to 10.5% in 2007, with a total nominal value added of 144.1 million, 20.5% higher than 2006
Construction remains at a high level in early 2007 until activities tailored off in the second half. In current market prices, construction value added generated $131.9 million with its share of total GDP of 9.6% in 2007. Construction accumulated a total value added of 98.8 million, a real increase of 8.1% compared to the revised 2006 figure of 91.5 million, following notable achievements in 2004 and 2005 with increases of 35.6% and 13.7% respectively. The growth in the industry has been stimulated by the ongoing public sector construction works in preparation for the SPG, coupled by church and private constructions. The sector is expected to slowdown in 2008 with the completion of these major
Electricity and water plays a crucial role in accelerating production in almost every industry. In 2007 value added at current prices was 64.9 million. During 2007, the electricity and water industries real value added stood at 47.8 million, an increase of 2.7%. This outturn was lower than the previous 4.5% in 2006 as evidenced by the completion of most major construction works that demanded a lot of electricity and water services in the first half of 2007. Ongoing and pipeline infrastructural and Institutional strengthening works to improve electricity and water management will fuel the development of this industry in the near future

Tertiary Industries: Commerce, Transport & Communication, Finance and Business services, Personal services and Hotels and Restaurants
Commerce in nominal terms expanded at an average annual rate of 9.9% in the past 5 years, reflecting the increasing monetarisation of the Samoan economy. During 2007, the industry accumulated a total value added of 281.5 million in current market prices, an increase of 5.7% from 2006 and thus represents a share of 20.5% of total GDP
Transport and communication activities have been and will continue to provide significant support to all sectors of the economy through the provision of information and technology, communication and transportation services. With this important role, the industry generated a nominal value added of 168.9 million in 2007. Transport and communication was the second largest industry behind commerce with a share of 12.3%
Hotels and Restaurants expanded further in 2007. As seen in figure 23.8 hotels and restaurants value added has shifted from 34 million in 2006 to 47 million in 2007 with its share rising from 2.7% to 3.4%. The shift was primarily due to a notable increase in the September quarter increasing by 43.8% compared to the corresponding quarter last year, evidenced by the record numbers of athletes and sports activities offered during the SPG

The finance and Business services sector has been the most consistent and fastest growing industry in the Samoan economy, recording an average annual growth rate in the past 5 years of 11.7%. In 2007 the industry generated a total value added of 122.8 million, an increase of 6.2% compared to 2006

1.6 Agriculture

Agriculture plays an important role in the economy of Samoa and is considered a key focal area in the Strategy for the Development of Samoa (SDS). Accordingly over 70% of households are agriculturally active, in that they are still capable of producing agricultural goods both for subsistence and commercial purposes. Even the wage earning population supplements their income with agricultural production. Agriculture is not only beneficial to the household level; it is also vital for the economy as it generates income from exporting agricultural produce to overseas markets. Samoa is largely dependent on its agricultural base and marine resources for its exports to the rest of the world.

Table 2. Number of parcels by level of agricultural activity by region:

Region	Level of Agricultural Activity			
	Total	Home Consumption Only	Mainly for Home Consumption	Commercial Producers
Total	*40,224*	*21,140*	*17,381*	*1,703*
Apia Urban Area	*3,383*	2,766	593	24
North West Upolu	*10,676*	6,374	3,867	435
Rest of Upolu	*12,362*	4,420	7,103	840
Savaii	*13,804*	7,581	5,818	404

Source: Agricultural Census 2005, Ministry of Agriculture and Fisheries

Samoa's farming system is still based on the traditional practice of mixed cropping whereby root crops are the most important stable food. Taro (*colocasia esculenta*) was traditionally the main root crop of Samoa until the cyclones Ofa and Val in the early 1990's and the spread of the taro leaf blight (*phytophtera colocasiae*) in 1993 and also the infestation of the Giant African Snail. This resulted in a major decline intaro production and accounts for less than 1% of export revenue today.

Generally the agricultural sector accounts for almost 40% of Samoa's GDP.

Source: Agricultural Census 2005, Ministry of Agriculture and Fisheries

All potentially cultivatable land was assumed to be used for agricultural purposes comprising of livestock and crops. The Agriculture survey results indicated that some 6,900 acres was covered by Cocoa Samoa, while Cocoa Solomon covered about 260 acres. On the other hand, area under Taro increased by 11 percent to 11,900 acres recorded in 2005. Land covered by Taamu (giant taro) also increased from 5,100 acres in 2004 to 6,100 in 2005. Area under Banana portrayed a significant change with an increase of 46 percent from 13,400 acres in 2004 to 19,600 acres in 2005.

Section on Livestock (paragraph explaining it

Type of Livestock	Total	AUA	NWU	ROU	Savaii
Cows	21069	2678	2693	9599	6098
Hiefers	8300	928	1499	3920	1952
Bulls	4969	699	1174	1950	1146
Steers	3452	566	665	1316	905
Calves	10783	1389	2102	4694	2598
Total Cattle	48573	6260	8133	21479	12699
Sows	44335	2993	8287	15098	17957
Breeding boars	30189	1698	6505	10087	11899
Gilts	21949	1287	4317	7975	8370
Barrow	22752	928	4697	8810	8318
Piglets	138432	6810	28962	47943	54717
Total Pigs	257657	13716	52768	89913	101261
Chicken	496931	66519	154751	131618	144043
Horses	2516	9	796	1118	594
Ducks	1150	984	69	71	26
Goats	20	0	0	20	0

Forestry

Samoa's total land area is about 285,000ha with more than 171,000ha categorized under forest areas. Forty seven (47) percent of Upolu and sixty nine (69) percent of Savaii's total land area is covered by forest.

Table 4: Main Category of Forests

Main Category	Savaii	Upolu	Total Samoa*	% of Samoa land area
Closed forest	0	0	82**	0.0
Medium forest	72151	403	72563	25.5
Open forest	22272	33049	55348	19.5
Secondary forest	19800	17296	37173	13.1
Scrub	15065	7000	22115	7.8
Forest plantation	3798	1305	5103	1.8
Mangrove	16	353	370	0.1
Wetland	148	597	745	0.2
Plantations	26158	26770	53114	18.7
Mixed crops	2463	7706	10228	3.6
Grassland	5193	12299	17494	6.2
Barren land	1973	30	2005	0.7
Built-up	1772	5292	7098	2.5
Infrastructure	32	432	463	0.2
Lakes	16	203	219	0.1
Rivers	22	42	64	0.0
Total	**170879**	**112777**	**284184**	**100**

Source: Agricultural Census 2005, Ministry of Agriculture and Fisheries

The biggest portion of Upolu's forest area is made up of open forest and secondary forest, proving clearly the high degree of forest depletion. Savaii's medium forest makes up for the largest portion (61%) of the total forest area, more than open forest and secondary forest combined. Forest plantations make up only for a very small portion if compared to the total remaining forest area of Upolu (2%) and Savaii (3%) as illustrated in table

Table 5: % of Total Forest Areas

Category	**% of total forest area of Upolu**	**% of total forest area of Savaii**	**% of total forest area of Samoa**
Closed forest	0	0	0
Medium forest	1	**61**	**42**
Open forest	**62**	19	32
Secondary forest	33	17	22
Forest plantation	2	3	3
Mangrove	1	0	0
Wetland	1	0	1

Agricultural Census 2005, Ministry of Agriculture and Fisheries

The only medium forest left is at the southern side of Upolu at Tafatafa Falealili. The upland of Upolu is covered with a large area of open forest that stretches along the central ridge from North West South East. It reaches the coast only in a few isolated locations such as south of Togitogina National Park and along the northeastern shore.

On Savaii, the open forest is rather situated in the lowland coastal areas, especially on the north eastern and the southern coastal strip. Secondary forest category is concentrated on the northern flanks of Upolu and covers predominantly the northern and northwestern lowlands.

Mangrove forests occur on Upolu where it is confined to small pockets on the south coast near Salamumu. Forested wetlands such as marshes and swamps are confined to small and isolated areas. E.g. Depressions on the eastern tip of Upolu and in a few inland crates on Upolu and Savaii. Forest plantations are mainly found on small scale village owned woodlots

Table 3. Estimated single crop equivalent area (acres) by crop type by region:

Type of Crops Grown	Region				
	Total	Apia Urban Area	North West Upolu	Rest of Upolu	Savaii
Total	*45,056*	*2,760*	*11,309*	*12,057*	*15,213*
Cocoa Samoa	*6,945*	230	1,758	1,454	2,877
Cocoa Solomon	*263*	1	51	75	125
Taro	*11,932*	546	1,988	3,983	3,738
Taamu	*6,142*	187	1,648	1,331	2,631
Cassava	*101*	3	15	3	29
Kava	*110*	2	28	3	72
Banana	*19,563*	1,791	5,821	5,208	5,741

Fisheries

Fisheries remain critical for Samoa for both subsistence and commercial purposes. Before European contact, Samoans derived most of their protein from fish and other lagoon and reef products (Kramer, 1901). According to the 2005 agricultural survey, a total of 5060 households engage in fishing, 62% of fish products is consumed, 22% is sold and 15% is given away.

The marine resources in Samoa are utilized under three categories, inshore fisheries, offshore fisheries and aquaculture. There are currently 11 fish reserves owned and maintained by village communities. Commercially, inshore fishery products sold via domestic markets and other outlets for the period 2006 to 2007 valued at approximately 1.5 million tala. Offshore fisheries on the other hand includes tuna longline fishery and troll and bottom fish fishery. For the period 2006-2007, 2370.8 metric tones of fishery products were acquired by tuna longline fisheries. Aquaculture activities include the nurturing of giant clams, tilapia farms, sea urchins (*tripnestes gratilla*) and mudcrab farms.

Fish and other marine resources are highly threatened by both natural and cultural practices. Fish poison and dynamite are some of the unsustainable fishing methods used by many Samoan fishermen. Climate variability also endangers many marine resources. Despite the continuing degradation, fishery is still a significant source for subsistence and income earning.

The Ministry of Agriculture and Fisheries (MAF) as the main organization which manages and protect the limited marine resources have developed effective and sustainable management strategies to conserve the available marine resources. The MAF in collaboration with village communities have introduced a Community-Based Fisheries Management Program (CBFMP) whereby problems are identified and determine solutions and propose possible actions that would lead to the sustainable management of the fisheries resources under their jurisdiction.

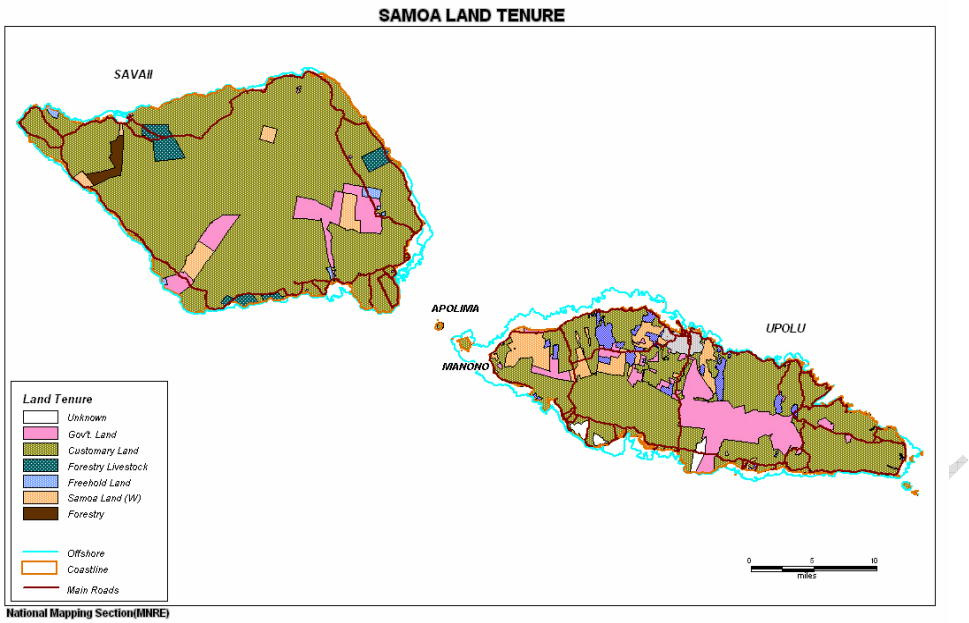
Village Fisheries bylaws are also imposed in village communities to ban the use of unsustainable fishing methods. These bylaws are prepared in accordance with legal recognition in the court of law. Village fish reserves are also set up and can be identified with floats, sticks or a “no fishing allowed” signboard. Undersize fishing is monitored weekly at the Apia Fish market, Fugalei market, shops and fish exporters.

The MAF have also raised the level of awareness through media advertisements, information dissemination, and several community consultation workshops.

License and registration are also enforced for all fishing vessels by the Regulation and Enforcement section of the MAF, these licenses are to be renewed annually. Boarding inspections are also conducted to ensure local and foreign fishing vessels are complied with licensing regulations and other policies governing fisheries sustainable management. Samoa’s Exclusive Economic Zone (EEZ) is also under surveillance by the Nafanua patrol boat with assistance from aerial patrols by the New Zealand and Australian defense forces.

Land Tenure

Figure 5: Samoa Land Tenure 1



Source: Mapping Section, Ministry of Natural Resources and Environment.

From the above map, the majority of land in Samoa is categorized under customary land. About 15% of Samoa's total land area is publicly owned or government land. Four percent (4%) is categorized under freehold land. Freehold land can be given or sold if desired by the owner, be it through gifting, exchange or leasing. However, alienation to overseas residents or non citizens is not allowed under the Alienation of Freehold Land Act 1972 unless consent is granted from the Head of State, Tuiatua Tupua Tamasese Efi. The other 81% is customary land and is primarily managed by a matai (chief) particularly a matai who is the head of an extended family. He has the responsibility of managing the land and allocating various uses for family members. Customary land is protected from alienation under the Constitution of the Independent State of Samoa 1960 except by way of lease or license in according with the Alienation of Customary Land Act 1965. In spite of this, all types of land can be leased to individuals, corporations, communities or private investors. Ideally, leasing allows the use of land without alienating it from traditional owners. The Government of Samoa through the Ministry of Natural Resources and Environment (MNRE) manages the lease agreements between the landowners (lessor) and the applicants (lessee).

MNRE puts forward land leasing designs to ensure that landowners are protected from entering into inappropriate land deals or making unwise decision, and to prevent alienation of customary land or ownership from landowners.

Water

The water supply system in Samoa caters for 90 – 95% of the total population; the remaining 5% receive their supply from wells, springs and accumulated rainwater. Despite this high availability of water, only a small

proportion of the population receives treated or safe water. This is because some villages receive water from their own individual water schemes which lacks treatment and daily maintenance. At the moment there are 22 water schemes in Samoa, 18 in Upolu and 4 in Savaii.

Table 9. Source of water supply by Region

Source of water supply	Region				
	Total	AUA	NWU	ROU	SAVAII
Total	23813	5183	7581	5443	5606
Tap	8636	1197	1977	3697	1765
Tap - shared	756	104	265	266	121
Metered Tap	11734	3621	4452	908	2753
Metered Tap - shared	926	187	386	67	286
Rainwater	1505	42	454	372	637
Well/spring	240	31	40	131	38
Tap and Rainwater	0	0	0	0	0
NS	16	1	7	2	6

Source: Statistics Department, Ministry of Finance

Samoa Water Authority (SWA) as the main distributor of water have introduced the use of meters in the urban area to minimize the wasting of water. This is a problem in most communities relying on their own water schemes, there is a high level of consumption and there is a high possibility that the water is contaminated. Maintenance to these water schemes is difficult to perform as there are less skilled professionals in rural areas. In addition, these communities earn less income to rehabilitate the water schemes. Despite this, these communities still desire to remain independent. This is because these villages mistrust the Government and to be free from government water charges without taking into account the current health problems relating to the consumption of contaminated water.

According to the SWA water supply is drawn from 11 rivers, 9 in Upolu and 3 in Savaii. Water catchment in Upolu is drawn from the Fuluasou, Vaisigano, Namo, Mulivai, Salani, Tafitoala, Nuusuatia, Lotofaga and Faleaseela. For Savaii, the main catchment areas are Sili, Palauli and the Maliolio River.

Major threat to Samoa's water supply is the continuing clearance in water catchment areas for plantation and the effects of tropical cyclones. The quality of water is also threatened by discharges of untreated wastewater with associated pathogenic organisms into streams. Land tenure is also a problem as many diputes have occurred over land with water resources. Further more, rapid urbanization is putting a great pressure on water supply and catchments used for urban and nearby rural water supplies. The impacts on the quality of water supplies make water unusable for days up to a month.

Health

Public health is closely monitored by the Government through the Ministry of Health (MOH). The Ministry of Health has now been split into two entities, the MOH and the National Health Services. MOH retains the regulatory, policy development & monitoring role while The National Health Services provides health services including all public hospitals and facilities. The facilities include the Tupua Tamasese Meaole (TTM) Hospital in Upolu, the main hospital and the Malietoa Tanumafili II (MTII) Hospital, a regional hospital for Savaii, and six

other smaller facilities in the rural districts. In addition, there are also Community Health Centers (10 Upolu and 9 Savaii) located in different villages and communities. According to the 2006 census, the number of doctors recorded was 37 working for the Government and 20 having their own private clinics.

Currently the Government have renovated and refurbished the existing facilities in order to improve operational efficiency and also strengthened their ties with the private sector to ensure that the best health service is provided to the people of Samoa

Health according to Samoa's National Assessment Report (NARs) is threatened by the poor management of waste, poor quality of water, domestic animals and the excessive use of fertilizers and pesticides in agricultural activities. Also mentioned in the NARs was the concern over the continual breakdown of traditional medicine systems. This is important as not all of the population can afford modern medicines Samoa also face health threats from other countries, such as HIV/AIDS and other contagious and vector borne diseases such as malaria, dengue fever and leptospirosis. Diseases arising from inadequate water supply and poor sanitation systems are widespread, especially in informal settlements in marginal locations. Diarrhea and other respiratory infections according to the MOH continue to be the major cause of child mortality while diabetes and other non-communicable diseases continue to take the older aged population (MOH, 2005).

Medical and dental services are efficient; however attention should be to the limited staff and the lack of proper equipment. Historians have discussed that the traditional indigenous diets have been replaced by the continuing dependency on imported food products, which according to the MOH is the main cause of obesity and diabetic diseases.

Table 10: Leading Causes of Mortality in Samoa (1999 and 2002)

Rank	Disease (Cause Groups)	1999		2002	
		Number	% Total Illnesses	Number	% Total Illnesses
1	Circulatory Diseases	65	25.4	70	38
2	Respiratory Diseases	35	13.7	19	10.3
3	Infectious & Parasitic Diseases	22	8.6	29	15.8
4	Certain Conditions originating in the prenatal period	22	8.6	8	154.3
5	Diseases of the digestive system	19	7.4	7	3.8
6	Injury, poisoning and other consequences of external causes	19	7.4	9	4.9
7	Endocrine, nutritional and metabolic disease	15	5.8	6	3.3
8	Neoplasm	14	5.4	14	7.6
9	Symptoms, signs and abnormal clinical and laboratory findings not elsewhere clarified	12	4.7	13	7.1
10	Diseases of the skin and subcutaneous tissue	11	4.3	9	4.9

Source: Ministry of Health Annual Report 1999, 2002 & 2003.

Waste

Waste is considered an inevitable product of society. Samoa is of no exception despite the ongoing campaigns by the Government and NGOs to stop and minimize this problem. Samoa's waste generation rate according to Ministry of Natural Resources and Environment is about .99kg per person per day. Uncontrolled discharge of waste into the environment is of great concern. Samoa does not have an environment that can sustain waste generations. Waste varies in type, quantity and source they originate from but can be generally grouped into material that is liquid, solid and gas - for example, waste from toilets, washing water, oils and chemicals, solid waste from packaging, and exhaust fumes that is discarded as a result of various land use and development activities

Heading on the improvement of the waste Management

Waste Management

The Tafaigata landfill is located 10km west of Apia. The landfill is about a 100 acres (approximately 40 ha). It accepts rubbish from the whole of Upolu island including house wate, incombustible bulky waste, sludge and medical waste.

Tafaigata landfill practices the Fukuoka method introduced and funded by JICA (a semi aerobic landfill structure) and costs up to SAT $400,000

Through the Fukuoka method leachate collection ponds are set up using local materils such as waste tyres and waste drums. Installed pipes provide fresh air into the dumped rubbish. Therefore the rubbish generates carbon dioxide (CO2) rather than CH4 thus low effect on global warming.

Leachate is caught into pipes and sent to leachate collection pond to be treated. After collecting leachate at collection pond, the leachate is treated through the treatment facility which employed natural cleaning methods instead of chemical treatment. Leachate from collection pond and wetland are monitored every once a week. Also ground water is monitored – chlorine, BOD, COD, Electric conductivity, dissolvef oxygen, NO2, NO3, PO, PH, Transparency, smell colour.

Other measures adopted by the MNRE through the Environment and Conservation Division relating to the proper management of waste in Samoa includes illegal dumping fines, improved waste collection systems, and setting up of a Fukuoka waste treatment facility in Savaii.

For dumping fees if a family is charged with illegal dumping they are to pay a sum of SAT$500. A company on the other hand will be charged a fine of SAT$5000 if they are caught with illegal dumping. On the spot fine of $10 is charged to individuals accused of illegal dumping.

Other measures include the redesigning of regions for easier waste collection. MNRE has divided Upolu island into 7 zones, zone A comprising of Apia town area, zone B1 including the suburban areas, B2 the high lands, C1 Faleata district, C2 Sagaga district

Rural zones – E1 Includes Faleula to Leulumoega region, E2 Leulumoega to Falelatai region and E3 Mulivai (Safata) Lefaga to Tanugamalala

These regions are visited by rubbish trucks twice each week for general wastes and twice a month for recyclable waste. Rubbish bins in the Apia area are often collected twice a day.

Table 11: Means of waste disposal by Region					
Means of waste disposal	Region				
	Total	AUA	NWU	ROU	SAVAII
Total	23813	5183	7581	5443	5606
Public Rubbish	14304	4140	4023	3102	3039
Public and Burned	605	98	129	137	241
Burned/Buried	7301	752	2878	1825	1846
Dumped at sea	81	7	26	34	14
Dumped at bush	1359	167	494	315	383
Burned/buried at home and Dispose at bush	43	5	3	3	32
Public Burned/buried at home & Dispose at bush	20	1	2	1	16
Public Burned/buried at home & Dispose at sea	9	0	1	1	7
Public Dispose at bush	91	13	25	25	28
NS	0	0	0	0	0

Source: Statistics Department, Ministry of Finance

Sanitation is also considered a major problem in Samoa even though the majority of the population have proper toilet facilities. Septic tanks are perhaps the only way of waste treatment, especially in the urban area. Other areas in the rural sector do not have proper septic tanks just a hole dug into the ground. This is considered unsustainable as it may lead to the contamination of the groundwater with waste. This contamination can result in the exposure of people to water borne diseases. Furthermore some households are situated in water deficit areas and find it very difficult to dispose waste.

Energy

Samoa's energy needs are mostly dependent on the importation of fuels, or petroleum products. These fuels include unleaded petrol, which is widely used for terrestrial and marine transport, automotive diesel, used for electricity generation, heavy machinery, land and marine transport. From 2001, diesel supplied 50% of electricity consumption. Also include kerosene which is mostly used for domestic purposes such as lighting and cooking and liquid petroleum gas used for domestic and commercial purposes. Forty percent (40%) of electricity generation is used domestically and the rest is used for commercial purposes.

More than 75% of Samoa is now covered by electricity. While access has been improved dramatically, the quality of electricity has been haphazard with breakages or outages becoming common in remote as well as heavily populated areas in the urban area due to a demand that is higher than the capacity of the supply.

The idea for geothermal power has been explored by a coupe of overseas developers, but the drilling is extremely expensive. The amount of land envisaged to be encircled within such an exploration exercise was confirmed substantial hence will be difficult to secure and compensate.

Biomass on the other hand is used solely for cooking and other domestic purposes, the rest is used manufacturing plants. However the use of biomass today has decline due to the introduction of fuels, namely kerosene and LPG.

Include

Table 12: Source of Cooking fuel by Region	
Source of Cooking fuel	Region

	Total	AUA	NWU	ROU	SAVAII
Total	23813	5183	7581	5443	5606
Wood	8651	596	2452	2565	3038
Gas	2100	1111	685	197	107
Kerosene	1096	537	370	128	61
Electricity	1033	549	332	68	84
Gas & Electricity	194	52	89	29	24
Wood/Gas	2823	683	1047	692	401
Wood/Kerosene	5447	1347	1970	1148	982
Wood/Electricity	1434	235	377	335	487
Wood/Charcoal	1035	73	259	281	422
NS	0	0	0	0	0

Source: Statistics Department, Ministry of Finance

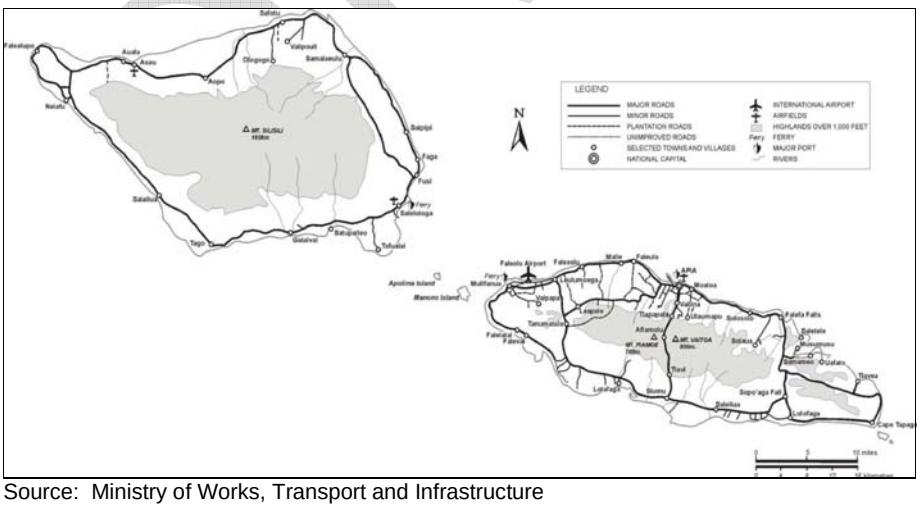
Include Final Energy

Transport

Road networks are relatively reliable in Samoa. According to the Ministry of Works, Transport and Infrastructure (MWTI), the tar sealed road system is approximately 429km in Upolu and 238km in Samoa. The unsealed roads are about 190km in total. Means of transportation include bus and taxi services and privately owned vehicles. The number of cars in Samoa is about 66 vehicles per 1000 population.

Maritime transportation services are offered by the two major wharfs, Matautu wharf in Apia, Mulifanua wharf in the far west of Upolu and Salelologa wharf in Savaii. Matautu wharf is the main international port for immigrants to Samoa and accommodates almost all international sea freight traffic. Mulifanua wharf on the other hand serve as an inter island transport port to and from Salelologa in Savaii.

Figure 6: Road Networks



Source: Ministry of Works, Transport and Infrastructure

Even though the road networks are reliable, the attention should be turned to the maintenance and improvement of the roads. Roads are highly affected in times of heavy rain and flood. Through the construction of the sport facilities in Tuana'imato for the South Pacific Games, the road systems were also improved and beautified with footpaths and better drainage. The Government at the moment are initiating a transition from left hand drives to right hand drives. Hopefully this transition can improve the quality of road systems.

Tourism

Tourism offers great potential for foreign exchange and employment for local site operators, both in resorts and in tourist related services. Some communities and individual families in the rural areas have set up small beach fales (cottage) for tourists and locals. Tourism development however, must be consistent with Samoan culture and traditions as according to the Samoa Visitors Bureau is the main focus of Samoan Tourism. Since 1994 tourism earnings have been the largest source of foreign exchange.

Between 1990 and 2000, tourists who have visited Samoa ranged from to 39,414 to 87,688, an annual growth rate of 5.1%. This increase has remained constant up to 2006 with the redirection of tourists to Samoa from Fiji because of political instability and military coups.

All tourism potential sites and development are environmentally friendly, meaning Environmental Assessments (EIA) must be undertaken before any establishments or development. The Development Consent process under the PUMA Act will also ensure the environment is protected while at the same time being utilized for tourism activities. Some hotels and motels have undertaken this process and is proved to be very successful as they gain ideas to improve designs and management plans from EIA consultations. The new famous Aggie Greys resort in Mulifanua and the Sinalei Resort in Siumu have undergone these procedures prior to their establishment. Unfortunately for some developments, their ignorance of these requirements has led to the delay and uncertainty in their establishment.

Annual Visitor Arrival To Samoa Statistics and Foreign Earnings			
Year	**2005**	**2006**	**2007**
American Samoa	**23433**	**26183**	**24112**
New Zealand	**36179**	**42966**	**50268**
Australia	**17724**	**23603**	**22087**
USA	**9237**	**8682**	**8057**
Other Pacific Isl	**6796**	**6099**	**9657**
Other European	**1858**	**1907**	**1796**
Germany	**1212**	**1094**	**1095**
Others	**2700**	**2667**	**2636**
UK	**1562**	**1580**	**1525**
Japan	**661**	**716**	**583**
Canada	**445**	**385**	**434**
Total	**101807**	**115882**	**122250**
% Change	**3.7 (from 2004)**	**13.8**	**5.5**

Tourist Earnings (millions)				
Year	**SAT $**	**% Growth**	**Yearly rates**	**US $**
1996	**98.9**	**0**	**.411**	**40.6**
1997	**101.8**	**2.932**	**.362**	**36.8**
1998	**115.2**	**13.16**	**.332**	**38.3**
1999	**125.8**	**9.201**	**.331**	**41.7**
2000	**133.8**	**6.359**	**.299**	**40**
2001	**139.8**	**4.484**	**.282**	**39.4**
2002	**152.6**	**9.156**	**.296**	**45.22**
2003	**163.5**	**7.143**	**.333**	**54.48**
2004	**193.1**	**18.1**	**.36**	**69.5**
2005	**207.8**	**7.613**	**.37**	**76.89**
2006	**248.9**	**19.78**	**.36**	**89.6**
2007	**282.4**	**13.46**	**.38**	**107.3**

Biodiversity

Samoa is considered as having a rich and diverse biodiversity in the entire Pacific both in terms of flora and fauna. The fauna of Samoa is comprised of 13 terrestrial mammals with 3 being native to the Samoan islands, the Samoan flying fox *(pteropus S. Samoensis*), the Tongan flying fox (*P. tonganus*) and the sheath-tailed bat (emballonura semi candata). The introduced species are namely the Polynesian rat (*rattus exulans*), pigs, dogs, cattle, horses, goats, cats, two other species of rats and the house mouse which was introduced by early Europeans. There are 35 species of land birds and 21 sea/shore birds with 8 being endemic and 4 being introduced, including the common myna bird (*acridontheres trisis*).

There are 14 species of lizards and one snake which have been recorded in Samoa. Fresh water fish species include the mosquito fish and the top minnows which were introduced as a biological control for mosquitoes and the African tilapia which efforts have been put forward to eradicate and be replaced with the Israel tilapia. There are 21 species of butterflies with 2 being endemic, 20 species of snails which are highly threatened by the spread of the Giant African Snail and 19 species of ants.

The flora of Samoa consists of 96 families, 298 genera and nearly 500 species, 32% are endemic. Native ferns consist of 521 families, 71 genera and about 220 species. Today, half of Samoa's floral composition is made up of introduced species, others being beneficial to agriculture and the environment and others being very destructive. A common pest amongst tree species today is the spread of the mile a minute vine (*mikania micarantha*) which was introduced to help with agricultural activities and have being a pest.

Table 13: Samoa's Biodiversity – Number of Species by Life Form

Life Form	Endemic Species	@ % Endemics	Native Species	Introduced Species	Threatened Species	@ Total Species	Relative Regional Ranking Endemism
Flowering Plants	174	30	540	500	136	770	5th
Ferns/Fern Allies	40	18	228	?	?	228	?
Land Birds	8	23	33	3	14	36	5th
Sea Birds	NA	NA	NA	NA	NA	21	?
Reptiles	1	7	4	11	4	14	?
Ants	12	18	30	7	?	68	?
Land Snails	35-38	49-53	64	14[5]	12?	72	2nd
Butterflies	2	NA	19	NA	1	21	?

Aquatic Fauna	NA	NA	25	4	NA	29	?
Marine Vertebrates	NA	NA	NA	NA	4	8	?
Marine Invertebrates	NA	NA	NA	NA	14	95	?
Fisheries	NA	NA	890	2	NA	991	?

Source: Table adapted from Samoa's Biodiversity Strategy and Action Plan: Keep the Remainder of the Basket. Government of Samoa, 2001. 95pp.

			NWU	ROU	SAVAII
			7581		5606
			2452		3038
			685		107
			370		61
			332		84
			89		24
			1047		401
			1970	1148	982
			377	335	487
			259	281	422
			0	0	0

Source: Statistics Department, Ministry of Finance

NATIONAL GREENHOUSE GAS INVENTORY

1. INTRODUCTION

Samoa's second national inventory of GHG emissions covers the years 2000 to 2007 and is based on the methodology described in the *2006 IPCC Guidelines for National Greenhouse Gas Inventories* ("2006 IPCC Guidelines"). As part of the second inventory the results of the first inventory were also re-visited and updated based on improved data.

The sectors and gases covered in the GHG inventory are summarised in Table 1, with the full results presented in inventory report. A summary of the key results is presented in the sections below, while full inventory tables are also included in the annex to this report.

Table 1: Sectors and gases covered in Samoa's second GHG inventory.

	GASES ASSESSED							
SECTORS COVERED	**CO_2**	**CH_4**	**N_2O**	**CO**	**NO_X**	**NMVOCs**	**SO_2**	**HFCs**
Energy	✓	✓	✓	✓	✓	✓	✓	
Industrial Processes and Product Use	✓					✓		✓
Agriculture, Forestry and Other Land Use	✓	✓	✓					
Waste	✓	✓	✓					

The GHG inventory attempts to cover all human sources of GHG emissions. The 2006 IPCC Guidelines provide a comprehensive overview and categorisation of all potential sources of GHG emissions, not all of which are relevant to Samoa. Furthermore, certain sources are relevant to Samoa but there is insufficient data to include them in the inventory. A detailed assessment of each IPCC category was carried out as part of Samoa's second GHG inventory, including each category's relevance to Samoa and the availability of data required to estimate emissions from these categories.

2. OVERVIEW OF NATIONAL EMISSIONS

In 2007 Samoa's GHG emissions totalled approximately 352.03 Gg CO_2-e. The GHG inventory also estimated CO_2 removals in forests and on croplands, which totalled -785.07 Gg in 2007. A summary of Samoa's GHG emissions for the years 1994 (base year), 2000 and 2007 is presented in Table 2. Full results for all years are presented as an Annex to this report.

Table 2: Summary of Samoa's GHG emissions for 1994, 2000 and 2007.

Sector	Gg CO_2-e		
	1994	**2000**	**2007**
Energy	102.83	142.74	174.35
Industrial Processes & Product Use	not available	4.59	9.51
Agriculture, Forestry & Other Land Use (excluding removals)	37.92	86.06	135.37
Waste	24.88	33.09	32.81
Total Emissions	**165.63**	**266.43**	**352.03**
Estimated CO_2 Removals			
Agriculture, Forestry & Other Land Use	-658.56	-1150.04	-785.07

The energy sector is the main source of GHG emissions, accounting for 50% of the national total in 2007 (Figure 1). This is followed by the Agriculture, Forestry and Other Land Use (AFOLU) sector, which accounted for 38% of emissions. Emissions from the Waste and Industrial Processes and Product Use (IPPU) sectors make up 9% and 3% of total CO_2-e emissions respectively.

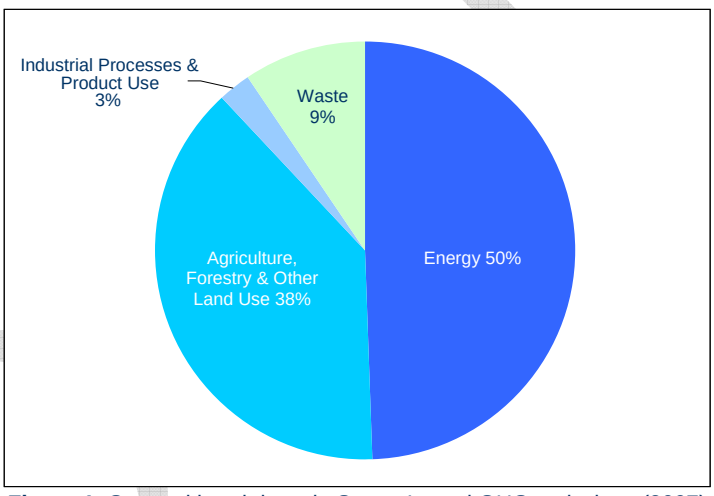


Figure 1: Sectoral breakdown in Samoa's total GHG emissions (2007)

The two activities contributing most to Samoa's emissions are road transport and livestock farming, which accounted for 27% and 25% respectively in 2007 (Figure 2). Electricity generation and other agricultural activities, including N2O emissions from managed soils, each account for approximately 13% of emissions. Other energy consumption, including fuel used by households and commercial and institutional organizations accounts for 10% of emissions.

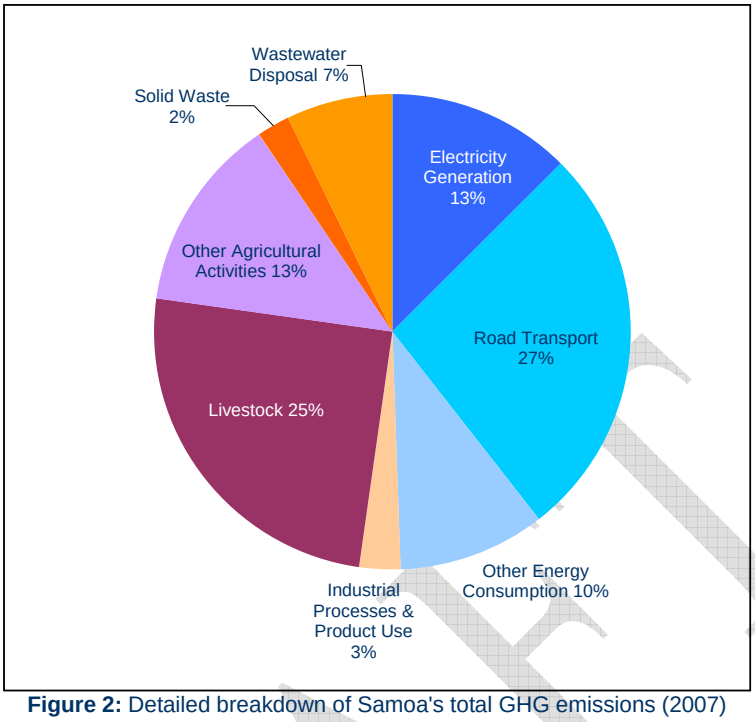


Figure 2: Detailed breakdown of Samoa's total GHG emissions (2007)

A significant finding from the second GHG inventory is that 95% of Samoa's emissions come from just six sources (Table 3). This has important implications for GHG abatement efforts, as it means that limited resources can target areas where they can have the biggest impact.

Table 3: Top six sources of GHG emissions in Samoa (2007).

Rank	Source	Emissions (Gg CO2-e)	% of total emissions
1	Road Transport	95.11	27%
2	Livestock Farming	88.36	25%
4	N_2O from Agricultural Soils	47.01	13%
3	Electricity Generation	44.21	13%
5	Other Energy Consumption	34.14	10%
6	Wastewater	25.44	7%
	TOTAL	**335.15**	**95%**

3. Trends in Samoa's GHG Emissions: 1994-2007

Samoa's GHG emissions have increased by approximately 113% since the 1994 base-year, when total emissions were approximately 165.63 Gg CO2-e. This represents an average growth rate of 16% per annum. As can be seen in Figure 3, the fastest rate of growth occurred in the AFOLU sector, which also increased its share of total emissions. A minor part of the growth in emissions can also be attributed to the inclusion of IPPU emissions, which

were not assessed as part of the first GHG inventory. It is important to note that the results presented here are the revised estimates from the first inventory (1994-1997).

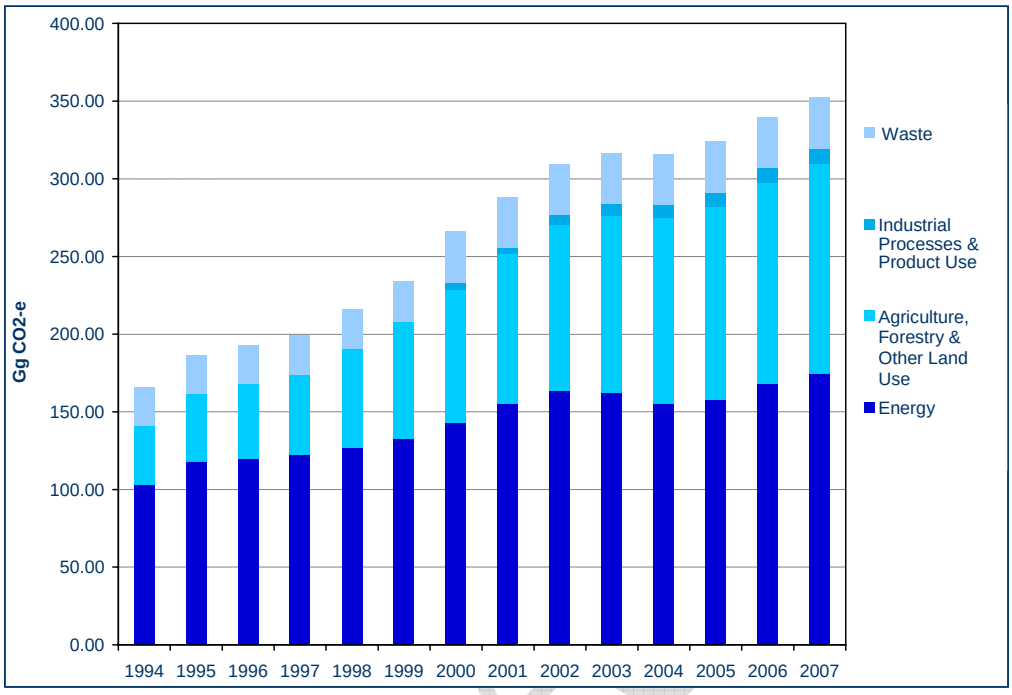


Figure 3: Trends in Samoa's GHG emission (1994-2007).

It is important to note that growth in Samoa's GHG emissions is coming off a relatively low baseline. In 1994, when emissions were first recorded, a significant portion of households still had no access to electricity and the economy was largely based on agriculture. Since then, much has changed in Samoa with significant social and economic development.

As shown in Figure 4, the livestock farming contributed the most to emissions growth in the period 1994-2007, accounting for 36% of total growth. Electricity generation was the next biggest source of growth in emissions, accounting for 19% of total growth. Growth emissions from agriculture, including N2O emissions from managed soils, pushed total emissions up by 17%. Energy use in the road transport and manufacturing and construction sectors accounted for 14% and 9% of total emissions growth respectively. Meanwhile, total emissions in the IPPU and waste sectors had a smaller impact of overall growth, accounting for 5% and 4% respectively.

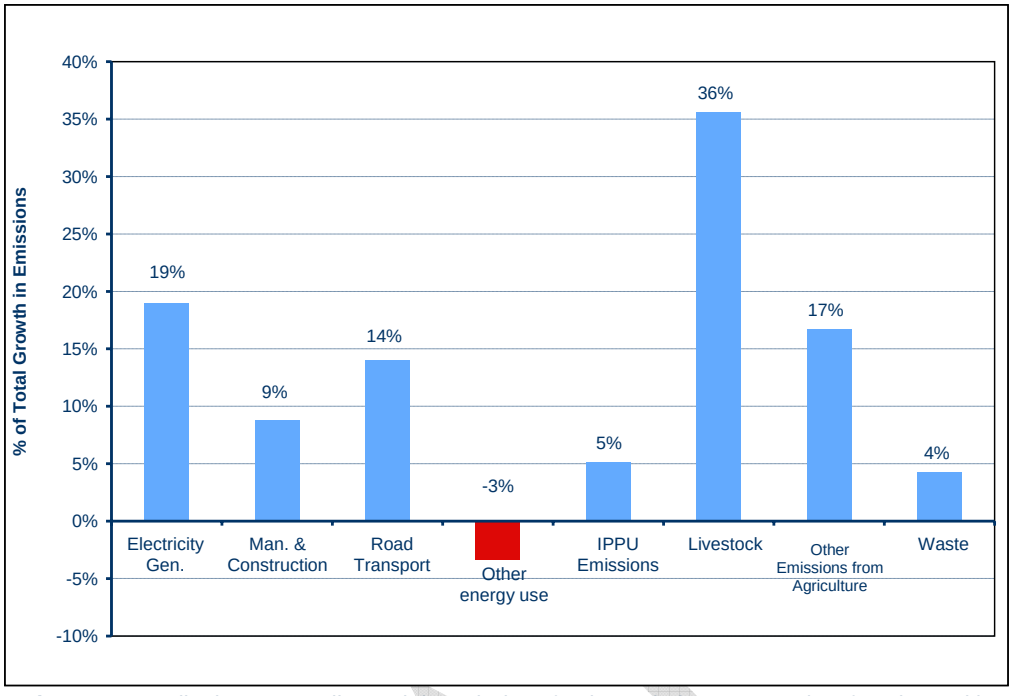


Figure 4: Contribution to overall growth in emissions for the period 1994-2007 (% of total growth).

4. Emissions by Gas

Carbon dioxide was by far the most important GHG emitted in Samoa in 2007, accounting for 51% of total CO2-e emissions (Figure 5). Methane and nitrous oxide accounted for 34% and 14% respectively. HFC gases made up approximately 1% of total CO2-e emissions.

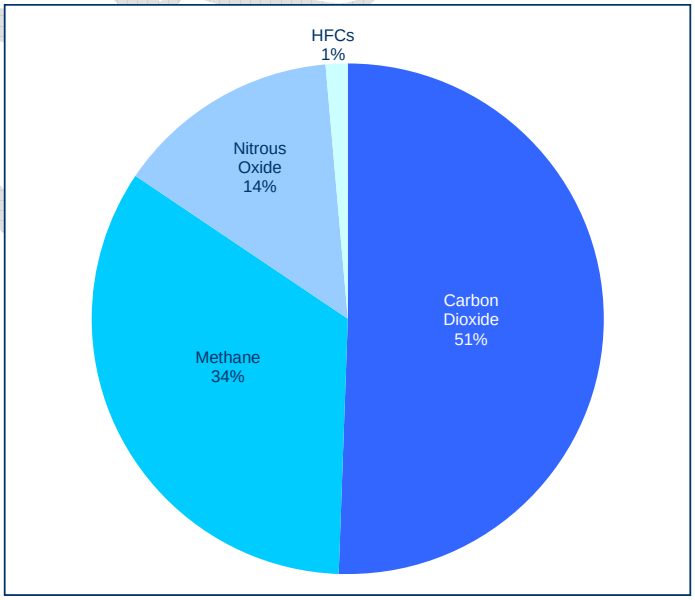


Figure 5: Contribution of each GHG to total CO_2-e emissions (2007).

Carbon Dioxide

The energy sector is the main source of CO_2 emissions, accounting for more than 96% of emissions of this gas. Overall emissions of CO_2 increased by approximately 22% in the period 2000-2007 (Table 4). Most of this growth occurred in the energy sector, with smaller growth in the IPPU and AFOLU sectors. Emissions of CO2 from the waste sector declined by approximately 34% during the period 2000-2007, reflecting the shift away from backyard burning of waste.

Table 4: Emissions of CO_2 (Gg; 2000-2007)

Sector	2000	2007	% change
Energy	138.73	170.98	23%
Industrial Processes & Product Use	3.70	4.14	12%
Agriculture, Forestry and Other Land Use	0.004	0.005	17%
Waste	3.67	2.41	-34%
TOTAL	**146.11**	**177.53**	**22%**

Methane

Livestock farming (reported under the AFOLU sector) is the main source of CH4 emissions in Samoa, making up approximately 74% of emissions of this gas. As shown in Table 5, the waste sector is also a significant source of CH4 emissions, particularly the disposal of residential wastewater. Samoa's overall emissions of methane increased by 42% in the period 2000-2007 reflecting the increasing number of cattle being farmed in the country. Methane emissions from the energy sector declined by approximately 20% during the same period, as a result of declining biomass use for residential energy needs.

Table 5: Emissions of CH_4 (Gg; 2000-2007)

Sector	2000	2007	% change
Energy	0.062	0.050	-20%
Industrial Processes and Product Use	0	0	0
Agriculture, Forestry and Other Land Use	2.58	4.21	63%
Waste	1.36	1.42	4%
TOTAL	**4.00**	**5.69**	**42%**

Nitrous Oxide

As shown in Table 6, in 2007 total N2O emissions reached 0.16 Gg, with approximately 94% of these emissions coming from the AFOLU sector. Despite falls in the energy, IPPU and waste sectors, strong growth in livestock farming pushed overall N2O emissions up by 40% during the period 2000-2007.

Table 6: Emissions of N_2O (Gg; 2000-2007)

Sector	2000	2007	% change
Energy	0.009	0.007	-14%
Industrial Processes and Product Use	0.0005	0.0004	-31%
Agriculture, Forestry and Other Land Use	0.10	0.15	48%
Waste	0.003	0.002	-35%
TOTAL	**0.12**	**0.16**	**40%**

Hydrofluorocarbons (HFCs)

Emissions of HFCs reached 5.25 Gg CO2-e in 2007, which represents a 630% increase on 2000 levels when emissions were estimated to be 0.72 Gg CO2-e. The main reason for the

growth is the shift to these gases for use in air conditioning and refrigeration equipment to replace ozone depleting substances.

Indirect and Precursor Emissions

The second GHG inventory also recorded indirect and precursor emissions, which are not included in Samoa's aggregate emissions because they do not have global warming potential values. This includes carbon monoxide (CO), oxides of nitrogen (NO_X), non-methane volatile organic compounds (NMVOCs) and sulphur dioxide (SO_2), which are reported separately in Table 7.

Table 7: Indirect and precursor GHG emissions, not included in total CO2-e emissions (2007).

Sector	CO Gg	NO_X Gg	NMVOCs Gg	SO_2 Gg
Energy	10.14	0.90	1.73	0.29
Agriculture, Forestry & Other Land Use	-	-	-	-
Industrial Processes & Product Use	-	-	0.10	-
Waste	0.0002	0.0003	-	0.0002
TOTAL	**10.14**	**0.90**	**1.83**	**0.29**

The trends in indirect and precursor emissions are summarised in Table 8. In the period 2000-2007 emissions of CO and NMVOCs declined by 17% and 9% respectively, reflecting the shift away from biomass as fuel for cooking. In the same period emissions of NO_X and SO_2 rose by 7% and 3% respectively, as a result of increased fossil fuel usage.

Table 8: Trends in indirect and pre-cursor emissions, by gas (Gg; 2000-2007)

Gas	2000	2007	% Change
CO	12.19	10.14	-17%
NO_X	0.86	0.90	7%
NMVOC	2.02	1.83	-9%
SO_2	0.29	0.29	2%

5. SECTORAL BREAKDOWN

Energy

In 2007 emissions from the energy sector accounted for approximately 50% (174.35 Gg CO2-e) of total GHG emissions, reflecting Samoa's heavy reliance on imported petroleum products to meet its energy requirements. Emissions from energy use increased by approximately 70% in the period 1994-2007 (Table 9).

Table 9: GHG emissions from the energy sector in Samoa (Gg CO2-e 1994-2007).

Source	1994	2000	2007	% Change since 1994	% Change since 2000
Electricity Generation	8.82	28.96	44.21	401%	53%
Manufacturing & Construction	-	12.48	16.30	-	31%
Domestic Aviation	0.06	0.06	0	-100%	-100%
Road Transportation	68.93	84.23	95.02	38%	13%
Domestic Shipping	2.24	4.22	5.51	146%	31%
Commercial & Institutional	1.17	0.93	1.39	19%	50%
Residential energy use	11.20	7.47	6.22	-44%	-17%
Fishing	10.40	4.39	5.70	-45%	30%
TOTAL	**102.83**	**142.74**	**174.35**	**70%**	**22%**

As shown in Figure 6, road transportation (55%) and electricity generation (25%) are the two biggest sources of GHG emissions in the energy sector. Energy use for manufacturing and construction (9%) is the third biggest contributor to emissions in the energy sector. Energy used by households (excluding electricity), fishing and for shipping each account for 3% of energy sector emissions.

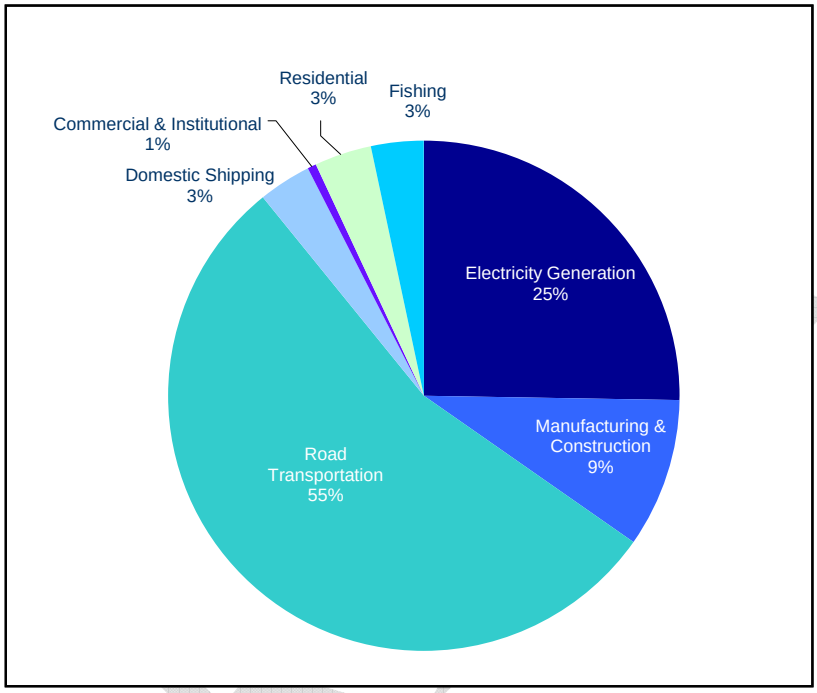


Figure 6: Breakdown of energy sector CO_2-e emissions in Samoa (2007).

Industrial Processes and Product Use

The Industrial Processes and Product Use (IPPU) sector includes emissions of CO2, N2O, NMVOCs and HFCs. Emissions of these gases are primarily from the use of products for non-energy and non-agricultural purposes. The key results for the IPPU sector are presented in Table 10.

Table 10: IPPU emissions in Samoa by gas (Gg; 2007).

Source	CO_2	N_2O	NMVOCs	HFCs
Lubricant Use	4.14	-	-	-
Solvent Use	-	-	0.10	-
Refrigeration and Air Conditioning	-	-	-	0.002
N_2O Use for Medical Applications	-	0.0004	-	-
Food and Beverage Production	-	-	0.002	-
Ammonia Use	-	0.00006	-	-
Total	**4.14**	**0.0004**	**0.10**	**0.002**

Agriculture, Forestry and Other Land Use

The Agriculture, Forestry and Other Land Use sector includes both emissions and CO2 removals, which are treated separately for the sake of clarity and because of the inherent uncertainties involved in estimating CO2 removals.

Emissions

In 2007, gross emissions from the AFOLU sector totalled 135.37 Gg CO2-e, representing 38% of Samoa's total emissions. As shown in Figure 7, the main source of emissions from the AFOLU sector is livestock farming, which accounted for 65% of emissions from this sector. Nitrous oxide emissions from the addition of nitrogen to agricultural soils accounted for approximately 35% of AFOLU emissions. Emissions of CO_2 from fertilisers contributed much less than 1% of emissions in this sector.

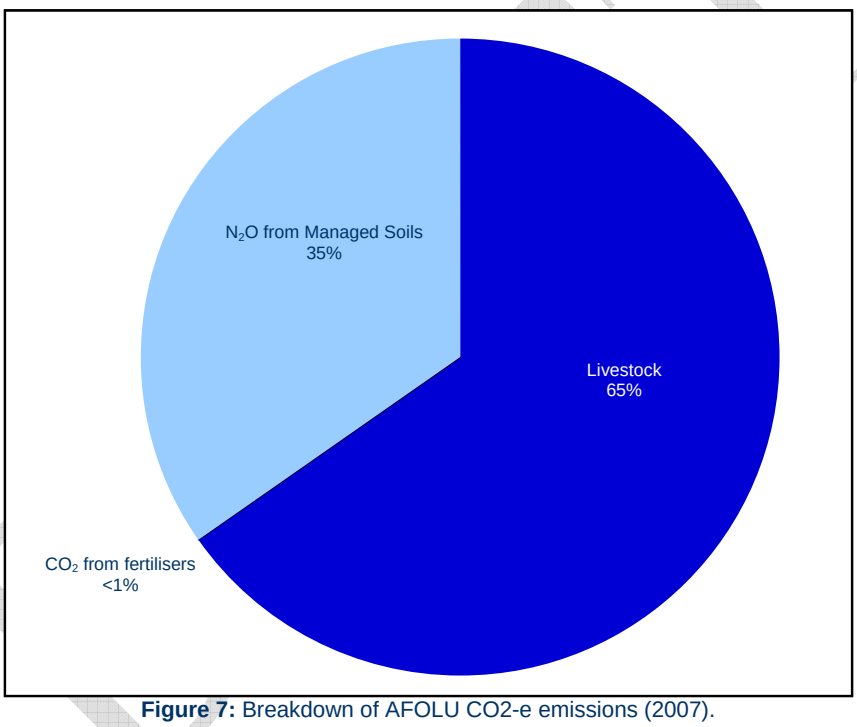


Figure 7: Breakdown of AFOLU CO2-e emissions (2007).

Emissions from the AFOLU sector have increased by approximately 257% since 1994 when emission totalled 37,920 t CO2-e (Table 11).

Table 11: GHG emissions from the AFOLU sector (2007, Gg CO_2-e)

Source	1994	2000	2007	% Change since 1994	% Change since 2000
Livestock Farming	22.07	54.14	88.36	300%	63%
Fertiliser Use (CO_2)	Not assessed	0.004	0.005	-	17%
N_2O from Managed Soils	15.86	31.87	47.01	196%	48%
TOTAL	**37.92**	**86.01**	**135.37**	**257%**	**57%**

CO_2 Removals

The approach used to estimate CO_2 removals and emissions from land use and land use change for Samoa's second GHG inventory is fully documented in the Methodologies report. It is important to note that there was very limited data available to accurately estimate how changing land use patterns may be affecting CO_2 emissions and removals. Until this additional work has been done, the CO_2 removal data presented here must be treated with caution.

The estimate of CO_2 removals from forests presented here are based on 1999 satellite images and expert opinion about the trends in forest area in the years since. As shown Table 12, the inventory does include CO2 emissions due to logging and fuelwood extraction, but does not consider any clearing of forests (e.g. for agriculture). Instead, it is assumed that there was no change in the area of forest between 2000 and 2007. This is consistent with the opinion of the Food and Agriculture Organization and Samoa's Forestry Second National Greenhouse Gas Inventory 26 Division (FAO, 2005). There is some anecdotal evidence to suggest that forests are being cleared for cattle farming. However, the general contraction in Samoa's agricultural sector since the 1990s taro blight suggests that some former croplands may have been converted back to forests. Without up to date satellite imagery the net effect of these processes on CO2 emissions cannot be accurately assessed.

The accuracy of these results can only be confirmed if and when new satellite imagery is made available and a comprehensive forest resource assessment is undertaken. If new images reveal that the overall area of forest has declined then the estimates of CO_2 removals and emissions from this source will need to be revised. There are plans to update Samoa's land use cover data with new satellite images in late 2008. If this goes ahead it will provide a good opportunity to re-assess CO_2 emissions and removals from forests.

Table 12: Net CO_2 removals from forests (Gg CO_2, 2000-2007).

	Annual Gg CO_2 Emitted / Removed (forests)							
Source/Sink of CO2	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Biomass Growth (removal)	-805.43	-805.43	-805.43	-805.43	-805.43	-805.43	-805.43	-805.43
Logging (emissions)	71.74	85.40	87.65	56.23	49.23	61.46	13.20	13.20
Fuelwood (Emissions)	28.43	27.12	24.88	22.83	20.94	19.21	16.09	14.76
Net Removals	-705.27	-692.91	-692.90	-726.38	-735.26	-724.76	-776.14	-777.47

Two perennial crop species were assessed as part of the second GHG inventory: coconut and cocoa. Data from the Ministry of Agriculture and Fisheries shows a downward trend in the total area of these two species under cultivation. As shown in Table 13, the inventory assessed CO2 removals through biomass growth for both these crops and CO2 emissions associated with their clearance. The observed trend for the period 2000-2007 is that net

amount of CO2 being removed from the atmosphere due to biomass growth on croplands is declining due to clearance.

Table 13: Net CO_2 emissions on croplands (Gg CO_2, 2000-2007)

	Annual Gg CO_2 Emitted / Removed							
Source/Sink of CO2	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Clearance of coconut and cocoa (Emissions)	400.10	400.10	400.10	338.62	305.04	372.20	338.62	338.62
Biomass growth of coconut and cocoa (Removals)	-844.87	-764.85	-684.83	-617.11	-556.10	-481.66	-413.94	-346.22
Net CO2 Removals	-444.78	-364.76	-284.74	-278.49	-251.07	-109.46	-75.32	-7.6

Waste

Emissions from the waste sector totalled 32.81 Gg CO2-e in 2007, which was approximately 9% of Samoa's total CO2-e emissions. As shown in Figure 6.1, the biggest source of emissions in this sector is wastewater management and discharge (78%), followed by open burning of waste (13%), solid waste management (9%) and waste incineration (<1%).

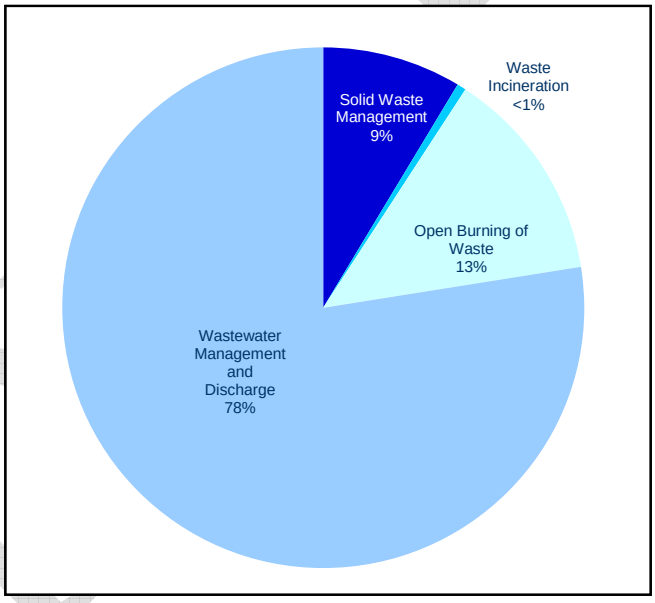


Figure 6.1: Source of waste emissions (2007).

As shown in Table 6.1, overall waste emissions declined slightly during the period 2000-2007 (-0.85%). This is largely due to the introduction of a national roadside collection service, resulting in more waste going to landfill rather than being burnt in backyards.

Table 6.1: Trend in GHG emissions from the Waste sector (Gg CO_2-e, 2000-2007).

Source	**2000**	**2007**	**% Change since 2000**
Solid Waste Management and Disposal	0.71	2.86	300%
Waste Incineration	not assessed	0.13	na
Open Burning of Waste	6.92	4.39	-37%
Wastewater Management and Disposal	25.46	25.44	-0.1%
TOTAL	**33.09**	**32.81**	**-0.85%**

6. BACKGROUND TO THE INVENTORY

Full details regarding the preparation of Samoa's second GHG inventory are provided in the inventory report and in the methodologies document. A brief summary is provided here.

International Guidelines

For the most part Samoa's second GHG inventory was prepared in accordance with the 2006 IPCC Guidelines. However, for several source categories the *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories* were used, as they better reflected national circumstances. This is a change from Samoa's first GHG inventory, which was prepared using the 1996 guidelines.

National Methodologies

The approach used to estimate GHG emissions in Samoa are fully documented in *Methodologies for Estimating Greenhouse Gas Emissions in Samoa* ("Methodologies"). This document explains all the assumptions and data used to calculate the GHG emissions for the second GHG inventory and should provide a good foundation for future inventories.

All of the estimates presented in this report were calculated using national-level activity data and IPCC default emission factors. Full details of all the activity data and emission factors used (including their source) are documented in the Methodologies. Global warning potential values used in the inventory are the 1995 IPCC values.

Revision of Old Data

A revision of the results from the first GHG inventory was undertaken as part of the second GHG inventory. This allowed a full and accurate trend analysis to be prepared for the years 1994-2007. A full explanation of the review process is provided in Appendix 1 of this document.

Key Gaps and Limitations

The GHG inventory is based on activity data from each of the sectors, including (for example) such things as fuel consumption, livestock numbers and waste generation. While there have been significant improvements in the availability and accuracy of activity data since the first GHG inventory, many limitations remain.

In general, there is a need to increase the level of detail in the activity data. While all sectors have some basic data, the GHG inventory can be strengthened with more detailed information. A good example of this is the energy sector, where there is good high-level data on fuel imports, but only limited detail on end-use. This means that certain assumptions and estimates have to be made, as well as certain activities being grouped together. Similarly, for

the waste sector there is very little data available on the delivery of waste to landfill sites. This means the estimates are based on findings from household waste audits, rather than actual deliveries to landfill.

Perhaps the biggest gap in the GHG inventory is the lack of accurate and reliable data on land use changes in Samoa. The results from the second GHG inventory show that Samoa is a net CO2 sink, removing more of this gas from the atmosphere than is being released. However, this does not take into account changes in the total area of forests and other land use categories during the inventory period. New satellite images may show that the total area of forest in Samoa has either increased of decreased in recent years. If this is the case, Samoa's GHG inventory estimates will need to be amended to reflect the emissions or removals associated with such a change in forest area.

Another significant source of uncertainty in the estimates for the energy sector is the data used for biomass fuel consumption. There is very little information available on the amount of biomass fuels used in Samoa. Samoa's Methodologies provide a detailed account of how biomass energy consumption was estimated for the second GHG inventory.

While the GHG inventory captures all the main sources of emissions, there are several activities that are excluded due to a lack of data. This includes emissions of NMVOCs from asphalt use in road construction, as well as emissions from aerosols, fire equipment and foam blowing agents. Efforts should be made to include these sources in future inventories.

End.

<INVENTORY TABLES AND WORKSHEETS. Over page to be included as annex at end of SNC REPORT>

VULNERABILITY AND ADAPTATION

3 Vulnerability and Adaptation to Climate Change

3.1 Introduction

(to be inserted) Note: (V&A Chapter is being developed and reviewed by the technical committee)

Water

Throughout the years, greater variability in the climatic patterns impacting water resource and supply has been observed, and people have had to cope with these issues in a more reactive approach in order to reduce any recurring impacts. This was noticeable in the significant improvement to water storage systems, and the increase in appreciation of coastal community springs, following the 1997-1998 droughts. Coping with the impacts of climate risks can be both at the national or community level. Community coping mechanisms although often simple and at a smaller scale are considered critical experiences, providing the foundation for current and future responses to climate change and its consequential impacts.

All of the adaptation activities identified by the NAPA as critical in reducing vulnerability of the water sector to climate change and vulnerability are currently being implemented at varying degrees throughout the country. Most obvious are the rationing programs during water shortages and the increase in water storage facilities being built for some community schemes and areas. In addition, the Samoa Water Authority continues to undertake programs on leak detection, exploration of new freshwater sources, water supply treatment, and immediate repairs to damaged water infrastructures to name a few, as means of safeguarding water quality and quantity. These activities often demand significant financial and human resources, as well as a lot of technical expertise and time

i) Water

Sector Component	Impacts	Adaptation Options	Cost	Practicability	Environment Approp.	Social Approp.	Cultural Approp.	Constraints	Strengthen Adaptive Capacity
Quality	- Contamination → poor water quality	- Treatment - Public notifications - Source protection → catchment replanting → catchment safety plans	H L H	H H H	M H H	H H H	L H H	- Capacity of community schemes - Lack of awareness & understanding - Lack of community involvement	- Campaigns to raise community awareness - Increase community participation & involvement
Quantity	- Low water quantity	- Control leakage and wastage - Control extraction - Water rationing - Metering/Pricing - Water storage	H L L L H	H H H H H	H H H H H	H L L L H	H L L L H	- Limited resources & capacity - Low compliance - Lack of awareness & understanding	- Increase compliance to regulatory mechanisms - Enhance understanding on why these adaptation measures are undertaken
Infrastructure	- Cyclone damage - Flood damage	- Upgrade & Maintenance - Improve design standards - Relocation	H H H	H H H	H H H	H H M	H H M	- Cost (recurring) - Resource availability - Land issues	

Health

Several adverse health effects are potentially climate sensitive; that is weather and climate affect their incidence and distribution. Some adverse health outcomes directly relate to weather and climatic events such as drowning and injuries in flooding while others relate indirectly such as water-borne and vector-borne diseases as well as mental problems.

Like many other small island countries, Samoa is currently highly vulnerable to several climate sensitive diseases. Waterborne and oodborne diseases such as typhoid, diarrhea and gastroenteritis remain high.

Vector-borne diseases including dengue and filariasis continue to receive highest priority in terms of vector control and prevention programs. Direct impacts including death and injuries resulting from extreme events such as cyclones and flooding remain an ongoing threat particularly for the poor and those residing in flood-prone areas.

ii) Health

Sector Component	*3.2 Impacts*	Adaptation Options	Cost	Effective-ness	Practica-bility	Environ. Appr.	Social Appr.	Cultu Appr.	
Vector-borne Diseases	Increased frequency & duration of outbreaks.	Mosquito spraying for hot spots & cases households.	MEDIUM	HIGH	3.2.1	MEDIUM	MEDIUM	MEDIU	
			HIGH	HIGH	LOW	HIGH	MEDIUM	LOW	
	Increased numbers of hospital admissions and attributed deaths.	Case investigations	LOW	MEDIUM		HIGH	MEDIUM	HIGH	
			HIGH	HIGH	HIGH	MEDIUM	MEDIUM	HIGH	
			HIGH	HIGH	MEDIUM	HIGH	HIGH	HIGH	

		Sanitation village inspections. National Filariasis Eradication Program. Media awareness.			HIGH				
Foodborne/ Waterborne Diseases	Increased frequency & duration of outbreaks. Increased numbers of	Development of standards and legislations.	3.2.2	HIGH	MEDIUM	3.2.3 3.2.4	MEDIUM	MEDIU	

	hospital admissions & attributed deaths.	Case investigations & contact tracing.	HIGH LOW HIGH	HIGH MEDIUM HIGH	HIGH *3.2.2.1.1* MEDIUM	**3.2.4.1** **3.2.4.2** HIGH HIGH HIGH	HIGH **3.2.4.3** HIGH HIGH	**3.** HIGH **3.**	

		Village Sanitation Inspections. Media Awareness.							
Mentall Illness	Increased number of people diagnosed with common mental	Development of policies and legislations.	**HIGH**	**HIGH**	**HIGH**	**HIGH**	**MEDIUM**	**LOW**	

	disorders.	Media awareness	HIGH	HIGH	MEDIUM	HIGH	HIGH	MEDIU	
Airborne Diseases	Increased numbers of hospital admissions and attributed deaths.	Media Awareness Expanded Program on Immun-ization. Development of Draft Avian Influenza Plan Establishment of Lab Surveillance System.	HIGH HIGH HIGH HIGH	HIGH HIGH HIGH HIGH	MEDIUM HIGH MEDIUM HIGH	HIGH MEDIUM MEDIUM MEDIUM	HIGH HIGH MEDIUM HIGH	MEDIU HIGH HIGH HIGH	
Direct Injuries including skin & eye diseases.	Increased number of attributed deaths & hospital admissions.	Community-based injury prevention workshops.	MEDIUM MEDIUM	MEDIUM HIGH	MEDIUM MEDIUM	HIGH HIGH	HIGH HIGH	HIGH HIGH	

		Development of emergency continuity plans.							
Infrastructure	Catastrophic damages to health centres and hospitals.	Rebuilding of weather-proof health centres.	3.2.7	HIGH	LOW	LOW	**3.2.8**	HIGH	

Infrastructure

About 70% of Samoa's population and infrastructure are located along the low-lying coastal areas of the Samoan islands.(source from NAPA). The main reason for this distribution pattern is the heavy reliance of the community on resources from the sea for subsistence consumption and for commercial purposes. Infrastructure therefore including buildings, bridges, roads and other utility services such as electricity, telecommunications and water are also located at these coastal hazard areas to assist the communities.

In the past the extreme event of tropical cyclones Ofa (1990) and Val (1991) caused damages to Samoa estimated to be about three times the GNP (NAPA, 2005) High winds, storm surge and heavy rains severely damaged 90% of the infrastructure including the coast of the main town Apia. In 2004 cyclone Heta struck and caused damages to the infrastructure but was not as serious as Ofa and Val.

Infrastructure

Climate change calls for a more innovative approach for dealing with climate risks and one that is already encouraged and practiced in Samoa: Adaptation.

Adaptation under Samoa's National Adaptation Plan of Action (NAPA) and CBDAMPIC

The Canadian funded project, Capacity Building for the Development of Adaptation Measures in Pacific Island Countries (CBDAMPIC) has already implemented some measures in two vulnerable communities; one in Upolu and the other in Savaii. These two pilot communities were identified according to their vulnerabilities to climate change and appropriate mitigations were implemented.

Saoluafata in the district of Anoamaa East was identified as being highly susceptible to coastal erosion; hence a sea wall was recommended and was constructed and completed in 2005.

Fig 11: Saoluafata seawall to overcome the rapid coastal erosion

The village of Lano in Savaii was also identified under NAPA as vulnerable to coastal flooding due to blockage of the natural stream route by the ford built. Therefore, a proper bridge was proposed and had just been completed to mitigate the problem.

NEED TO INSERT RELEVANT INFORMATION FROM THE NAPA

Agriculture

The agriculture sector is highly affected by changes due to climate such as extreme winds, high rainfall, high temperature and long dry periods. At the same time, pests and disease incidence will also increase which has caused a great loss of crop quality produce.

Instability of food production levels caused by climate induced disasters affect income generating activities to meet higher demands from communities and country at large is the most devastating direct effect of natural disasters. Samoa's geographical location plays more roles to the agriculture vulnerability by natural hazards such as cyclones, droughts and flooding. Three intense cyclones visited Samoa within the last twenty years. Thus since the 1990's the contribution of the agricultural sector to the economy started to decline steadily, particularly the two cyclones, Ofa and Val, in 1990 and 1991 causing severe damage to crops.

iii) Agriculture

Sector Component	Adaptation options	Cost	Effectiveness	Practicability	Environ Appr.	Social Appr.	Cultural Appr	Constraints
Crop Production	• Research on plant growth suitable to changing climate	H	H	M	H	H	H	High costs
	• Development of new taro varieties adapted to certain weather conditions	H	H	M	H	M	H	High cost, less expertise
	• Control Methods for fruiting	H	H	M	H	M	L	Lack professionals
	• Encouraging traditional knowledge of weather/climate variability	L	H	H	M	H	H	Villagers not committed
	• Planting short term crops	L	M	H	H	H	M	
	• Maintaining of cultivars and nurseries	M	H	H	H	M	H	
	• Research into the seasonality of crop planting	H	H	M/L	H	H	H	
Pests and Diseases	• Research into the use of biological control	H	H	M/L	L	L	L	Risk of biological control becoming pest

	• Quarantine surveillance of fruit flies	M/L	M/H	L	L	L	L	Lack equipment
	• Emergency Plan – Control and eradication of disease outbreaks	M	M/H	L	H	H	M	High Costs
Livestock	• Quarantine Protocols – Imported livestock treated for diseases before reaching Samoa	H	H	M	H	H	H	High Costs
	• Introduction of a new drought resistant cattle		H	M	L	M	M	
	• Introduction of the Fiji Fantastic sheep to diversify Samoan diet		M	H	M	H	L	Needs more training on sheep farming
Distribution								

Fisheries

All components of Fisheries (Oceanic Fisheries, Coastal Fisheries and Aquaculture) show very high vulnerability to levels of CO2. There may be no immediate impact but increasing levels of CO2 over time definitely will have consequences on global warming and this is very important to all sectors of Fisheries. SST is very critical for both the coastal and oceanic component in the immediate and long term as it can alter environmental conditions required to produce optimum productivity of the coastal fishery and deprive our EEZ of favorable habitats for important pelagic species to thrive on. For aquaculture, it stresses broad stock (giant clams) for restocking purposes as it will not operate within its normal range of temperature tolerance. There is no known immediate or long term vulnerability of Oceanic and Aquaculture on sea-level rise but it is important for coastal fisheries in the context of coastal erosion as this will have an impact on marine organisms particularly the sessile species. Extreme winds are all important for all components of Fisheries however, for Oceanic and Aquaculture, its infrastructure are more vulnerable as fishing vessels will be smashing onto each other at berth and along side the wharf, and the hatchery required for spawning purposes will be vulnerable from flying objects and fallen trees. Coastal and Aquaculture component of Fisheries are very vulnerable to extreme rainfalls as to the consequences of run off from land that will have in the coastal marine environment. Wave action if extreme will have a devastating effect on the coastal fishery and aquaculture. Wave action is also important for the oceanic component of Fishery.

There are currently no adaptations mechanisms for the Fisheries sector under NAPA however elements under tier 1 and tier 2 could be explored for fisheries resource users to build their capacity to adapt to climate change.

Matrix showing each sector component with likely impacts of climate change and its time dependency.

Sector Component	Climate Risks	Future Impacts	Methods Used to Assess impacts	Time Frame

Oceanic Fisheries	Extreme winds,	Increased extreme winds will reduce oceanic fisheries catch landings as to the safety of fishermen is a priority.	Oceanic fisheries catch and CPUE trends SST monthly records Expert judgement	Immediate to long term. (1 to 20 years)
	Sea Surface Temperature	High SSTs will affect CPUE for albacore, This could be in favour for yellowfin and skip jack as they are tropical species		
Coastal Fisheries	Sea surface temperature	*Coral bleaching, fish may move elsewhere*	Monitoring, Analogues, statistical models, expert judgement	Immediate to long term (1 to 30 years)
	wave actions	*Destroy nursery areas and damage habitat*		
	flooding,	*Flooding causes siltation, put pressure on corals and sessile invertebrates May smother fish nursery areas*		
Aquaculture	Flooding,	*Smother broad stocks of giant clams*	Monitoring and expert judgement	Immediate to long term (1 to 30years)
	wave actions,	*Could wash stress broad stock and consequently dies*		
	Temperature	*Stress broad stock and consequently dies.*		

Biodiversity

Many changes are anticipated for the biodiversity sector as a result of climate change, not only in terms of species population but the entire ecosystems as well. The impacts of these changes will eventually lead to other inter-related sectors namely fisheries, forestry, agriculture, tourism, infrastructure, health and water. Together with the detrimental impacts of human activities, climate related impacts on biodiversity will increase the need for effective adaptation activities in the future for the biodiversity sector.

Additional Requirements for Adaptation

Adaptation is practiced in two levels in Samoa: the community/village level and the national level. Adaptation measures are funded by the government and overseas donors, as well as by individuals and companies seeking to reduce their susceptibility to climate risks,

Community Level

Samoan communities are mostly settled in low-lying coastal areas. Here they plant coconut trees, banana patches, and other tree species to shelter their homes from sea sprays. This is a natural trend common to most Pacific island countries. Traditionally, coastal communities adopted a reactive response by temporarily moving inland to deal with impacts such as sea level rise, storm surges and cyclone events. This practice is still commonly found in Samoa, however some people have started to realize the importance of planning ahead and developing a more proactive response. This is seen by the enhancement of coastal restoration and mangrove conservation efforts seen at Vaiusu Bay and Moataa Mangrove Conservation Area.

Sand mining and gravel extraction is quite common in the community level. Beautification of villages results in excavation of too much sand from the coast. This was a traditional approach to villages along the coast and most people were not aware of its impacts until awareness programs were conducted under government programs to disseminate information on the impacts of these community activities on the environment.

National Level

The introduction of the NAPA project identified most of the vulnerabilities and adaptations at the national level.

The Infrastructure Asset Management Plan through its CIM Plans has identified coastal areas that are prone to hazards. As a result the Government of Samoa had completed constructing sea walls at some of these priority areas and is continuing building them at areas identified. In addition to seawalls, mangrove rehabilitation was also introduced in the CIMPs to help the coastline to regenerate and for the natural fauna and flora of the past to get back to the area.

Legislation, regulations, policies and relevant guidelines are also in place to guide the infrastructure sector, relevant authorities as well as the public in ensuring vulnerabilities are recognized and adaptation measures are adopted to counteract the impacts of climate change. The enactment of the Planning and Urban Management Act 2004 had been one of the government's strategies to attain sustainable development in Samoa. The Act requires that all developments in Samoa must be approved via the Development Consent Process. This process consists of an assessment by PUMA to ensure that the development has taken into account the environmental, social and economic impacts as well as remedial measures that the developer must implement to ensure sustainability of a proposed development.

Identify barriers and policy needs based on the sector and the activities/priorities identified.

MITIGATION

5 Introduction

5.1 Background on Mitigation

Samoa, along with most other countries including its Pacific island neighbours, has ratified the UNFCCC, which has the following objective:

> …stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time-frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner.[1]

This objective makes reference to the two broad options for dealing with climate change: mitigation and adaptation. Mitigation deals with the cause of climate change (rising GHG emissions), whereas adaptation addresses the effects (rising temperatures, sea level rise etc.). While adaptation is crucially important for Samoa, the main focus of this report is on mitigation. Further information on adaptation can be found in Samoa's National Adaptation Programme of Action.

In the context of climate change, "mitigation" refers to any action that reduces the magnitude of climate change through GHG abatement. Mitigation strategies aim to reduce GHG emissions (e.g. through efforts to reduce fossil fuel use) and/or enhance GHG sinks (e.g. through re-forestation). Mitigation, through GHG abatement, is the only long-term strategy to minimise the extent of climate change. Without urgent and immediate mitigation efforts at the global level, the Intergovernmental Panel on Climate Change (IPCC) predicts that the world will experience dangerous climate change, causing widespread social, environmental and economic damage. According to the IPCC, to avoid dangerous climate change global greenhouse gas emissions will need to be reduced by up to 85% below 2000 levels by 2050.[2]

5.2 UNFCCC Requirements and Guidelines

Samoa ratified the UNFCCC in 1994, which means it is obligated to take certain steps to implement this international agreement. The obligations related to mitigation are briefly summarised below.

- **Article 4.1(b):** Samoa is obliged to "[f]ormulate, implement, publish and regularly update national and, where appropriate, regional programmes containing measures to mitigate climate change".

1 UNFCCC, Article 2.
2 IPCC (2007), *Climate Change 2007: Synthesis Report. Summary for Policy Makers.*

- **Article 4.1(d):** Samoa is obliged to manage, conserve and enhance sinks and reservoirs of greenhouse gases, including forests and other terrestrial, coastal and marine ecosystems.
- **Article 4.1(f):** Where relevant, Samoa must take climate change into account in its social, environmental and economic policies and actions.
- **Article 6:** Samoa is required to develop and implement public education and awareness raising activities, as well as encouraging and facilitating public participation in efforts to reduce GHG emissions.
- **Article 12:** Samoa is required, through its national communications to the COP, provide details on its efforts into implement the Convention. This includes details on mitigation efforts. As a developing country, Samoa may also voluntarily propose projects for financing, including those aimed at reducing GHG emissions.

- *Guiding Principles*

While the UNFCCC creates certain obligations for Samoa and other developing countries, these must be interpreted in the context of the Convention's guiding principles. Most importantly, the UNFCCC recognises that countries have "common but differentiated responsibilities and capabilities." This means that while all countries must help to address climate change, "developed country Parties should take the lead." However, while the UNFCCC grants special consideration for developing countries, to ensure they are not adversely effected by the implementation of the convention, all countries are required "to take precautionary measures to anticipate, prevent or minimize the causes of climate change."

For Samoa, which has many development challenges another important principle is the right to sustainable development. According to Article 3.4 of the Convention "[p]olicies and measures to protect the climate system against human-induced change should be appropriate for the specific conditions of each Party and should be integrated with national development programmes, taking into account that economic development is essential for adopting measures to address climate change." It is important to recognise that efforts to reduce greenhouse gas emissions should not constrain sustainable social and economic development.

- *Requirements for Developed Countries to Support Developing Countries*

Recognising the limited financial and technical resources of developing countries, the UNFCCC includes specific provisions requiring developed countries to support developing countries in their efforts to implement the Convention. Article 3.3 requires that developed countries provide "new and additional financial resources" to help with developing countries to fulfil their obligations under the Convention. This includes financial support to implement mitigation activities. Samoa's obligations to reduce GHG emissions are therefore conditional on sufficient financial resources being made available.

- *Guidelines for National Communications*

At its eighth session (New Delhi, 2002), the UNFCCC Conference of the Parties adopted revised guidelines for the preparation of national communications from non-Annex I Parties (i.e. developing countries). With regards to mitigation, these guidelines include the following requirements:

- **Methodological approaches:** The methodology used by non-Annex I Parties to formulate and prioritise mitigation efforts should be appropriate to national circumstances. Mitigation assessments should include sustainable development considerations, including social, environmental and economic factors. Non-Annex I Parties are also encouraged to make use of technical resources.
- **Reporting:** Non-Annex I Parties are encouraged to provide information on mitigation activities have been implemented or which are planned. This should include information on methods used, scenarios, results achieved and institutional arrangements.

- *Mitigation Assessment Guidelines*

At its fifth session, the UNFCCC Conference of the Parties established the Consultative Group of Experts (CGE), with the objective of improving national communications from non-Annex I Parties. Amongst other things, the CGE prepared a detailed training manual for preparing mitigation assessments for national communications. While countries are not required to follow the manual, it does provide a useful resource. The training manual is available at: http://unfccc.int.

5.3 National Policy Context

- *Strategy for the Development of Samoa 2008-2012*

The Strategy for the Development of Samoa (SDS) is Samoa's main planning document, outlining a five-year national development programme. The latest update of the strategy covers the period 2008-2012, covering three broad priority areas: (i) economic policies, (ii) social policies and (iii) public sector management and environmental sustainability. The SDS includes a number of activities that are relevant to climate change mitigation. This includes a commitment to "make significant greenhouse gas reductions," to be achieved through "renewable energy use, energy efficiencies, sustainable transport and public awareness of the importance of greenhouse gas abatement."[3]

- *National Climate Change Policy*

Cabinet approved Samoa's *National Climate Change Policy* in early 2008. This policy "provides a national framework to mitigate the effects of climate change and adapt to its impacts in an effective and sustainable manner." The policy includes six objectives covering the following areas: public awareness; information management; capacity building; mitigation; adaptation; and regulation. Each of the objectives is backed up with a series of strategies to be implemented over the coming years. Activities related to mitigation include:

- Work closely with relevant sectors to monitor GHG emissions

3 Government of Samoa (2008), *Strategy for the Development of Samoa 2008-2012*, p.40.

- Update the national GHG inventories
- Explore Samoa's involvement in carbon trading
- Promote Clean Development Mechanism projects to reduce GHG emissions
- Promote mitigation actions in sectors including: Energy supply; Industry; Buildings; Transportation; Waste; Agriculture; and Forestry.
- Promote energy efficiency measures in the following sectors: Energy supply; Industry; Buildings; and Transportation.
- Develop new hydro power plant and improve the efficiency of existing generators
- Develop other sources of renewable energy such as solar, wind and ocean
- Work closely with relevant stakeholders to promote the use of renewable energy and energy efficiency
- Implement energy efficiency initiatives in the energy supply and transportation sectors through medium-sized projects funded by the Global Environment Facility (GEF) and Italy respectively
- Implement the Pacific regional renewable energy project coordinated by SPREP
- Implement the Pacific regional sustainable transport project coordinated by SOPAC
- Provide financial incentives to encourage climate change mitigation actions

- *National Strategy for Greenhouse Gas Abatement (draft)*

The overall objective of the draft *National Greenhouse Gas Abatement Strategy* (NGHGAS) "is to mitigate the impact of climate change through GHG abatement; supporting global action to reduce GHG emissions but also strengthening the national economy by the efficient operation of the relevant sectors producing GHG." This will be pursued through activities in the following objectives:

- Reduced GHG emissions from the land transport sector;
- Reduced GHG emissions from the electricity sector;
- Reduced GHG emissions from buildings;
- Reduced GHG emissions from deforestation and degradation;
- Reduced GHG emissions from the aviation and maritime transport sectors;
- Reduced GHG emission from replacing fossil fuel with biofuel;
- Reduced GHG emissions through new sources of renewable energy; and
- Regulatory framework to mitigate GHG emissions strengthened.

- *National Energy Policy*

The *National Energy Policy* was adopted by Cabinet in June 2007, with the following over-arching vision: "To enhance the quality of life for all through access to reliable, affordable and environmentally sound energy services and supply."[4] This vision is to be pursued through two goals: (i) "To increase the share of mass production from renewable sources to 20% by year 2030"; and (ii) "To increase the contribution of renewable energy for energy services and supply by 20% by year 2030." The policy includes a number of strategies that are of particular relevance to mitigation:

- Indigenous energy resources;
- Renewable energy resources and technologies;

4 Government of Samoa (2007), *National Energy Policy*.

- Efficiency of electricity production, transmission and distribution;
- Demand-side management strategies for increased efficiency;
- Regulate the importation of energy efficient vessels, motor vehicles and aircrafts;
- Promote fuel efficiency in land and sea transport; and
- Encourage the use of public transport.

- *Policies and Laws Relating to Forests [STILL TO COMPLETE]*

Samoa's forests are governed by the Forest Act 1967 and the Forest Regulations 1969, both of which are primarily focussed on the management of forests for commercial logging interests. However, in early 2007 Cabinet passed a motion banning all commercial logging operations. This Cabinet decision will be given legal effect by the *Forest Resource Management Bill*, which is to be passed by Parliament before the end of 2008.
Still to complete- The Forest policy – see old version and new draft.

- *Other National Policies [STILL TO COMPLETE]*

Other national policies that are relevant to Samoa's mitigation efforts include:
- *National Land Use Policy*;
- *National Policy on the Conservation of Biological Diversity*;
- *National Waste Policy*;
- *Water Sector*;
- Agriculture Sector; and
- *Protection of the Ozone Layer Regulations*,

5.4 Regional Policies

Samoa is an active participant in Pacific island regional affairs and has signed on to a number of regional policies and initiatives that have implications for climate change mitigation. These are briefly outlined below.

- **Pacific Plan***:* Endorsed by Pacific island leaders in October 2005, the *Pacific Plan for Strengthening Regional Cooperation and Integration* includes some strategies for the promotion of environmentally sound energy options and the facilitation of international financing for action on climate change.
- **Pacific Island Framework for Action on Climate Change:** Approved by Pacific island leaders in June 2005, the PIFACC includes regional activities aimed at "contributing to global greenhouse gas reduction." In relation to mitigation, expected outcomes by 2015 include: Energy efficiency actions and cost effective technologies promoted and implemented; Cost effective renewable energy technologies and local sources promoted, shared and implemented; and Clean Development Mechanism initiatives developed and implemented, where appropriate. The Secretariat for the Pacific Regional Environment Programme (SPREP) is responsible for implementing the PIFACC and is currently preparing an implementation plan.
- **Pacific Islands Energy Policy:** Adopted in November 2004, the policy includes a number of important goals relevant to mitigation: efficient power generation; environmentally clean and efficient transportation; development of renewable energy; and improved energy efficiency.
- **Solid Waste Management Strategy for the Pacific Region:** Developed by SPREP and adopted by Pacific island countries and territories in 2005. While

the Strategy does not include any reference to GHG emissions, it's implementation may help to promote recycling and reduce the amount of waste going to landfill, which in turn may help to reduce emissions.

5.5 Outine of the Mitigation Analysis Presented in this Report

In broad terms, there are two options for climate change mitigation. Option one involves taking steps to reducing the amount of GHGs being released into the atmosphere, while option two involves enhancing carbon sinks to absorb more carbon dioxide from the atmposphere.

In Samoa the energy sector is the major source of GHG emissions and is also the sector where there is the greatest potential to reduce emissions. For this reason, the bulk of this report focusses on mitigation in the energy sector. A more concise summary of mitigations in the non-energy sectors is also provided. Finally, a discussion of the potential to enhance forest sinks is presented.

- *Reducing Energy Sector Emissions*

Reducing GHG emissions from the energy sector primarily involves taking steps to reduce fossil fuel consumption. Burning of fossil fuels, such as diesel, gasoline, kerosene and LPG, for electricity generation, transport and other energy needs results in GHGs being released into the atmosphere. In some countries there are also GHG emissions from the fossil fuel refining processes, but this is not the case in small countries such as Samoa where there is no fossil fuel production.

Mitigation strategies targeting the energy sector must focus on the key users of fossil fuels, as well as the activities that are dependent on fossil fuel use. For example, in Samoa electricity generation accounts for the bulk of total diesel consumption, which means to reduce GHG emissions attention must be given to reducing diesel used for this purpose. This can be done by improving the efficincy of electricity generators to minimise diesel consumption, using alternative sources of energy for electricity generation, or reducing demand for electricity. The first two of these strategies is focused on the supply-side of electricity sector and directly targets fossil fuel consumption for this purpose. The third strategy shifts attention to the activities that drive demand for electricity. Implementing measures to minimise demand, indirectly results in GHG savings by reducing the amount of electricty that needs to be generated and as a consequence the amount of diesel used.

- *Reducing Emissions from Non-Energy Sources*

There are a variety of other sources of GHG emissions, not related to the use of fossil fuels. The potential to reduce emissions varies between these sources, with some offering significant abatement opportunities. In this report attention is focussed on the main sources of non-energy sector emissions, while activities that are a minor source of emissions are not assessed.

- *Enhancing Carbon Sinks*

Forests absorb carbon from the atmosphere, thus offering a potential carbon sink, which can offset carbon dioxide emissions from other sources. Much of this report is

focussed on what Samoa needs to do to improve data and information on forests, deforestation and forest degradation. Some discussion is provided for how Samoa may be able to participate in the international carbon trading market through efforts to reduce emissions from deforestation and degradation (REDD).

6 Samoa's GHG Emissions and Implications for Mitigation

The results from Samoa's second GHG inventory provide an important starting point from which to assess mitigation options. The GHG inventory was prepared using the *2006 IPCC Guidelines for National Greenhouse Gas Inventories*, and assessed emissions in the following four sectors: energy, industrial processes and product use (IPPU), agriculture, forestry and other land use (AFOLU), and waste. Full results from the GHG inventory are presented in the inventory report. A brief summary of key findings is presented below.

6.1 Key Sources of GHG Emissions in Samoa

In 2007 Samoa's GHG emissions totalled approximately 352,034 tonnes of CO_2-equivalent (t CO_2-e). The GHG inventory also estimated CO_2 removals in forests and on croplands, which totalled -785,067 tonnes in 2007. Full records of Samoa's GHG emissions covering 1994-2007 are provided in appendices 3-4.

Sector	CO_2	CH_4	N_2O	HFCs	Equiv. CO_2 Emissions	CO_2 Removals
	tonnes	tonnes	tonnes	t CO2-e	t CO_2-e	Tonnes
Energy	170,981	50	7.5	-	174,350	-
Industrial Processes & Product Use	4,138	-	0.4	5,253	9,507	-
Agriculture, Forestry & Other Land Use	4.55	4,207	152	-	135,366	-785,067
Waste	2,409	1,422	2	-	32,811	-
TOTAL	**177,533**	**5,679**	**161**	**5,253**	**352,034**	**-785,067**

Table 2.1: Samoa's overall GHG emissions and removals (2007).

The energy sector is the main source of GHG emissions, accounting for 50% of the national total (Figure 2.1). This is followed by the Agriculture, Forestry and Other Land Use (AFOLU) sector, which accounts for 38% of emissions. Emissions from the Waste and Industrial Processes and Product Use (IPPU) sectors make up 9% and 3% of total CO_2-e emissions respectively.

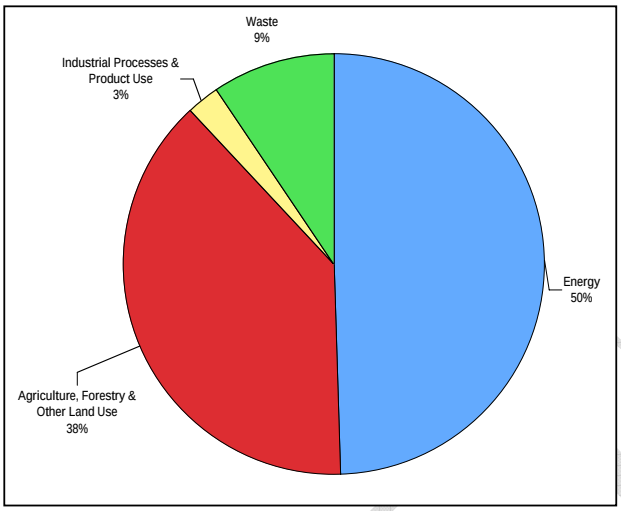


Figure 2.1: Sectoral breakdown in Samoa's total GHG emissions (2007)

The two activities contributing most to Samoa's emissions are road transport and livestock farming, which account for 27% and 25% respectively (Figure 2.2). Electricity generation and other agricultural activities, including N_2O emissions from managed soils, each account for approximately 13% of emissions. Other energy consumption, including fuel used by households and commercial and institutional organizations accounts for 10% of emissions. Wastewater and solid waste disposal (including incineration and open burning) accounted for 7% and 2% respectively. Activities in the IPPU sector contributed 3% of emissions.

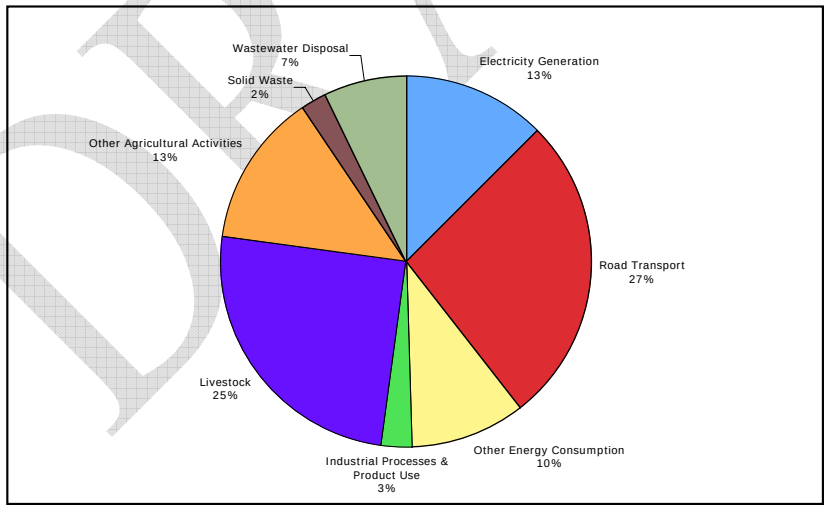


Figure 2.2: Detailed breakdown of Samoa's total GHG emissions (2007)

As shown in Table 2.2, the results of the GHG inventory confirm that 95% of Samoa's emissions come from just six sources. This has important implications for GHG abatement efforts, as it helps to ensure limited resources target areas where they can have the biggest impact.

Rank	Source	Emissions (t CO2-e)	% of total emissions
1	Road Transport	95,105	27%
2	Livestock Farming	88,357	25%
4	N_2O from Agricultural Soils	47,005	13%
3	Electricity Generation	44,214	13%
5	Other Energy Consumption	34,141	10%
6	Wastewater	25,438	7%
	TOTAL	**335,150**	**95%**

Table 2.2: Top six sources of GHG emissions in Samoa (2007).

6.2 Trends in Samoa's Emissions

Samoa's GHG emissions have increased by approximately 113% since the 1994 baseline, when total emissions were approximately 165,633 t CO_2-e. This represents an average annual growth rate of 16%. As can be seen in Figure 2.3, the fastest rate of growth occurred in the AFOLU sector, which also increased its share of total emissions. A minor part of the growth in emissions can also be attributed to the inclusion of IPPU emissions, which were not assessed as part of the first GHG inventory. A full analysis of the trends in each sector is provided in subsequent sections of this report. As already discussed, it is important to note that the results presented here are the revised estimates from the first inventory (1994-1997). A full explanation of the revisions process is given in Appendix 1.

It is important to note that growth in Samoa's GHG emissions is coming off a relatively low baseline. In 1994, when emissions were first recorded, a significant portion of households still had no access to electricity and the economy was largely based on agriculture. Since then, much has changed in Samoa with significant social and economic development. Further discussion of the key drivers of GHG emissions is provided in the subsequent sections of this report.

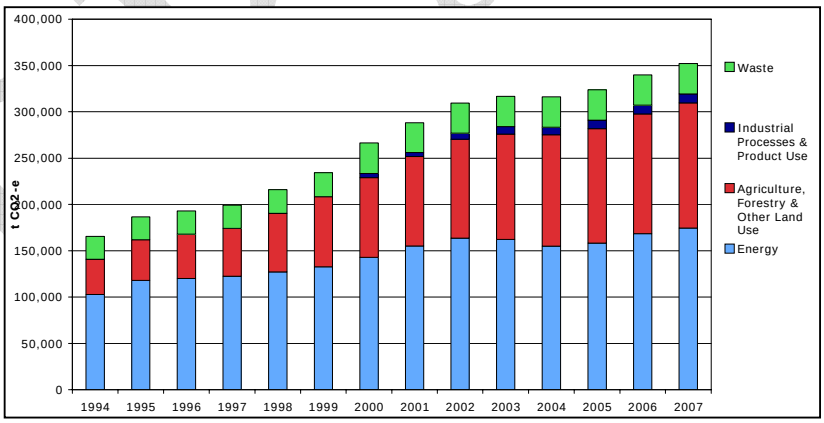


Figure 2.3: Trends in Samoa's GHG emission (1994-2007).

As shown in Figure 2.4, the livestock farming contributed the most to emissions growth in the period 1994-2007, accounting for 36% of total growth. Electricity generation was the next biggest source of growth in emissions, accounting for 19% of total growth. Growth emissions from agriculture, including N_2O emissions from managed soils, pushed total emissions up by 17%. Energy use in the road transport and manufacturing and construction sectors accounted for 14% and 9% of total

emissions growth respectively. Meanwhile, total emissions in the IPPU and waste sectors had a smaller impact of overall growth, accounting for 5% and 4% respectively.

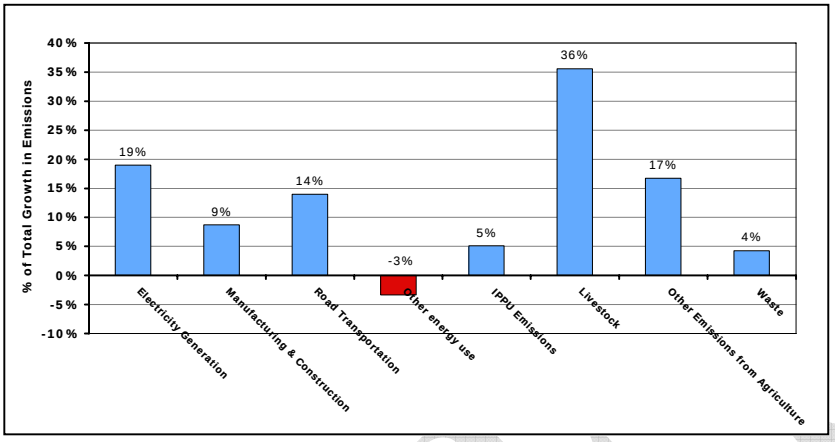


Figure 2.4: Contribution to overall growth in emissions for the period 1994-2007 (% of total growth).

6.3 Key Drivers of Emissions Growth

The increase in Samoa's GHG emissions can be attributed to a range of different factors. Most importantly, the rising number of cattle being farmed in Samoa has been a major driver of emissions growth. Indeed the surveys carried out by the Ministry of Agriculture and Fisheries show that between 1999 and 2005 the number of cattle being farmed in Samoa grew by 74%, from 28,000 to more than 48,500. This large increase in cattle numbers has put upward pressure on methane emissions from livestock farming, as well and nitrous oxide emissions from agricultural soils, which are two of the main sources of emissions growth in Samoa (see discussion above).

The second factor forcing up Samoa's GHG emissions is the growing reliance on imported petroleum products for energy needs. In the period 1989-2007 imports of diesel and motor gasoline have increased by 118% and 112% respectively. A nationwide electrification programmed undertaken by the Electric Power Corporation in the mid-1990s was a key factor behind this rising demand for diesel, pushing total electricity generation up from 58.82 GWh in 1994 to approximately 111 GWh in 2006. While in 1994 approximately 89% of Samoa's electricity was supplied through hydropower schemes, this figure that had been reduced to 47% in 2006, with most of the rising demand met through diesel generation (Figure XXX).

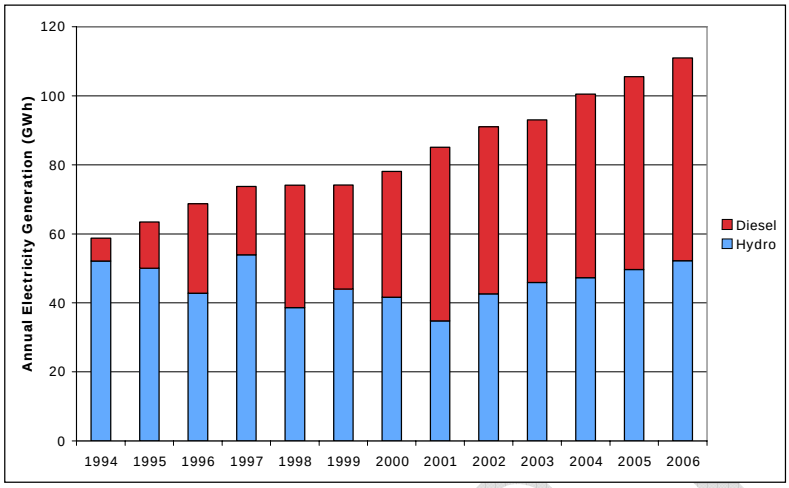


Figure XXX: Hydro vs diesel electricity generation in Samoa (GWh, 1994-2007). (Figures for 1994-2003 from SPREP; 2004-2006 from EPC 2006)

The growth in emissions from road transport is a consequence of the increasing number of cars and trucks on Samoa's roads, which has driven up demand for fossil fuels. The total number of vehicles registered in Samoa has almost doubled since 1994. As illustrated in Table XXX, there have been particularly big increases in the number of private cars, pick-ups, taxis and trucks.

Year	Pvte Cars	Pick-ups	Trucks	Buses	Taxis	Motorcycles	Tractors	Other	Total
1994	2134	2710	510	209	1057	110	30	729	7480
2000	2017	2173	922	252	1000	80	*Na*	103	9983
2005	4591	3493	1201	333	1798	80	39	3228	14763

Table XXX: Trends in the number and type of registered vehicles in Samoa (source: IPA, 2005)

7 Mitigation in the Energy Sector

7.1 Introduction

As outlined in the previous section, the energy sector is the largest source of GHG emissions in Samoa, particularly the consumption of petroleum products for transport and electricity generation. This section provides an overview of options for reducing these GHG emissions in Samoa, including past, present and planned activitities, as well as additional future options.

7.2 Past Activities

A number of activities/initiatives have been implemented in the past, which have helped to limit fossil fuel consumption in Samoa's energy sector. While these activities were not specifically implemented to reduce emissions, this was nevertheless an important additional benefit. Each of these past activities is briefly summarised below, along with an estimate of the annual GHG savings.

- *Hyrdo-Power System*

Samoa has an extensive network of hydro-power plants, with a capacity to generate XX MW of electricity. Over the period 1994-2006 an average of approximately 45.79 gWh of hydro-electricity has been produced annually, saving approximately 13,468 kl of diesel each year, which would have otherwise been used to produce electricity. This equates to annual GHG savings of approximately 36,335 t CO_2-e.[5]

It is important to note that the proportion of electricity generated from hydro-power versus diesel has declined over recent years. In 1994 approximately 89% of Samoa's electricity needs were met through hydro. However, in 2006 hyrdo provided only approximately 47% of Samoa's total electricity requirements. This is because the growth in demand for electricity has not been matched with investment in new hydro-power plants. Since XXX all new generation capacity in Samoa has been from diesel generators.

- *Solar Power Initiatives*

The most recent experience with solar photovoltaics (PV) is on Apolima Island, where a 13 kWp photovoltaic system was installed in 2006, providing nine households with 24 hr electricity supply. A separate 1 kWp PV system was also installed at the same time to provide electricity for Apolima's church. Prior to the installation of this PV system, electricity needs were met by a small and unreliable diesel generator. It is estimated that the Apolima PV system produces approximately 9.2 mWh of electricity per annum, reducing diesel consumption by approximately 2.7 kl annually.[6] This results in GHG savings in the order of 7.2 t CO_2-e annually.

As noted by Wade (2004), a trial PV system was installed in Safotu village in 1986. However for a range of reasons this small-scale initiative was not successful and village is now grid connected. Wade (2004) also noted that Virgin Cover Resort in Sa'napu village has installed a PV system, but no further details are provided.

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5 This is calculated using the *2006 IPCC Guidelines for National GHG Inventories*.
6 Estimated using national average household energy use figure (1,024.29 kWh/household/year) and national average diesel generator efficiency figure (3.4 kWh/litre).

A relatively number of households and businesses have installed solar hotwater heaters. However, the vast majority of households do not have any plumbed hotwater systems. For the most part bathing is done using cold water, while cooking and cleaning is done using water heated on gas, electric, kerosene or wood stoves.

- *Coco-Generation Trial*

Throughout XXX, EPC trialled a bio-fuel made from coconuts in several of its diesel generators. The "coco-diesel" was blended with regular diesel at levels of 5-20%. This was only a trial, which means there were no ongoing GHG savings. EPC has indicated that the trial was successful and is currently exploring options for using coco-diesel on a permanent basis.

7.3 Planned Mitigation Activities

A number of planned activities have been identified, which are likely to reduce GHG emissions in Samoa. Details of these activities are provided below. A summary of the potential GHG savings from these activities is also provided in Table XXX.

- *Renewable Energy*

The development and expansion of renewable energy resources provides an important opportunity to reduce GHG emissions in Samoa, by helping to reduce dependency on fossil fuels. In recent years the level of attention given to renewable energy in Samoa has increased substantially, reflecting a number of factors. The main driver behind the push for renewable energy in Samoa is to reduce the country's dependence on imported petroleum products. However, reducing GHG emissions has also become a central goal of Samoa's renewable energy programme.

Hydroelectric Power

Hydroelectric power has been identified as a priority renewable energy option for Samoa, and preliminary investigations have identified a number of potential sites (REF). As part of the Asian Development Bank (ADB) supported Power Sector Expansion Program, finances have been allocated to invest in a hydropower scheme, with work to begin in 2012. While no formal decision has been made about which site will be developed, most of the attention has been given to the proposed Vaita'i scheme (Sili village). According a study prepared as part of the ADB project, it is envisioned that a 2.0 MW hydropower station be built at the Vaita'i site, with an average annual energy output of 8,600 MWh/annum (REF). Given the current community opposition to the Vaita'i proposal, it remains unclear whether this scheme will be developed. However, even if it does not go ahead, ADB has reportedly given preliminary approval for an alternative scheme to be financed (Ref: EPC, 2007 – draft data collection programme – printed doc from Ed.).

Assuming that a hydropower scheme of a similar size to the proposed Vaitai scheme is developed as part of the Power Sector Expansion Program, this will result in annual GHG savings of approximately 6,410 t CO2-e from 2014 onwards. This estimate is based on the assumption that 8,600 MWh will be generated annually, saving approximately 2,300 kilolitres of diesel.[7]

In addition to the proposed Vaita'i scheme, various other potential schemes have been identified. An initial study prepared as part of the Power Sector Expansion Program preparatory phase identified 13 additional potential schemes, with a total estimated capacity of 31.34 MW (REF). The Electric Power Corporation has indicated that at least two years of hydrological data is required to confirm the true potential of these proposed hydropower schemes (E. Langham, pers comms). In addition, a more extensive feasibility study would be required. The Electric Power Corporation (EPC) plans to initiate stream flow monitoring at 8 sites, beginning in 2008. This will provide the hydrological data needed to assess the viability of other proposed hydropower schemes. This monitoring work is being supported by the Global Environment Facility as part of the Pacific Island Greenhouse Gas Abatement through Renewable Energy Project (PIGGAREP). To date there are no firm plans to develop any of these sites and, unlike the proposed Vaitai scheme, no funding has been earmarked.

Biofuels

Petroleum Products Supplies (PPS), a privately owned company, has announced plans to begin production of coconut oil as a substitute for regular diesel. According to the General Manager of PPS, machinery and equipment has been purchased and is due to arrive in Samoa during 2008, with production to being shortly after. The short-term target is to produce 3.5 million litres of coconut oil per year, with the longer-term goal (within 10 years) of producing up to 15 million litres per year. PPS has indicated that their immediate preference it to sell all of this coconut oil to EPC. However, as of February 2008, no formal agreement had been reached with EPC.

According to PPS their coconut oil will not require blending with other fuels, so can be used as a 100% diesel substitute. Assuming the target of 15 million litres is met, and that no blending is required, this initiative has the potential to save 40,397 t CO2-e per annum by 2018.[8]

The Research and Development Institute of Samoa, a stand-alone research body that reports to the Minister for Natural Resources and Environment, has established a research programme aimed at producing ethanol as a fuel source. This research is currently funded by the Government of Samoa, however MNRE has also applied for funding (US$250,000) from the Government of Italy to support this initiative. The research programme will explore the viability of producing ethanol from breadfruit, cassava and other food crops that are readily available in Samoa. The preliminary intention is to blend the ethanol with unleaded petrol at a ratio of 10:90 ("E10") for use in cars. RDIS has a target to produce 3 million litres or ethanol per annum within

7 The estimated efficiency of diesel generators on Savaii is 3.62 kWh/litre (based on data from EPC).
8 Include details of how emissions savings were estimated…

five years. Assuming this target is met, the associated GHG savings would be approximately 6,963 t CO2-e per annum.[9]

As part of its proposed Greenhouse Gas Abatement in Samoa's Electricity Sector, MNRE has applied for financial support from the GEF for a biomass gasification demonstration project. IF approved, this project is expected to begin in early 2009. At this stage the finer details of the gasification component of the project are still to be finalised. No production target has been set, which means that a potential GHG savings are unknown.

Ed's scoping doc makes reference to MoU with FOA re use of ag/forest waste for electricity prod…

Solar Energy
Building on the experience gained through the Apolima solar project (discussed above), EPC plans to roll out a photovoltaic (PV) electrification programme, targeting households that are not currently connected to the electricity grid. This program is still in the preparatory phase, which will determine the exact number of households to be connected to PV systems. According to EPC it is likely that 300 stand-alone systems will be installed through this programme [need to confirm with Ed whether this will be 300 households?]. If this is the case, the anticipated GHG savings will be approximately 234 t CO2-e per annum.[10] However, this figure could be higher if most of the PV systems are installed in Savaii, where all of the electricity is currently supplied by diesel.

It is important to note that the PV systems installed under EPC's PV programme will be meeting additional electricity demand, which means it does not constitute a reduction in GHG emissions. Nevertheless, by avoiding additional demand for electricity generated from diesel, this initiative will help to slow the growth in emissions.

Wind Energy
With funding from UNDP, EPC has installed two wind monitoring masts on Upolu, with the intention of assessing the overall wind resource for Samoa. The data collected will be used to prepare a wind atlas for Samoa, which will help to identify suitable locations for wind generators. Depending on the findings of this work, more detailed feasibility studies will be prepared for each potential site to assess the technical, institutional, environmental, economic and financial viability. While this preparatory work does not generate any GHG savings, it is hoped that it will lead to the installation of wind turbines in Samoa, which will displace the need for diesel generation.

- ## *Energy Efficiency*

The efficient generation, distribution and use of electricity helps to minimise diesel consumption, which in turn helps to reduce GHG emissions. To date, there has been very little emphasis on energy efficiency in Samoa. However, as outlined below, there

9 Include details of how emissions savings were estimated…
10 Include details of how emissions savings were estimated…

are a number of plans to improve both supply- and demand-side efficiency in the coming years.

Supply Side Efficiency
The term "supply-side efficiency" refers to the overall efficiency of electricity generation and distribution. An efficient generation and distribution system is one where the total amount of electricity generated closely matches demand. In contrast, an inefficient system is one where more electricity is generated than is actually needed, resulting in "lost" electricity. Overall system losses for Samoa's electricity grid were estimated to be approximately 20% in 2006 (XXX). This means that the amount of electricity being generated is 20% higher than what is required to meet electricity demand.

As part of the Power Sector Expansion Program, EPC aims to reduce technical system losses by 10% by 2010 and 20% by 2012 through improving the efficiency of the transmission and distribution system. Accounting for a forecasted demand growth of 4% per annum, this is equivalent to reducing electricity demand by approximately 1.42 GWh in 2010 and 3.08 GWh in 2012. Assuming these targets are met, this resultant annual GHG savings will be approximately 1,131 t CO2-e and 2,446 t CO2-e for 2010 and 2012 respectively.

As part of its proposed Greenhouse Gas Abatement in Samoa's Electricity Sector project, MNRE intends to implement a demonstration project to improve supply side efficiencies in the electricity sector, covering generation, transmission and distribution. The finer details of the proposed project are still to be finalised and potential savings have not yet been quantified.

Demand Side Efficiency
MNRE's proposed Greenhouse Gas Abatement in Samoa's Electricity Sector project, intends to implement demonstration projects to showcase opportunities for demand side energy efficiency in the following areas: domestic end-users, industrial end-users, peak time electricity utilisation and building systems (Ref: PIF document). As mentioned above, the details of these projects are yet to be finalised and no targets for GHG abatement have been set.

The Power Sector Expansion Program will include the development of a demand-side management and energy conservation strategy for Samoa. According to the ADB, this strategy will "focus on the policy environment and tax incentives to promote energy efficiency."[11] Exactly how this will translate into actual energy savings remains to be seen.

- ## *Initiatives Targeting Transport*

MNRE has designed the Greenhouse Gas Abatement through Energy Efficiency and Biofuel Applications in the Land Transport Sector project, which has been submitted to the Government of Italy for possible funding. If approved, the project will include a component to promote energy efficiency in the land transport sector. The proposed

11 ADB (2007), *Technical Assistant Report: Independent State of Samoa: Technical Assistance Cluster for Implementing the Samoa National Energy Policy* (Project number 38183), available from: www.adb.org, p.3.

project is still in its early stages of planning, with specific activities to developed once approval has been granted by the Italian Government. The preliminary project concept includes the following activities relevant to fuel efficiency in the transport sector:

- Awareness programmes on energy efficiency for land transport users
- Enforcement of requirements for vehicle exhaust testing as part of the warrant of fitness
- Enforcement of engine performance as priority in vehicle road worthiness
- Promotion of vehicle engines with efficient fuel consumption
- Enforcement of road speeds to maximize fuel consumption
- Review design and construction of roads to maximize fuel consumption
- Introduce vehicles using fuels other than fossil fuel (e.g. electric cars, hybrids, coconut oil, etc.)
- Strengthen public transport services and enforce operating schedules
- Provide safe and comfortable bus stop shelters
- Promote the use of car pooling (even for taxis)
- Standards to support energy efficiency in motorized transport operations.
- Financial mechanisms to encourage energy efficiency in transport operations.
- Utilization of non-motorized transport.

The South Pacific Applied Geosciences Commission (SOPAC) has designed the Promotion of Environmentally Sustainable Transportation in the Pacific Islands (PESTRAN) project, which has been submitted to the GEF for consideration as part of the Pacific Alliance for Sustainability. If this regional project received GEF approval, it will include a number of activities to promote sustainable transport in Samoa. However, the details of these proposed activities have yet to be finalised. The PESTRAN document submitted to the GEF includes some estimate GHG savings. However, these are based on estimated GHG emissions taken from the UN Statistics website, which are substantially higher than Samoa's actual emissions. It appears that more work is needed by SOPAC to confirm what the actual emissions savings may be from this project.

Mitigation Option	**Activities**	**Agency / Agencies**	**Funding Source**	**Timeline**	**Potential GHG Savings**
Renewable Energy	2.0 MW hydropower scheme (Savaii)	EPC	ADB	2008-2010	
	Coconut oil as a diesel substitute (PPS)	Petroleum Products Supplies		Production to begin in 2008.	
	Ethanol for blending with unleaded petrol.	Research and Development Institute of Samoa, Ministry of Natural Resources and Environment		Aim is to have ethanol market ready by 2012.	
	▪				
				???	
	▪				
Energy Efficiency					
Abatement of non-energy					

emissions					

- *Other Initiatives Planned for the Energy Sector*

Legal Reforms

A number of legal reforms have been proposed that will have implications for GHG abatement in the energy sector. These are briefly outlined below:

- The Ministry of Finance has announced plans for prepare a Renewable Energy Bill in 2009 (MoF XXX Strat act plan). No further details are available regarding what the Bill may aim to achieve.
- As part of its proposed Greenhouse Gas Abatement in Samoa's Electricity Sector project, MNRE plans to introduce energy efficiency standards electrical equipment and appliances and buildings. As part of the same project, MNRE aims to prepare enabling legislation for energy efficiency

Clean Development Mechanism

As part of the Power Sector Expansion Program, the Ministry of Finance plans to establish Samoa's Designated Authority (DNA) to oversee and approve clean development mechanism (CDM) initiatives. The aim is to have the DNA established by February 2009 (ADB, 2007x). Once the DNA is operational, this will allow CDM activities to be implemented in Samoa. The establishment of the DNA will also be financially supported by PIGGAREP.

Clean Energy Fund

As part of the ADB funded Power Sector Expansion Program, the Government plans to establish a Clean Energy Fund (CEF). The aim of the CEF is to "improve the coordination of financing sources for clean energy resources in Samoa and is envisaged as a revolving fund" (ADB, 2007x). The exact details of how the CEF will operate remains unclear, but holds significant promise as an important option for financing renewable energy activities.

Training and Capacity Building

ADB (supported by PIGGAREP) – still to include.

Energy Data Management

The Ministry of Finance has developed an electronic database to manage all energy import, sales and consumption data, including data on renewable energy. According to staff from the Energy Section, the database will be fully operational in mid-2008, when the first biannual report will be released. While the energy database will not directly contribute to GHG abatement, it will provide an important tool for monitoring overall GHG emissions.

Education and Public Awareness

Education and public awareness have been identified as key areas for action to promote renewable energy and energy efficiency in Samoa. A number of specific plans have been put forward, including the following:

- MoF, in its Energy Policy Strategic Action Plan (REF), plans to hold an annual National Energy Awareness Campaign, as well has coordinating annual public awareness campaigns on renewable energy and fuel efficiency in land and sea transport.
- The two energy projects proposed by MNRE's (see above) include significant

public awareness activities.

7.4 Additional Mitigation Options

The assessment of mitigation options presented in this report has been prepared using a bottom-up methodology, whereby GHG abatement options were assessed for each of the key sources. A timeframe of 2030 has been used…

- *Assessment Criteria*

- *Electricity*

Energy Efficiency

To date there has been very little work done to improve energy efficiency in Samoa, nor has there been a comprehensive assessment of energy efficiency options. However, it is widely recognised that energy efficiency should be a priority for reducing dependance on imported petroleum products, which will also help to reduce GHG emissions. As discussed above there are a number of plans to target energy efficiency in the coming years. The following additional activities are proposed to maximise the impact of energy efficiency efforts in Samoa.

- **Improving supply-side efficiencies:** Efforts to reduce system losses being implemented as part of the Power Sector Expansion Program should be expanded upon. The short-term goals adopted as part of this program should be complimented by a longer-term continuious improvement plan, whereby system losses are progressively reduced and kept to a minimum. A system should be implemented to monitor losses and implement response measures. Long-term planning and strategic investments will help to ensure system losses are minimised.
- **National energy efficiency assessment:** To date, there has been no comprehensive assessment of energy efficiency options in Samoa. Such an assessment is fundamentally important as it will help to identify where the simplist and most cost effective interventions can be made.
- **Demand-side energy efficiency strategy:** As discussed above, a national demand-side energy efficiency strategy will be prepared as part of the Power Sector Expansion Program. This strategy should be based on the findings of the national energy efficiency assessment. Key elements of the strategy may include:
    - *Commercial energy use:* In 2006 commercial customers accounted for 45% of total electricity consumption in Samoa. A program should be developed and implemented to improve efficiency in this sector. Ideally, this should begin by targeting the biggest users.
    - *Household energy efficiency:* In 2006 domestic customers accounted for approximately 24% of all electricity sales. Anecdotal evidence suggests that there is signifcant scope to improve energy efficiency in households, through education behaviour change programs, as well as through the promotion of more efficient technology. Lighting is believed to be a key opportunity to improve efficiency.
    - *Government departments:* Government departments accounted for 10% of electricity sales in 2006. There are many opportunities to cut

demand in this sector, particularly through simple changes such as turning off computers and airconditioning overnight.

- *Other electricity users:* Hotels, industrial customers, churches and schools account for make up the remaining 21% of electricity use in Samoa. Energy efficiency programs may be particularly effective by targeting these customers.

In the absence of a comprehensive assessment of demand-side energy efficiency options for Samoa, it is difficult to accurately estimate the potential GHG savings to be made. However, according to one study, demand-side energy efficiency measures could reduce energy demand by 15%. Based on 2007 emission estimates, this would equate to annual GHG savings of XXX t CO_2-e. Assuming savings of this magnitude are achieved over a ten year period beginning in 2010, during which time demand is expected to grow at a rate of 4% pa, the potential GHG savings by 2020 would be XXX t CO2-e.

Expansion of the Hydropower Network

As discussed above, the expansion of Samoa's hydropower network has been identified as a priority option for meeting growing electricity demand. However, to date, the only firm plans are for a new 2.0 MW system to be built as part of the Power Sector Expansion Project. According to a number of preliminary studies there is potential for an additional XXX MW of hydropower to be installed, producing approximately XXX GWh of elextricity annually (see Table XXX). Assuming that all of these potential locations are indeed viable, the potential GHG savings would be XXX t CO_2-e per annum. Given the significant investment required to establish hydro-power schemes, it is likely that such savings would be achieved by 2020. A more realistic prospect is that XX of the potential hydropower schemes are developed between 2010 and 2020, resulting in savings of XX t CO2-e pa by 2020.

On balance, the expansion of Samoa's hyrdopower network is considered a high priority for GHG abatement. As well as being an effective method to reduce emissions, as detailed in Table XXX, expanding the hydropower network is considered a technically and economically viable option for reducing GHG emissions in Samoa. However, based on past experience there is a risk that future hydropower schemes may face opposition from community stakeholders. In addition, hydropower schemes have the potential to cause damage to surrounding environmental assets, including freshwater resources and biodiversity.

Wind Energy

Whether or not wind energy represents a viable option for electricity generation in Samoa depends on the outcomes from the wind monitoring programme that EPC currently has in place. While there is significant optimism amoungst key stakeholders, the true potential of wind energy in Samoa remains unknown. However, despite this uncertainty there at least one report has been prepared to put a figure on the potential contribution of wind energy in Samoa. In his report prepared as part of the Pacific Regional Energy Assessment, Wade indicated that it would be realistic to expect five 250 KW wind turbine systems to be viable in Samoa. A wind energy network of this size would contribute approximately 1 MWh of elecricity per annum, thus displacing approximately XXX litres of diesel generation. This is equivalent to GHG savings of approximately XXX t CO2-e annually.

Stand-alone Solar PV Systems
Although technically viable, stand-alone solar PV systems remain expensive and are only considered financially viable in situations where there are high costs of grid connection. In the short-term, the planned use of PV systems for rural electrification (discussed above) is likely to be the only economically viable application in Samoa. Once this programme is rolled out it is anticipated that there will be very few unelectrified households remaining in Samoa. In addition, it is conceivable that stand-alone solar PV systems may be viable for some tourist developments, where grid connection costs are high or where the scale is large enough to justify the investement in solar (Ref to this in file "info on prep phase incl assessment of RE.pdf").

In the medium- to long-term stand-alone solar PV systems may become more financially viable, presentng a realistic option for GHG abatement in Samoa. However, this is only likely to occur if the cost of grid-connected electricity continues to rise and if the costs stand-alone PV systems declines.

Grid-connected Solar PV Systems
Grid-connected solar PV systems have the important advantage of not needing batteries to store electricity. Instead, the electricity produced by the PV cells is fed directly into the grid. This helps to substanitally reduce the capital, installation and maintance costs of solar PV. However, the downside is that withough batteries the electricity produced by grid-connected PV cells cannot be stored and is only available for immediate use. When the sun goes down, the PV cells will cease to produce electricity This means that it does not provide a realistic option for baseload electricity generation.

Biofuels
As discussed above, there are a number of plans to use of cocounut oil as a substitute for diesel for electricity generation. A number of other biofuel options exist, which may provide other opportunities to reduce diesel consumption. Each of these is briefly assessed here.

Anaerobic digestor

Gasification - *see REEP report – has some info on this.*

Georthermal Energy
As noted in several reports, there has been some speculation that there may be potential for a 4-5 GW geothermal power plant on Savaii. However, to date there have been no detailed studies into this resource or its commercial viability. However, if a geothermal power plant of this size was to be developed, the estimated annual GHG savings would be XXX t CO2-e. Until further research is undertaken geothermal energy must be considered only a long-term, and highly uncertain mitigation option for Samoa

Ocean Energy
Harnessing the energy of the ocean (e.g. tidal or waves) may at some point in the future prove to be a viable option for Samoa. However, for the time period of this assessment, it was considered an unlikely option.

Lower Emission Fuels

- LPG
- Natural Gas

▪ *Transport*

As outlined in Section 2 of this report, fuel used for transport is the single biggest source of GHG emissions in Samoa, accounting for XX% of total emissions. To date there has been very little attention given to reducing emissions from this source. This is set to change, with a number of initiatives set to be implemented in the coming years (see above). If all of the proposed actions are successfully implemented, this will go someway towards reducing GHG emissions from transportation in Samoa.

According to one study, energy efficiency measures have to potential to reduce fuel consumption in the road transport sector by approximately 10%. Based on 2007 data, this is equivalent to reducing emissions by approximately XX% per annum.

▪ *Other Energy Sector Emissions*

Shift away from fuelwood… May want to make some reference to this… need to see how much it actually contributes (methane, CO, etc)

CHECK SMEC CDM report – includes est of GHG abatement through viable cdm projects.

7.5 Prioritising Energy Sector Mitigation Options

Insert table

Priority	Activity	Potential GHG Savings	Timeframe
High			
Medium			
Low			

8 Non-Energy Emissions

8.1 Introduction

8.2 Past Activities

▪ *Solid Waste Management*

Solid waste management in Samoa has been improved significantly over the last decade, particularly through the introduction of a nation-wide roadside collection service and the establishment of properly designed landfill sites. While this was not specifically designed as mitigation activity, these improvements in waste management

have helped to reduce emissions by promoting a shift away from backyard burning of waste. Indeed, the second GHG inventory estimates that annual emissions from backyard burning of waste declined by approximately 35% in the period 2000-2007.

With financial support from the Government of Japan, Samoa's two landfill sites have been converted to semi-aerobic systems. According to SPREP (Ref), emissions from semi-aerobic systems are approximately 60% lower than from standard landfill sites. Based on 2007 emission levels, this initiative is estimated to have save approximately 4,300 t CO2-e annually.

8.3 Planned Mitigation Activities

8.4 Additional Mitigation Options

- *Industrial Processes and Product Use*

As highlighted in Section 2 of this report, GHG emissions from the industrial processes and product used are relatively small in Samoa. The main source of emissions is from the use of HFC gases for refrigeration and air conditioning. According to XXX … explore options for alternative gases…

Small amounts of NMVOCs are also released from the use of paints, as well as from beer production. However, considering their relative insignificance in Samoa's overall emissions profile, no further analysis of mitigation options was carried out.

- *Emissions from Agriculture*

Reducing Emissions from Livestock Farming

International experience with reducing methane emissions from livestock is still in its infancy. According to the IPCC, the main options are: XXX.

Another option would be restrict livestock farming in an attempt to limit overall numbers, especially of cattle. However, this is likely to face considerable opposition from those… also has social and cultural implications…

Reducing Nitrous Oxide Emissions

In Samoa, the main activities contributing to nitrous oxide emissions in the agricultural sector are livestock farming and the use of nitrogen-based fertilisers.

Reducing CO2 Emissions from Lime and Urea Usage

- *Waste Sector Emissions*

Emissions from Landfill Sites

Waste Incineratation

Open Burning

Wastewater Emissions

Table XXX Assessment of Additional Abatement Options for Non-Energy Emissions

9 Forest Sinks

9.1 Introduction

9.2 Past Activities

As outlined in the second GHG inventory, Samoa's existing forests are an important carbon sink and could be absorbing up to 800,000 t CO_2 per annum (GoS, 2008). However, this has not always been the case. Up until the mid-1990s Samoa experienced rapid deforestation, losing up to 2,500 ha per year, primarily through clearance for agriculture and commercial logging (Ref: Deforestation Study, XXX). Such a high rate of deofestation would have meant Samoa's forest sector would have been a net source of CO2 emissions. Over the last decade the rates of deforestation are believed to have slowed substantially due to the downturn in the agricultural sector since the taro blight in the 1990s. In fact, according to the Forest Resource Assessment prepared by the Food and Agricultrue Organisation (FAO, XXX), it is likely that there was no net change in the area of forest during the period 1999-2005.

A number of government initiatives have also played a role in protecting Samoa's forest resources. These are briefly outlined below.

- *Establishment of National Parks*

In December 2007 the Government procliamed three new terrestrial national parks, bringing the total number in Samoa to five. The combined area of these national parks is approximately XXX ha, most of which is forest. Based on the methodology outlined in the *2006 IPCC Guidelines* and assuming no removal of timber or fuel wood, these national parks are estimated to absorb approximately XX tonnes of CO_2 annually. Moreover, it is estimated that approximately XX t of carbon is stored in the forests contained in Samoa's national parks, which would be equivalent to XX t of CO2 emissions if this land were to be cleared. However, it should be noted that such estimates are inherently uncertain and more detailed analysis would be required to confirm the true level of GHG abatement.

- *Ban on Commercial Logging*

In early 2007 Cabinet announced banned all commercial logging in Samoa. *Still to complete.*

- *Reforestation Program*

During the 1970s and 1980s Samoa had an extensive reforestation program, which was financially supported by the Government of New Zealand (Ref: outlook study). However cyclones Ofa (1989) and Val (1990) destroyed approximately 75% of the plantations that been established through this program. Today, the Forestry Division of MNRE continues to manage a national reforestation program, but this is limited to approximately 100 ha per year.

- *Community Forestry Program*

The Community Forestry Program coordinated by the Forestry Division has replanted approximately 190 ha since its inception (Outlook Study). Through this program

participating farmers are each provided with 200 seedlings made up of a mixture of native and exotic species. Some of the species are designed for short rotation plantings and are intended to provide a sustainable source of timber for the construction of Samoan *fales* and other buildings (Aukuso pers comms). Commercial species, including mahogany, are also planted as part of this programme, with the intention of providing an additional revenue stream for farmers. The Community Forestry Program also includes an agro-forestry component, whereby farmers are encouraged to plant trees within existing crop and grazing lands.

Direct GHG abatement through the Community Forestry Program has not been quantified, because it is unknown what percentage of the trees planted are harvested. However, it is likely that this program has helped to alleviate pressure on existing native forests, thereby helping to enhance these carbon sinks.

9.3 Planned Mitigation Activities

Currently approximately 100 ha of forest is re-planted annually (ref: outlook study). Applying the methodology provided in the *2006 IPCC Guidelines*, it is estimated that approximately XX t CO2 is removed annually as a result of this reforestation initiative…

Community Forestry Programme…The Government's community forestry program, introduced above, is to be expanded/ continued (check this).

National Parks

9.4 Additional Mitigation Options

- *Reforestation*

- *Avoided Deforestation*

Table XXX Assessment of Additional Mitigation Options through Forest Sinks

10Emission Scenarios – (to be completed)

10.1 Purpose of Scenarios

10.2 Scenarios for Samoa's GHG Emissions

- *Baseline Scenario*

Graph showing emissions of each sector and overall trend 2007-2030

Separate discussion on forest sinks

- *No Regrets Mitigation Scenario*
- *Advanced Mitigation Scenario*

10.3 Comparing the Scenarios

11Implementing Mitigation Actions: Opportunities and Challenges

11.1 Financing Mitigation

CDM

- Thomas: need for bundling
-

Bilateral Donors
GEF

11.2 Capacity to Implement Mitigation Activities

11.3 Integration with Sustainable Development

11.4 Barriers

11.5 Technology Needs

11.6 Capacity Building Needs

12Conclusions and Recommendations

TEHCNOLOGY TRANSFER

Technology Transfer

Introduction

1.1 Background

Decision 4CP/7 defines the technology needs assessment process as a set of country driven activities that identify and determine the mitigation and adaptation technology priorities of Parties other than developed country Parties, and other developed Parties not included in Annex II, particularly developing country Parties.

Technology transfer is concerned with the flow of experiences, know how, and equipment between and within countries. Technology transfer is a priority action under the UNFCCC. Decision 4/CP7 of the UNFCCC notes that technology transfer has five key elements connected within an integrated framework. These elements are:

(i) the technology needs assessment,
(ii) improving access to technology information,
(iii) improving and strengthening local capacity,
(iv) creating enabling environments, and
(v) instituting technology transfer mechanisms.

The Ministry of Natural Resources and Environment has conducted an assessment of Technology needs for Samoa as part of this Second national Communication. This is first time that Samoa has undertaken such an assessment hence it is very much preliminary in its nature.

1.2 TNA and SNC

The purpose of a technology needs assessment is to assist in identifying and analyzing priority technology needs, practices, and policy reforms which can form the basis for a portfolio of environmentally sound technologies projects, and programmes which can facilitate the transfer of, and access to, the environmental sound technologies and know-how in the implementation of Article 4, paragraph 5, of the Convention.

The TNA assessment also involves different stakeholders in a consultative process to identify the barriers to technology transfer and measures to address these barriers through sectoral analyses. These activities may address soft and hard technologies, such as mitigation and adaptation technologies, identify regulatory options, and develop fiscal and financial incentives and capacity building.

1.3 TNA Approach

Samoa is one of the island states within the UNFCCC that has progressed all its obligated commitments since becoming a party to the convention. A number of assessments have therefore been carried out on vulnerabilities to climate change as well as estimated levels of GHG emissions. Henceforth, an excellent source of information were derived from National policies on national development, climate change, disaster management, energy, transportation, land use agriculture and forestry, fisheries etc. The most relevant of documents reviewed include Samoa's Initial National Communications, Samoa's national Adaptation Programme of Action (NAPA), UNCCD Country Report, National Energy Policy, Samoa Green House Gas Abatement Strategy, and the revised Climate Change Policy. Other sources of information considered include other vulnerability and adaptation assessments, mitigation studies, energy planning studies and national/sectoral development plans.

Most of the reports and documents reviewed were developed within the last 15 years either as responses to legal obligations under the various conventions relevant to climate change and including it, that Samoa is party to, or as part of enabling project deliverables that were funded under the Global Environment Fund. The main information looked for were GHG emission volumes or rates of emission for Samoa over the years, the state of sectoral vulnerabilities to adverse impacts of climate change at the national, community and site specific levels, the types of technology being used in main emission sources sectors, and the needs identified to address the existing technologies' and experiences' inadequacies with a view to pointing out the future needs for technology transfer.

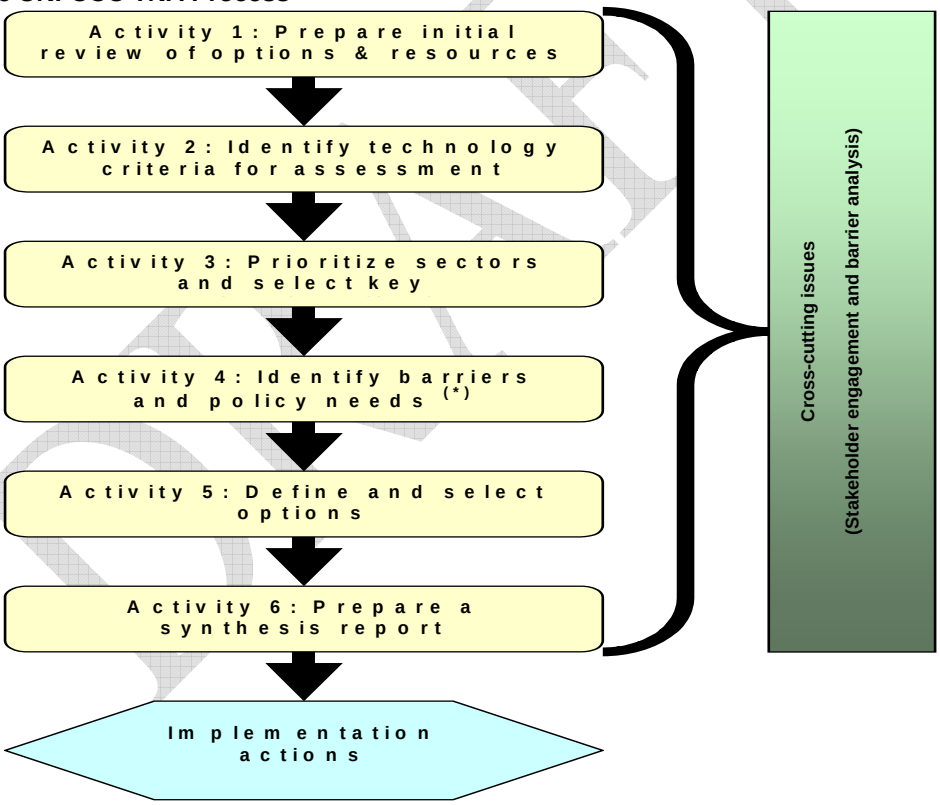
1.3.1 The UNFCCC TNA Process Guidance

The TNA handbook prepared by UNDP, in collaboration with Climate Technology Initiative (CTI), the Expert Group on Technology Transfer (EGTT) and the UNFCCC secretariat has been designed to provide guidance on how to conduct the TNA on GHG mitigation and adaptation to adverse effects of climate change. It is a "how to" guidance, that deals with the manner in which the technology needs are assessed. The handbook lays out the key steps, decisions, methods and resources needed for the TNA, taking into consideration the fact that country circumstances and needs are different. This approach ensures the flexible nature of the handbook. Therefore this most current and updated guidance as a methodological approach for conducting the TNA study was adapted and applied.

Due to time limitations and the urgency of completing Samoa's TNA, the main steps of the TNA process were followed but with limited group consultations. That is because, all of the key documents that have been used as the basis of the assessment are derived from fully consultative assessments to establish baselines. Discussions with stakeholders mainly focused therefore on either reaffirming the content of existing information or updating them as necessary. Much time was spent during the consultations in soliciting views on a most appropriate criteria for evaluation of the technologies and deciding on the best approach for the actual prioritization exercise.

Six activities or steps are proposed in the UNDP TNA process. This is presented below in Fig 1.

Fig.1 The UNFCCC TNA Process



* *note that Activity 4 (identifying barrier) is also a cross-cutting issue*

Guidance

The above process was adapted in accordance to the national circumstances and availability of information from Samoa's climate change working group. The six steps were followed.

Defining areas and sectors to be considered in the TNA requires a preliminary assessment of the current status of sectors and of technology and resource options therein. A preliminary assessment of the main sectors identified in previous assessments of vulnerability and adaptation of Samoa enabled a review and data gathering exercise that pointed out those sectors with opportunities for mitigation technology development as well as those most vulnerable that in turn needs responses and measures strengthened. A detailed assessment of technologies identified from within the sectors was thereafter undertaken followed by a detailed evaluation against nationalized criteria.

2. Overview of Green House Gas Emissions in Samoa

"Hard" technology as opposed to "soft" policies and measures is mainly in mitigation. Some are also present in adaptation but are restricted to coastal protection and water resources conservation and storage facilities. Otherwise adaptation technology is mainly policies and practices.

A preliminary overview of the sectors for Mitigation calls for a Review of the GHG Inventory, Identification of Key Sectors and a review of sectoral and national Plans.

According to the November 2007 version of Samoa's SNC, Samoa's GHG emissions totaled approximately 352,034 tonnes of CO_2-equivalent (t CO_2-e). The GHG inventory also estimated CO_2 removals in forests and on croplands, which totaled -785,067 tonnes in 2007. Full records of Samoa's GHG emissions covering 1994-2007 are provided in the GHG Inventory 2007.

Table 1. GHG Emissions and Removals in Samoa

Sector	CO_2	CH_4	N_2O	HFCs	Equiv. CO_2 Emissions	CO_2 Removals
	tonnes	tonnes	tonnes	t CO2-e	t CO_2-e	Tonnes
Energy	170,981	50	7.5	-	174,350	-
Industrial Processes & Product Use	4,138	-	0.4	5,253	9,507	-
Agriculture, Forestry & Other Land Use	4.55	4,207	152	-	135,366	-785,067
Waste	2,409	1,422	2	-	32,811	-
TOTAL	**177,533**	**5,679**	**161**	**5,253**	**352,034**	**-785,067**

(Source: GHG Inventory, 2007)

The results of the SNC's GHG inventory confirms that 95% of Samoa's emissions comes from just six sources. This has important implications for GHG abatement efforts, as it helps to ensure limited resources target areas where they can have the biggest impact.

Table 2. Six Highest GHG Emission Sources in Samoa (GHG Inventory 2008)

Rank	Source	Emissions (t CO2-e)	% of total emissions
1	Road Transport	95,105	27%
2	Livestock Farming	88,357	25%
4	N_2O from Agricultural Soils	47,005	13%
3	Electricity Generation	44,214	13%
5	Other Energy Consumption	34,141	10%
6	Wastewater	25,438	7%

	TOTAL	**335,150**	**95%**

(Source: GHG Inventory 2007)

The SNC GHG inventory also reported indirect and precursor emissions that include GHG that do not have global warming potential values. This includes carbon monoxide (CO), oxides of nitrogen (NO_X), non-methane volatile organic compounds (NMVOCs) and sulphur dioxide (SO_2) as presented in Table 4.

Table 4 Indirect and Precurser GHG Emissions in 2007.

Sector	**CO**	**NO_X**	**NMVOCs**	**SO_2**
	tonnes	tonnes	tonnes	tonnes
Energy	10,140	896	1,729	293
Agriculture, Forestry & Other Land Use	-	-	-	-
Industrial Processes & Product Use	-	-	102	-
Waste	0.21	0.25	-	0.15
Total	**10,140**	**896**	**1,830**	**293**

(Source: GHG Inventory, 2007)

2.1 Energy

According to the SNC inventory, emissions from the energy sector accounted for approximately 50% (174,350 t CO2-e) of total GHG emissions in 2007, reflecting Samoa's heavy reliance on imported petroleum products to meet its energy requirements. Emissions from energy use also indicated substantial increases in the period 1994-2007. Only domestic aviation indicates a negative growth, but has been indicated by the Inventory as a result of the absence of data rather than an actual decline. Growth in all forms of commercial energy demand is expected to continue over the next 10 to 20 years as a consequence of increases in vehicles and growing demand for electricity in the buildings sector (National Energy Policy, 2007).

Table 3 GHG Emissions from the Energy Sector in Samoa .

Source	**1994**	**2000**	**2007**	**% Change since 1994**	**% Change since 2000**
Electricity Generation	8,820	28,960	44,214	401%	53%
Manufacturing & Construction	-	12,481	16,297	-	31%
Domestic Aviation	62	61	0	-100%	-100%
Road Transportation	68,928	84,230	95,015	38%	13%
Domestic Shipping	2,242	4,223	5,514	146%	31%
Commercial & Institutional	1,165	926	1,389	19%	50%
Residential energy use	11,209	7,474	6,223	-44%	-17%
Fishing	10,403	4,386	5,699	-45%	30%
TOTAL	102,830	142,741	174,350	70%	22%

Note: (t CO2-e 1994-2007).

Emissions from motor vehicles continue to pose a significant threat to the environment and lives of urban populations such as Apia. Vehicle emissions in many Asian countries are expected to increase over the next few decades, as the vehicle population rapidly increases. If no effective action is taken to clean up fuels and vehicles, urban air quality will continue to decline.

Within the Transport sector, road transport provides the main method of transportation on land. Vehicle registration over the years noted a steady annual increase of between 0.05 and 2% since 1996. Actual vehicle registration at the main office for all vehicles in the same period more than doubled from just 7,374 in 1996 to 17,887 in 2007 (Transport Control Board, 2008). Between 200 to 600 vehicles are also registered in Savaii on an annual basis.

- Road transportation (54%)
- Total Emission in (2005) was 85 metric tones from 14400 vehicles.

Cleaner fuels will play an important role in reducing vehicle emissions and improving urban air quality. Fuel specifications influence emissions. They also influence driveability, engine-wear, and fuel efficiency, which are also important in terms of greenhouse gas emissions (ADB,2008) Therefore, reducing emissions from motor vehicles depends upon introducing cleaner fuels for the advanced emission control technologies that require these cleaner fuels.

2.2 Agriculture Forestry and Landuse

The GHG emission from the AFLUS sub sectors are ranked as follows:

- Livestock (62%)
- Managed soil (35%)
- Others (3%)

The links between forests as carbon sinks and climate change has received much attention during discussions and awareness programmes on climate change at the national and community levels. This has also been recognized at international negotiations. Samoa actively contributes to regional and international debate on ways and means of ameliorating this problem. At the national level, however, outside of the context of public education and awareness activities wherein climate change is discussed, this has yet to translate into real practical action particularly technology transfer. The issue of carbon credits and carbon sequestration are still being considered although there are plans to establish an institutional se- up for a CDM National Authority.

Wood is the main source of fuel for open fire cooking and stone-ovens which is the traditional way of preparing food. In the last 20 years the use of wood as fuel has been increasingly replaced by electricity and liquefied petroleum gas (LPG), and coconut shell charcoal for charcoal ovens. The demand for wood fuel in homes is therefore significantly reduced, at least in most places in the Apia town area. Statistics on wood fuel production and consumption are not collected although it has been estimated that the demand has been declining over the last 10 years, and is probably continuing the same trend (Sesega, 2006).

With livestock, most of the emissions are from cattle and then swine and the bulk is from enteric fermentation followed by manure decomposition (GHG Inventory, 2008). Almost all of the managed soil emissions (N_2O) are from livestock urine and dung.

2.3 Waste

The main source of methane emissions in Samoa has been reported to come from livestock farming as indicated under the AFOLU sector. Samoa's overall methane emission increased by 42% (GHG Inventory, 2008) from a combination of livestock, and waste sector from the semi containment landfill at Tafaigata that allows for the anaerobic decomposition of solid waste. Methane emissions from the energy sector declined by approximately 20% during the same period, as a result of declining biomass use for residential energy needs.

Total N_2O emissions in 2007 reached 161 tonnes, with approximately 94% of these emissions coming from the AFOLU sector (GHG Inventory, 2008). Despite falls in the energy, IPPU and waste sectors, strong growth in livestock farming pushed overall N_2O emissions up by 40% during the period 2000-2007

2.4 Industrial Processes and Product Use

Emissions of HFCs reached 5,253 t CO2-e in 2007, which represents a 630% increase on 2000 levels when emissions were estimated to be 720 t CO2-e. This has been the result of the major shift from ODS based refrigerants to alternative non-CFC refrigeration where HFCs are the main replacements.

3. Overview of Vulnerabilities of Priority Sectors to Impacts of Climate Change

The are thirteen national sectors12 that were identified in the NAPA Climate Synthesis Report (2004) as critical to achieving a high adaptive capacity for Samoa. The same report identified that 69% of these sectors as highly vulnerable to the adverse impacts of climate change, and climate variability including extreme events. The nine sectors considered highly vulnerable from the highest to lowest include the Water sector, Agriculture & Food Security sector; Forestry sector; Health sector; Urban Settlements; Coastal Environments; Communities; Trade & Industry sector; and Works Transport & Infrastructure sector. All thirteen sector's urgent and immediate needs were considered with priority weighting given to the nine sectors identified as highly vulnerable. The Fisheries sector was considered on a 'no-regrets' approach even though it had an unknown net effect from the impacts of climate change.

Climate change and climate vulnerability induced disasters will place instability on food production levels to meet higher demands and affecting income generating activities for communities and country at large.

3.1 Water

Water resources and supply systems are extremely vulnerable to current climatic patterns (MNRE, 2007,*Water Sector Synthesis Report*). In 1997-1998 and 2001, water supply was rationed and water reservoirs were fully utilized during periodic draughts associated with ENSO events that caused major water shortages in the country. As recently as October 2006, low flows resulting from a 57% below average rainfall (associated with a weak-moderate El Nino) resulted in water shortages despite a 32% and 41% above average rainfall records for the months of August and September respectively. An increase in diesel power generation was also recognized as a result of this event as available water for hydro-power generation became scarce (MO, 2007) .

Conversely, impacts of flooding associated with cyclones and periods of heavy rainfall, has also been experienced on water quality and quantity, due to erosion and sedimentation associated with flash floods. Flash floods and low flows in dry periods are often rapid responses as a result of the small and steep slope characteristics of the country's watershed areas.

The impact of floods especially for the water quality and quantity in the urban area, is exacerbated by extensive forest clearance and developments within the uplands of the watersheds to the south of Apia. Extreme heavy rainfall causing immediate flooding also causes extensive erosion, loss of terrestrial habitats, damage to agro-forestry, as well as interruptions and destruction to vital infrastructure such as hydrological monitoring equipments and reticulation systems. Reservoirs for water supply and hydro-power have been known to become filled with sediments as a result of sediment mobilization during flooding, thus impacting on water supply and generation of electricity as was the case for the Fuluasou hydropower reservoir.

Impacts of historic and recent events as discussed, demonstrate the high sensitivity and vulnerability of the sector to current variability in rainfall, which is critical in determining flooding and drought events.

3.2 Health

Evidence of growth in vector borne and water borne diseases reconfirms the already changing climate and the impact it has on the health sector. Climate Change and climate variability will favor conditions for the occurrence and spread of these diseases. Other health impacts would result from the impacts on ecological and social systems. These impacts would include changes in local food production and under nutrition, and various health consequences of population displacement and economic disruption.

Several adverse health effects are potentially climate sensitive. That is weather and climate affects their incidence and distribution. Some adverse health outcomes directly relate to weather and climatic events such as drowning and injuries in flooding and tidal waves, while others relate indirectly such as water-borne and vector-borne diseases as well as mental problems. Direct impacts including death and injuries resulting from extreme events such as cyclones and flooding remain an ongoing threat particularly for the poor and those residing in flood-prone areas.

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12 Thirteen national sectors include: agriculture & food security; forestry; water, health, communities, biological diversity; fisheries, trade & industry; works transport & infrastructure; tourisms, urban planning and development; coastal environments and energy

3.3 Agriculture Forestry and Land use

Agriculture's contribution to Samoa's GDP dropped from 12% in 1998 to 8% in 2003 and stayed at 7% during 2004-2007. The MAF has claimed that one of the factors contributing to this trend, due to its exacerbating effect on the already strong pressures from remittances and more attractive salary opportunities in other growing sectors such as tourism and manufacturing, is climate change (MAF, 2007).

These include the impacts of climate change and variability such as tropical cyclones, flash floods, high rainfall, high temperature and long dry periods. At the same time, pests and disease incidence will also increase which has caused a great loss of crop quality produce.

Instability of food production levels caused by climate induced disasters affect ability of income generating activities to meet higher demands from communities and country at large. This demonstrates the most devastating direct effect of natural disasters. Samoa's geographic location also presents difficulties in reducing agriculture's vulnerability to climatic hazards such as cyclones, droughts and flooding. Three intense cyclones visited Samoa within the last twenty years. Thus since the 1990's the contribution of the agricultural sector to the economy started to decline steadily, particularly the two cyclones, Ofa and Val, in 1990 and 1991 causing severe damage to crops. Table 8 demonstrates the high vulnerability of the agricultural production to impacts of climate change according to the assessment by the climate change working group on agriculture vulnerability.

Forest and trees are, if anything, more important to island states like Samoa for their role in watershed management, environmental protection, provision of wood and non-timber resources, and as a reserve of biodiversity. Unfortunately, Samoa's forest cover has declined signifigantly since its coverage was first estimated in 1954 due to agro-deforestation and logging in the mid 1970's and well into the 80s (Sesega, 2006). Tropical cyclones also contribute to forest degradation and fragmentation (Whitmore, 1984). This was most evident during the cyclones of Ofa and Val in 1990 and 1991, where the extent of degradation and loss to the native forests were devastating, and more especially on the plantation forest resources.

Forest protection is to be promoted to conserve Samoa's indigenous species and maintain biodiversity habitats for Samoans' existence as well as acting as sinks for the GHGs.

3.4 Coastal Infrastructure

With more than 70 of Samoa's population residing along the coastal planes, supporting infrastructure and works, if not well managed, will be the most vulnerable sector given the cost incurred for construction and maintenance. The coastline of Samoa will continue to be highly susceptible to coastal erosion and coastal flooding (BECA, 2000). Most of the climate stresses will still affect infrastructure by testing the integrity of its foundations (including power poles, bridges, buildings, towers etc.). Projected changes in rainfall intensity are likely to increase the potential for flooding in water basins, with over-tipping of dams, culverts and flood control structures. Simultaneously droughts will also impact on the economy of Samoa in terms of tourism industry as buildings and utilities networks are affected, as well as on infrastructure such as dams and water reservoirs.

The SIAM Program and CERP has assisted in developing CIM Plans as well as promoting design standards and COEPs for road work and structures for coastal protection. Through the CIM Plans, the government and communities have agreed on various solutions for the management of coastal infrastructure from coastal erosion, flooding and landslide induced by Tropical Cyclonic activity. These initiatives ought to be extended to accommodate inland flooding and watershed management in light of their impacts on coastal infrastructure and works.

Despite all these actions, the climatic stresses acting on infrastructure such as tropical cyclones, prolonged periods of droughts, extreme flooding, storm surges and sea level rise are likely to continue to increase over the coming decades. (IPCC, 2007). Accompanying these changes will be the increased frequency of occurrences of extreme climatic events, including cyclones, droughts and heavy storms. For instance, an extreme flooding event would occur within a 10 to 30 year period. In 2006, extreme flooding as a result of excessive rainfall occurred in February and November of the same year which is a rarity in the history of flooding in Apia. Henceforth the impacts of climate change on Samoa's infrastructure sector will gradually increase as the current risks become more frequent and more intensified.

The Vulnerability synthesis (MNRE,2007) of this sector estimated timeframes for future impacts of climate change to occur in the next 10 to 30 years. Therefore it is urgent to consider suitable technologies that effectively realise the adaptation measures being developed.

Tourism is a major economic sector in Samoa and most tourism spots are located within the coastal area. Tourism has provided employment and a source of income generation. Impacts of climate change and climate variability have been widely acknowledged as both direct and indirect. Direct impacts would consider loss of beaches, inundation, and degradation of the coastal ecosystems, saline intrusion and damage to critical infrastructures. Indirectly the industry will be sensitive to other climate-related impacts, such as loss of attractiveness of coral due to bleaching, heat stress causing high humidity which can be very uncomfortable.

4. Identification of Technology Options

4.1 Technology Needs for Mitigation

Technology needs for Mitigation has been identified using the criteria developed above and expert knowledge of relevant stakeholders. Key consideration was for sectors and technology that support global action to reduce GHG emissions, and at the same time also strengthening the national economy by the efficient operation of the relevant sectors that are emitting that particular GHG. Technology action will be mainly in the energy sector, particularly land transportation and electricity generation where dual global and national benefits could be achieved while trade offs in the agriculture, land use and land use change and forests may provide cross-cutting national benefits in key sectors such as tourism and manufacturing.

In the land transportation sector, energy efficiency is a top priority in the motorized subsector while the increased use of non-motorised transport would lead to further reduction in GHG emissions. Energy efficiency is also a main consideration in the electricity sector focusing on both the demand and supply management (MNRE,2008). While the development of renewable energy is increasingly promoted, it is really in energy efficiency where the main benefits in GHG reduction will accrue during the next 30-50 years (International Energy Agency, 2007).

According to the National Energy Policy (2007), the generation of electricity using renewable energy sources will be heavily promoted as alternatives in light of the increasing price of imported fuel and its impact on foreign reserves and the environment. To this effect, the Electric Power Corporation is piloting solar panel fields to generate electricity from solar energy. The results of this project will be crucial to the long term developments in electrical energy. The use of coconut oil as fuel for electricity generation is also being developed although facing problems with coconut supply due mainly to the unprofitable price that coconuts are expected to be provided by suppliers.

The power generators of EPC will be upgraded to ensure an efficient level of electricity production is maintained. Coconut Oil is also being used for running vehicles of one of the coconut oil producers in Samoa. Efforts will also be geared towards minimising transmission losses. The Energy Policy emphasized that instruments related to the provision of power in the Public Bodies (Transparency and Accountability) Act 2001 must be adhered to for any new development.

Public Awareness programs need to be conducted on energy efficiency and conservation, appliance energy consumption ratings, promoting energy audits as well as illustrating ways to minimise electricity usage thus promote energy savings through different options available. These efforts will culminate in greater consumer awareness on cost saving measures in terms of household and business kilowatts usage or demand side management.

4.2 Technology Needs for Adaptation

On the adaptation side, the NAPA synthesis identified the most vulnerable sectors as agriculture and food security, forestry, water, fisheries, health and urban settlements.

Technologies for adaptation should be cost effective, proven, flexible, aid in vulnerability reduction and be easy to use. Technologies for adaptation should look at technologies in the broadest sense.

Hence essentially they must:

a) be proven and commercialized (not an experimental or one under development)
b) improve resilience / reduce vulnerabilities of communities rather than the other way around
c) rely on local human and natural resources and promotes local manufacturing, trade and improved skills, employment and income
d) uphold local culture and promotes gender equality
e) comply with locally adopted infrastructure standards
f) be cost-effective and self financed over its life cycle

For adaptation technologies, all sectors were found to be contributing to the development of Samoa and to improving the adaptive capacity of Samoa to climate change impacts. A further consideration was strategic in ensuring that sectors that were already undergoing project implementation under other programmes were relegated to the less priority needs. Each technology including policies and measures were checked against each of the criteria developed.

The more recent Assessment of vulnerabilities and adaptation needs, that was conducted as part of the SNC preparations updated the NAPA evaluation and ranked the following four sectors as the most important for urgent adaptation. A key consideration in this ranking is the absence of any current programmes at the national level to address the vulnerabilities and needs in the sectors. Specific adaptation needs were detailed with corresponding technologies to enable these needs were also suggested. All sectors are priorities for adaptation. However due to time constraints and the level of detail expected of this report, the four top priorities are explored. These are;

- Water
- Health
- Coastal Infrastructure
- and Agriculture.

Potential adaptation measures that can be implemented to address the key identified vulnerabilities in these four sectors were considered during the stakeholder workshop. The stakeholders weighted each technology option against the refined criteria to suit Samoa's situation.. Such response measures can include changes in established practices and do not necessarily involve the direct use of technology. Response measures might use technology in an indirect manner, such as by establishing computerized data management systems, or for a specific purpose, such as better management of a resource.

5. Barriers to Implementation of Priority Technologies

Having the required capacity to develop policies and practices as well as their implementation and evaluation is critical to the success of technology transfer. It is even more important for equipment and mechanical technology or hard technology to have the expertise available locally to ensure their continued operation, maintenance and regulation. Policies and systems must be in place to enable institutional capacity to function. Individuals will also have the opportunity to excel in their field of expertise. All these would need resources and when there is a lack of any of these features, they become barriers to the transfer of technology.

5.1 Mitigation

5.2 Adaptation

6. Priority Technologies

For mitigation only one step was necessary which directly follows from the identification of technology needs in the first step. This is to compile the priority technologies based on the evaluation against the criteria, and then taken through a stakeholder assessment workshop for support and endorsement.

Evaluation of Adaptation technology also followed a similar chronology but based entirely on a country driven criteria that used expert knowledge and local perceptions to determine the relevance of each technology or measures against each of the developed criteria.

6.1 Criteria for Technology Selection

According to the TNA handbook, the identification of priority sectors, technologies and actions requires an assessment of the contribution that the new technologies in different sectors will make to:

(a) National or sectoral Development goals;

(b) Contribution to climate change (GHG mitigation and adaptation);

(c) and Market potential

In Samoa's case this involved a review of technology options and resources that are applicable to GHG mitigation in the key sectors already identified. This step also includes the setting of criteria against which technologies can be assessed. Two steps were taken to develop criteria for sector and technology assessment as outlined below. The identification of Technology Needs for both mitigation and Adaptation were started with synthesis of sectors and reiterating the technology needs therein contained in the various documentations assessed and personal consultations.

6.1.1 Prepare List of Sectors

The priority list of sectors are derived from the previous activity of the TNA process. The above three criteria were then used to assess the sectors. The evaluation of sectors using the above criteria, with a view to selecting three to four main sectors for technology development was suited to both mitigation and adaptation. As mitigation deals mainly with reduction of emission and sinks proliferation, requirement (b) of the criteria became the most important consideration. Sector prioritisation for Adaptation technology needs was based on level of vulnerability and the level of assistance and action that has been accorded to the sector with those remaining the least addressed being piroritised.

6.1.2 Review Technologies

In setting technology selection criteria, emphasis was placed at least on the factors outlined in the first and second TNA process sections, namely contribution to development goals, ability to mitigate GHG emissions, market potential, and access to/availability of the technologies. The appropriateness of the technology option to Samoa's situation necessitated their evaluation against technology specific criteria. Samoa's Climate Change Working Committee considered that obvious difference in the nature of technology needs between mitigation and adaptation. That is most or perhaps al of the technology needs for adaptation involved responses and measures inclusive of policy development, legislation and capacity building with only a few hard or structural technologies. Technologies needs for mitigation on the other hand emphasized the development of local fuels, and importation of more efficient equipment and renewable energy dependent machineries that reduce green house gases.

Hence forth, the various technologies for Mitigation were then evaluated on the basis of the following four criteria.

a. *Technology must be proven and commercialized (not an experimental or one under development)*
b. *Technology must reduce emissions rather than the other way around*
c. *Technology used must rely on local human and natural resources and promotes local manufacturing, trade and improved skills, employment and income.*
d. *Technology must uphold local culture and promotes gender equality.*

Stakeholders considered these four criteria and resolved that all are applicable to technology that is locally developed, particularly criteria (c) but will mostly be in the piloting or experimenting stages. Technology originating from outside of Samoa will therefore need to have local capacity strengthened in order to be able to meet the (c) criteria. The criteria applicable to mitigation technology appears to be suited more to equipment than policies and measures, hence applied in a very general manner.

Technology needs for Mitigation have been identified using the criteria developed above and expert knowledge of relevant stakeholders. Key consideration was for sectors and technology that support global action to reduce GHG emissions, and at the same time also strengthening the national economy by the efficient operation of the relevant sectors that are emitting that particular GHG. Technology action will be mainly in the energy sector, particularly land transportation and electricity generation where dual global and national benefits could be achieved while trade offs in the agriculture, land use and land use change and forests may provide cross-cutting national benefits in key sectors such as tourism and manufacturing.

Adaptation prioritization is based on a country driven criteria. The key steps are ;

6.1.3 Prioritise Vulnerable sectors through the Identification of their respective Sectoral Characteristics.

An extensive assessment of Samoa's vulnerability to climate change impacts was undertaken during the preparation of Samoa's National Adaptation Programme of Action (NAPA) and more recently the SNC V&A studies (MNRE, 2007, unpublished) . All sectors vulnerable to impacts of climate change and sea level rise were therein synthesized and prioritized. Discussions with stakeholders had reconfirmed the evaluations reported in the NAPA document and its basis on the synthesis undertaken.

6.1.4 Rank the list of responses to address vulnerability.

The list of responses to address vulnerability to climate change impacts which have also been prioritized is also contained in the NAPA document, which has been refined and reiterated in this report. Some of the adaptation activities have been pursued already with water resources and coastal resources management being addressed respectively under the WASSP and the World Bank integrated SIAM II/CERP projects.

The evaluation and ranking of Adaptation technologies was based on the following criteria and each technology was assigned a low, medium or high based on each technology meeting each requirement. Technology with high weightings will become the priorities. That is, the extent to which each technology;

a. *is proven and commercialized (not an experimental or one under development)*
b. *improves resilience / reduce vulnerabilities of communities rather than the other way around*
c. *relies on local human and natural resources and promotes local manufacturing, trade and improved skills, employment and income*
d. *uphold local culture and promotes gender equality*
e. *comply with locally adopted infrastructure standards*
f. *be cost-effective and self financed over its life cycle*

6.1.5 Prioritised Technology Impact Assessment

The TNA process recommends that an assessment of impacts on the socio economic conditions as well as the environment of Samoa of each of the prioritized technologies will need to be undertaken. This is seen as the last filter for the technologies before their transference to ensure their acceptability into the country, and sustainable operation without causing adverse impacts leading to mismitigation or maladaptation.

As this part of the exercise requires additional time and resources, existing information references on general impacts of the prioritized technologies were consulted and noted for the identified technologies. Further detailed assessment of impacts will be undertaken for each of the technology at the project profiling stage which is recommended for future work on the TNA.

6.2 Technologies for Mitigation

6.2.1 Priority Technologies for Energy

1. Energy Efficiency and Effectiveness

In line with the SDS strategic focus in providing reliable utility services, effort will be directed to improve efficiency and effectiveness in the production and management of electricity. Public Awareness programs need to be conducted on energy efficiency and conservation, appliance energy consumption ratings, promoting energy audits as well as illustrating ways to minimise electricity usage thus promote energy savings through different options available. These efforts will culminate in greater consumer awareness on cost saving measures in terms of household and business kilowatts usage or demand side management.
In the land transportation sector, energy efficiency is a top priority in the motorized subsector while the increased use of non-motorised transport would lead to further reduction in GHG emissions. Energy efficiency is also a main consideration in the electricity sector focusing on both the demand and supply management (MNRE,2008). While the development of renewable energy is increasingly promoted, it is really in energy efficiency where the main benefits in GHG reduction will accrue during the next 30-50 years (International Energy Agency, 2007).

2. Renewable Energy Development.

According to the National Energy Policy (2007), the generation of electricity using renewable energy sources will be heavily promoted as alternatives in light of the increasing price of imported fuel and its impact on foreign reserves and the environment. To this effect, the Electric Power Corporation is piloting solar panel fields to generate electricity from solar energy. The results of this project will be crucial to the long term developments in electrical energy. The use of coconut oil as fuel for electricity generation is also being developed although facing problems with coconut supply due mainly to the unprofitable price that coconuts are expected to be provided by suppliers.

The power generators of EPC will be upgraded to ensure an efficient level of electricity production is maintained. Coconut Oil is also being used for running vehicles of one of the coconut oil producers in Samoa. Efforts will also be geared towards minimising transmission losses. The Energy Policy emphasized that instruments related to the provision of power in the Public Bodies (Transparency and Accountability) Act 2001 must be adhered to for any new development.

6.2.2 Priority Technologies for Agriculture Forestry and Land use

1. Conservation programme through policy for forests for carbon sequestration

The critical issue facing forestry in Samoa is the inevitable depletion of the native forest resource and the absence of a replacement plantation forest resource to sustain the local industry. Hence without such forestry resources the indigenous forest will continue to be deforested to meet the growing local demand. Due to the criticisms of the framework within which forests are managed by the MNREM under the Forest Act 1967 and Forest Regulations 1969 where there were conflicting actions on allocation of forest resources on customary land and resource pricing, the recent reviews of the National Forestry Policy and the new draft Forestry Bill is an attempt to address these.

Under these measures the MNRE seeks to manage forests and its multiple functions in a holistic and more integrated manner. This promotes the private sector as the driver of forest resource development with the Forestry Division to concentrate on a regulatory and research role and as a provider of technical expertise and advice to tree planters in the private sector.

2. Biogas from Piggery/livestock/poultry

The strengthened relation between the government of China and Samoa has reinvigorated the research in agricultural production at the grassroot level. Experiences of livestock farmers in China were shared with local agricultural officers that led to the development of a Biogas project using piggery and livestock waste. This is a proven technology that provides electricity for rural farmers in China.

The transfer of this technology would need investment in the construction of the waste collection tanks and gas collection network with storage and converters to generate electricity.

3. Biofuel cultivation

The trialing of coconut fuel as a substitute for diesel is ongoing. This technology needs to be further developed to perfect its application for energy generation.

Other bio fuels to be developed further are bio ethanol which is being tested by Samoa's Research and Development Institute. Other plants with bio fuel potential also needs to be explored and trialed.

4. Forest Fire Prevention Programs

The National Disaster Management Strategy provides for the preparation, implementation and recovery from extreme events of national significance. Forest fires are common in the western side of Savaii particularly during the dry season and after prolonged periods of no rain. The National Diastase Management Office already has a fire disaster response plan in place but will need strengthened awareness of preventive measures to ensure forest fires are not instigated by agricultural clearing and careless fire start ups. These range from data and information storage to determine the historical pattern of fires, community awareness programmes, and a network of warning signs to indicate areas prone to fire at certain temperatures and dry spells in the area.

5. Reforestation / Rehabilitation (sustainable forest management)

Samoa could focus on plantation forestry development. The national planting target currently at 100 ha/yr should be increased to **400ha** for the next 10 years. Cornwall Estate on the western side of Savaii should be fully replanted to expand Samoa's forest coverage and as the core of the forest estate for a future integrated forestry industry.

6. Conservation Areas and promotion of awareness

A number of conservation programes are currently implemented by the MNRE. Of most importance is Samoa's protected area system that includes areas of high conservation value previously identified in the Samoa NBSAP. The conservation of these areas as well as those that are of no economic interest to communities need to be strengthened through nationwide awareness programmes.

7. Steam Sterilizer for Quarantine

The MAF is already using its steam sterilizer to quarantine crops, vegetables and fruits for export. The system replaces the use of Ozone Depleting Substances (CFCs). This technology however requires constant maintenance and expensive replacements of parts with a high level of technical knowledge to operate successfully.

6.2.3 Priority Technologies for Waste

1. Containment landfills to collect methane as biogas

A semi sanitary landfill is operated by the Ministry of Natural Resources and Environment through a contractor. Its design follows the Fukuoka method of landfilling where locally material is used for collecting surface flow, leachate and methane. While the problems of vermin and odour are greatly reduced by the constant covering of solid waste, leachate continues to seep though the soil (minimal after collection) and methane is allowed to escape unabated into the atmosphere. Containment of the methane gas is therefore needed so that it can be flamed to reduce its global warming potential to the level of CO2.

2. Discourage Burning of Waste

Burning of solid waste has been reduced substantially as reflected in the drop of emissions from burning between 1994 and 2005. This may be a result of improved solid waste collection service by the government and the impacts of extensive national awareness progranmmes on the dangers of burning associated with Persistent Organic Pollutants (POPs). This program needs to be continued as its predecessors' effects have been proven to reduce GHG emissions.

3. Biogas generation from waste decomposition

A pilot for the generation of biogas was conducted by the MNRE with assistance by New Zealand Aid in 2004 to generate biogas from enhanced anaerobic decomposition of solid waste. It was a well designed technology except that the feedstock did not eventuate as planned. Food waste and abattoir discharge were targeted as the main catalysts for decomposition and gas quality. Unfortunately the first target was mostly taken up by domesticated animals feed while the second source does is yet to be built.

This technology has potential for connection with the containment landfill, and with the establishment of the abattoir which is now certain in the next three years would favor its reestablishment. The technology set up was decommissioned and stored with a local contractor.

4. National Waste Bill (MWB)

The MNRE has recently released for public comment a draft NWB (2008). The Bill provides for strengthened management of waste in Samoa and takes the current provisions of the LSE Act 1989 on waste management further by imposing revised fines on wasteful productions, systems and individuals. This piece of legislation needs further development and its consequent implementation/enforcement will require resources for both the MNRE

and private sector, for the latter to invest environmentally friendly technology for waste disposal and management practices.

6.2.4 Priority Technologies for Industrial processes and Product Use

In the Industrial and processes and product use sector there is need for the promotion and implementation of efficiency standards for electrical appliances, devices and equipment established, and improve the operation of industrial processes and systems.

Financial incentives must also be established to encourage efficient electricity use, as well as self generation of electricity for large sized production sites. Also promoted for incentives consideration is importation of fuel efficient vehicles and renewable energy based cars.

6.3 Adaptation

6.3.1 Priority Technologies for Water

The priority technologies for water resources are grouped into technologies for adaptation to water quality protection, waster quantity conservation, and infrastructure improvement and maintenance.

1. Develop water purification programs for communities

Water treatment for quality maintenance or improvement through chlorination and disinfection by the Samoa Water Authority have been implemented. The laboratory of the SWA is able to handle the tests for water quality, but will need to be upgraded in order to test for a wider range of heavy metals and contaminants.

2. Develop watershed management programme for (other) communities

The Water Resources Management Unit of the MNRE is actively pursuing watershed management and conservation programmes with consistent monitoring of the resources within the watershed areas and identifying of new sources for future protection. These activities need resources and have to deal with land issues when customary lands are involved.

3. Alternative water storage programs

Community initiatives to rehabilitate freshwater springs as alternative water sources as well as water tank establishment for water storage are currently being undertaken through financial support from projects such as the Cyclone Emergency Recovery Programme (CERP), GEF-Small Grants (SGP) and Community Based Adaptation (CBA) Programmes, Japan Official Development Assistance, AusAID, EU, Canadian Fund, NZAid etc.

6.2.2 Priority Technologies for Agriculture Forestry and Land use

1. Integrated Crop selection based on Soil and Geographic selection fro Plant Growth Research.

The MAF research station at Nu'u continues to pursue research of varieties of food crop species that are tolerant to pests and diseases. In addition the impact of draughts and heat waves on crops have also been seriously considered. Henceforth, the tolerance of arid conditions and increasingly hot weather have also been taken into account in testing of food crop varieties.

Also included in the research is the promotion of short term crops in association with the use of traditional knowledge of weather and climate variability to plan the right time and duration for the crops to be cultivated. With a shortened planting season the technology response is use more efficient machinery such as tractors. The MAF has introduced the use of tractors to accelerate tilling of the land.

2. Taro Development Progammes

New varieties have been distributed out to the public for piloting but yet to be recommended as acceptable food species/type. That is because they have to be continuously tested. Pests and Diseases tolerant species are being developed as well as those being tolerant to arid and drought conditions. Equipment for testing the specimen as well as storage and interpretation of data is needed.

3. Disaster Response Plan

An Emergency and Disaster Response Management Plan has been developed for the Agriculture Sector as part of the National Disaster Management Strategy and Plan. This has been reviewed annually and integrated with climate change ready collection of plants and animals.

4. Treatment of Imported Livestock for disease

The laboratory and capacity for testing imported livestock as well as other farm animals for disease needs upgrading. Otherwise the tests need to be fully undertaken before the animals enter the country.

6.3.3 Priority Technologies for Health

The priority technologies for the health sector include programmes that range from Mosquito spraying for hot spots & cases households, Case investigations, Sanitation village inspections, National Filariasis Eradication to treatment of direct injuries resulting from extreme events. Other programmes include inspections of sanitation systems and prevention of water borne diseases. All have been assessed as medium to high priority for technology improvement.

The key to ensuring the above preventive and disease reduction programmes are effective is education and awareness. Emergency and injury prevention methods are also regarded as highly important for technology development.

6.3.4 Priority Technologies for Coastal Infrastructure

1. Implement Coastal Zone Management

The government of Samoa received assistance from the World Bank and government of Australia since 2000 for an Integrated Asset Management Project (IAMP). This project is into its second phased which has enabled the development of Coastal Infrastructure Management Plans (CIMPS) for all villages to set out plans to respond to impacts of extreme events particularly tropical cyclones and flooding. Technologies for government to implement include structural rehabilitation of roads, bridges and coastal protection, while the community develops management plans and rule for resources management and

2. Relocation of roads further inland

The consultations identified the relocation of utilities and most of the transport structures inland to avoid the vulnerable stretches of coastal flat land upon where they are currently located. New buildings are also encouraged to be located outside of the hazard areas that have been determined as having high vulnerabilities to extreme events.

3. Construction of seawalls (subject to existing plans)

The construction of seawalls is also encouraged but only for the protection of infrastructure that cannot be moved in the short term. All the CIMPs have provisions for the appropriateness of coastal revetments at certain locations and these ought to be followed closely.

7. Conclusion.

The evaluation of the needs in Samoa for the transfer of technology has been:

- An information collative exercise for the preparation of Samoa's Second National Communication on climate change. This allowed the identification of technological options for mitigation and adaptation, and

- A new exercise for the country, which has never had the opportunity to assess its needs in terms of environmentally sound technologies for both mitigation and adaptation.

The needs expressed in that regard reflect the vulnerability towards the impacts of climate change but also at the level of economic development and the vulnerability of the island ecosystem. These factors show the need to integrate the needs in the transfer of environmentally sound technologies in the development programmes.

Data and information on GHG sources and emissions as well as mitigating and adaptation technologies has improved since Samoa's INC. Previous assessments have been conducted and culminated in literature derived from extensively consultative processes of participatory assessments. Synthesis of vulnerable sectors to climate change have also been completed which could all be utilised to further Samoa's future initiatives on technology transfer. These would lay an excellent foundation or baseline for future technology needs assessments.

The key sectors with critical technology needs to address mitigation are energy (including transport fuel and electricity generation), agriculture and land use, waste management, industrial processes and product use. Technology introductions must be assessed on the basis of their impacts on the environment and socio economic aspects of Samoa. The review of policies relevant to these key sectors and outcome of the stakeholders' assessments of available and future needed technologies within them has resulted in a list of technology options that Samoa ought to pursue for transfer. Each technology has associated barriers that have also been identified. Some of these have been addressed to a certain extent by the various initiatives led by the relevant energy units of the MOF, MNRE, EPC and private sector companies. The more difficult challenges remain and will be targeted by the future actions of technology transfer for Samoa.

Adaptation technologies are mainly associated with soft solutions. These have been identified for the four priority sectors for technology development, investment, and implementation. Namely, water, health, coastal infrastructure and agriculture.

The most commonly aired barriers to implementation of technology transfer are the lack of capacity within the private sector to develop country driven technology, and the inability of central government systems to accommodate such initiatives without good quality supporting data and demonstrations. A number of renewable energy pilots have been started but none has really taken off aside from some sites specific solar panels. This brings up the next most common barrier which is the lack of coordination between government and private sector entities in promoting alternative energy technologies. Adaptation technologies inclusive of responses and measures to impacts of climate change have seen countrywide implementation. However, they have also proven costly and dependent on the commitment of communities to work within the realms of the strategies and plans that have been centrally developed when ownership is essentially seem to lie within themselves.

8. Recommendations

It is recommended that Samoa should :

(i.) Set-up, as soon as possible, the institutional framework for the transfer of technologies as advocated in this document.

(ii.) Take further the proposals for implementation of the GHG Abatement Strategy which has been developed and endorsed by the CEO of MNRE.

(iii.) Undertake separate detailed assessments for Mitigation and Adaptation

(iv) Conduct Cost benefit analysis for project profiling as well as Technology Impact Assessments (TIAs) for each of the technology options

(v) Accelerate the development and use of clean technologies as these may provide a competitive edge on global markets and lead to a path of greater efficiency. The simplicity and stability of these technologies may, in the future, offset impacts of external pressures such as continuously increasing petrol prices and devaluation of the currency. Activities, on alternate sources of energy, could also encourage local resources to invest more in applied research activities.

(vi) Encourage further work on new financing schemes that have the potential to address issues on high investment risks, high transaction and investment costs, and loan guarantees, in particular for those technologies identified in the TNA studies. This is because Financing remains a core issue in technology transfer.

(vii) Encourage and Implement Capacity Building activities needed for the transfer, operation and maintenance of technology.

Implement Awareness programmes to address confusions in perceptions of alternative energy, and encourage energy use efficiency

OTHER INFORMATION

13 Other Information

13. *Research and Systematic Observation*

To a large extent, the bulk of climate related observations both current and historical, are meteorological and atmospheric and their collection rests with the Meteorology Division of the Ministry of Agriculture, Forests, Fisheries and Meteorology (MAFFM). This report focuses mainly on these activities directly relevant to the GCOS and the other WMO observing programs. Some other activities that have been identified as having potential for establishment at other institutions, for example the existing water quality monitoring activity undertaken by Samoa Water Authority, and sediment loading monitoring project undertaken by the Fisheries Division of MAFFM, are also investigated into at some detail under the relevant sections.

The establishment of a fully-fledged national forecasting unit at the Meteorology Division in 1998 consisting of WMO trained forecasters, the addition of a meteorological office at the Faleolo International Airport, and the re-establishment of the Climate Unit have helped consolidate and increase the range of the Division's weather and climatic observing and data collection operations. The installation of 6 NOAA automatic weather stations (AWS) around Samoa between 1991 and 1997, and the formalization of tropical cyclone warning issuance procedures in collaboration with the American Samoa Weather Service Office, have resulted in much-improved products and services provided by the Division. Daily routine products and services the Division has gained access to, through assistance from several overseas institutions and organisations, have increased the reliability and redundancy of systems employed for issuing accurate forecasts and warnings. The 4-day forecasts issued twice a day officially since late 1998 is part of this favourable development.

The Division maintains a national climate and rainfall station network covering most of the two main islands. These networks have been in existence for more than 20 years and have established good records and data sets for climate analysis. In 1993, a SEAFRAME tide gauge was installed at the Apia wharf as part of a regional climate and sea-level monitoring project. To date, it has collected 9 years of data and is the only oceanographic component of the Division's observations. The tide gauge measures amongst several other parameters, sea-level and water temperature data.

Samoa Water Authority's (SWA) Environmental Business Unit (EBU) and MAFFM's Fisheries Division are the only other institutions with activities this report seeks to identify for consideration to GCOS or its sub-networks. The EBU is responsible for water quality monitoring, carrying out analysis at its laboratories, on-site at surface water in-takes and borehole stations and has been doing so actively for approximately 15 years. The Fisheries Division's CIDA funded climate change project focused on marine and coastal resources plans to institutionalise a system to monitor sediment loading from major rivers around Samoa.

Existing climate monitoring networks and national plans

A brief history of the Apia Observatory

The Apia Observatory was established at the turn of the last century as the German scientific community began establishing observing centres in strategic positions around the world to begin a coordinated terrestrial geomagnetic observation programme.

Initial climatological observations began in 1890 at a location within the present Apia town area. It was then shifted to the Observatory's present location at Mulinu'u when German geophysicists and meteorologists arrived in June 1902 to begin work at the newly established Observatory. A few of these meteorologists (Dr. Franz Linke in particular) carried out research and routine observations returning to Germany where their work would earn them later recognition as pioneering fathers of present day meteorology. In its past colourful history the Observatory also played a role as the regional forecasting centre for the World War II Pacific theatre, operating under the New Zealand government that had officially taken over from its German founders at the end of the First World War in 1921. Under this new

leadership a hydrological component was added to the Observatory to monitor and collect information on various water sources and rivers around the country.

The meteorological, hydrological and geophysical data that the Observatory holds has the potential to be of great value to the international scientific community. Maintenance of its current operations in collecting data has been assisted by organisations such as the WMO, NOAA, NIWA, USGS and BoM to name a few. However, over the past recent years, even as meteorological operations gained success in expanding the climate and rainfall station network that encompass the country, increasingly limited resources and rising maintenance costs have seen drastic reduction in the number of observing stations of some of these networks. This report will also identify key areas where assistance in restoring networks is needed and refer to more detailed sources of information and reports containing particular identified needs.

13 Meteorological and Atmospheric Observations

The Apia Observatory, now the Meteorology Division (of the Ministry of Agriculture, Forests, Fisheries and Meteorology), is the national forecasting centre for Samoa. Standard reporting of synoptic weather observations (SYNOP) are carried out including hourly meteorological aviation reports (METAR) from the station at the Faleolo International Airport. Apia and Faleolo stations are the only two fully manned, 24-hour stations. Weather forecasts are produced twice daily along with other aviation products such as route forecasts (ROFOR), area forecasts (ARFOR), and terminal aerodrome forecasts (TAF) for two local airlines flying between Samoa and American Samoa and upon request from the flying public.

The Division's Weather and Forecasting Unit collaborates with the American Samoa and Fiji Meteorological Services in monitoring tropical depressions and cyclones as they occur near and in the vicinity of the island group, and monitoring of local weather observations as requested. Part of the collaboration with American Samoa also includes a review and update of the Samoan language translation of weather forecast terminology (particularly wind strengths and directions) and a review of tropical cyclone monitoring procedures and performances.

All meteorological observations/reports, including production of national forecasts are the responsibility of the Meteorology Division.

13.1.1 National Climate Observation Network

The Meteorology Division is also responsible for developing a national plan to maintain and improve its climate-observing network. The Climate Unit is responsible for its management and monitoring and there are 6 climate stations13 currently in operation that make up this network. Five of these stations are based on Upolu with the remaining station on Savai'i. The Apia, Asau and Faleolo climate stations are registered WMO observing stations (the stations and their location coordinates are listed in Appendix 2). Below follows a summary of the key climate stations among them for GCOS consideration.

1. Apia Climate Station

The Apia Observatory is recognized as one of the longest of the climate stations in operation in the region, celebrating its centennial in June of 2002. It is for this achievement that it is recognized regionally as a key climate observing station, not having had a site shift in its entire 100-year record. Historical data at this location is yet to be completely digitised due to

13 Refer to Appendix 2 for the list of climate stations, their local network and WMO numbers and their geographical locations

Figure 1. *View of the Apia climate station from the south. Beyond the enclosure is a concrete seawall, built after the severe impacts of TCs Ofa and Val. A Vaisala wind mast is also visible in the background.*

the lack of technical equipment to move the process forward. Technical assistance in the form of desktop computers and digitizing equipment is being sought to aid the process and firmly establish the Division's National Climate Database. This station is highly recommended for inclusion in the GCOS network.

The station records14 wind, rainfall, temperature, atmospheric pressure, sunshine hours and evaporation data. It is expected to still be operational in 2005.

2. Faleolo Climate Station

The Faleolo climate station is located at the Faleolo International Airport (no picture available). This station is a METAR and SYNOP reporting station (including other aviation related reports it is responsible for producing such as SIGMET and SPECI reports) and has been in operation under the Division since 1999, although records go back to early 1960s when it operated under the Samoa Airport Authority. The future of this station is secure given it fulfils the requirement of an international airport for a meteorological observation station on-site. The station is also likely to benefit from an upgrade of office facilities and technical equipment, with future plans and projects underway to improve its operations. The station records temperature, wind, rainfall, and atmospheric pressure.

3. Nafanua Climate Station

The Nafanua climate station is located approximately 5 kilometres to the southeast of the Apia Observatory at an elevation of 100m above sea level. It is a fenced enclosure composed of a Stevenson screen (standard temperature observations) with a rain gauge, checked daily at 0900hrs. Although it is of relatively close proximity to the Apia station, it is its elevation (strategically located near mid-point between Apia at sea-level and Afiamalu at mountain peak) and length of the good quality data recorded (1965 - ongoing) that this station has its value within the local network and to the GCOS network. The station records rainfall and

Figure 3*. The enclosure of the Nafanua climate station is behind the observer. The station is located on a government plant nursery.*

14 These recordings refer to measurements by equipment only and do not exclude cloud types and other meteorological observations that are part of standard weather observations. Temperatures refer to maximum , minimum, dry and wet bulb measurements.

temperature. This station could benefit from upgrade of thermometers and addition of other measuring instruments and equipment to expand its current observations. The future of this station is considered safe.

4. Afiamalu Climate Station
The Afiamalu station is located approximately 11 kilometres to the south of the Apia Observatory at an elevation of about 700m above sea level, and is visited daily. It has been in operation since 1965 and data recorded here is considered to be of good quality. Existing equipment including thermometers and siphon rain gauge need urgent upgrading and replacement. Wind and sunshine recording equipment are no longer operational here though

Figure 4. *180-degree view of the Afiamalu climate station enclosure. The building at the left (south) of the station houses the seismic monitoring and data transmission controls.*

their reinstallation would be useful considering the past data accumulated over a span of several years. The length of the data and the contrast to the coastal climate it records makes this station important to the local climatology where rainfall distribution, wind and temperature and other climatic observations at this altitude are concerned. The future of this station is considered safe long term as it is on government property, with no external interests indicated to threaten its continuation. It currently records temperature, evaporation, and rainfall.

13.1.2 Other Meteorological Networks

National Rainfall Network
The National Climate Observation Network is supported by the National Rainfall Station Network, also administered by the Climate Unit, a total of 28 stations (14 each on Upolu and Savai'i) distributed across both main islands. The majority of these stations have continual observations of more than 15 years. The Electric Power Corporation (EPC), a government corporation, also collects rainfall data from its own network of rainfall stations though these are fewer and restricted only to catchment areas that feed its single hydroelectric power station situated at Afulilo. Appendix 2 lists these stations and the length of operation along with a distribution map.

Automatic Weather Stations
A collection of 6 Automatic Weather Stations (AWS) evenly split between Upolu and Savai'i and installed by NOAA's National Weather Service (NWS) reports weather observations (wind speed, direction and gust, temperature, and atmospheric pressure) at hourly intervals. This data is accessed via a designated NWS website and aids the forecaster by providing on the hour wind, temperature, and rainfall data, in monitoring current weather. These stations are serviced twice a year by visiting NWS technicians. Data however is not stored locally because of the requirement to access the internet on a regular basis, which the Division cannot guarantee time for due to slow internet connection times and forecasting requirements taking precedence. The first AWS was installed in 1991 and the rest have been added over the years. Refer to Appendix 2 for the complete list of AWS locations and installation dates.

13.2 Oceanographic Observations

13.2.1 SEAFRAME tide gauge

As part of the AusAID-sponsored South Pacific Sea Level and Climate Monitoring Project ("Pacific Project") for the FORUM region, in response to concerns raised by its member countries over the potential impacts of an enhanced Greenhouse Effect on climate and sea levels in the South Pacific region, a **SEAFRAME** (**Sea** Level **F**ine **R**esolution **A**coustic **M**easuring **E**quipment) gauge was installed in Apia, Samoa, in February 1993. The gauge has been returning high resolution, good scientific quality data since installation. The Meteorology Division is the local counterpart of this project.

The Meteorology Division is responsible locally for data obtained from, and physical care of, the tide gauge located on the Apia wharf. The tide gauge was installed and is maintained by the National Tidal Facility (NTF) of Flinders University (Adelaide, Australia) under the Sea Level and Climate Change Monitoring Project. The tide gauge has collected 9 years of data and records the following data types at various time intervals:

1. Sea Level (with calculated and adjusted residuals)
2. Wind Direction, Speed and Gust
3. Water Temperature
4. Air Temperature
5. Barometric Pressure

The project is ongoing, and is currently in its third phase. Continuous GPS measurement capability has been added to determine vertical land movement with respect to the International Terrestrial Reference Frame. Instalment of benchmarks around the greater Apia area for this purpose was completed in late 2002. The Division receives raw real-time data directly transmitted via microwave from the gauge for local download and storage on a project supplied computer with a real-time display module. All data is officially processed for quality control and analysis by the National Tidal Facility.

Other than data received from the tide gauge directly and monthly summary reports produced by the NTF, the Division does not currently undertake oceanographic observations other than tide height measurements that have since ceased in the 1970s. The data collected by the tide gauge is accessible via the Internet and via CD-ROM in a yearly compilation form produced by the NTF. The Division archives the raw transmitted data and analyses it for local extreme events as they occur. It also uses the tide tables produced by the NTF with this data as its official guide for tides in the islands.

The tide gauge is expected to be operating in 2005.

13.3 Terrestrial Observations

13.3.1 River Stage and Discharge Monitoring

A network of hydro-meteorological stations was initially set up in 1971 under the Apia Observatory to begin water resource investigations resulting in the establishment of a handful of experimental boreholes with supporting hydro-meteorological stations installed in areas with potential for water supply and hydro-power development. By the end of 1976 the hydro-meteorological network consisted of 16 stream-gauging stations, 30 rainfall stations and 3 fully equipped climate stations.

Today, the Meteorology Division's Hydrology Section is responsible for the collection and analysis of river stage and discharge data at most rivers around Samoa. It is also responsible for undertaking hydrological surveys to establish water table depths and elevation profiles for borehole site investigations. There is no direct operational link between it and the Samoa Water Authority (SWA), a government corporation managing the distribution of water in the country, aside from requests for a hydrological survey to be conducted to site new boreholes, and occasional data requests made by the SWA of the Division's Hydrology Section. The Hydrology Section maintains a rainfall station network (installed at key catchment areas) based on monthly measurements of rainfall (versus the daily rainfall measurements recorded at stations under the Division's Climate Section).

The Pacific HYCOS project proposal, now completed and in funding transition (refer to WMO and SOPAC) will see the nomination of this hydrological network for inclusion and participation in the project's proposed activities.

13.3.2 Water Quality Monitoring

Samoa Water Authority's (SWA) Environmental Business Unit (EBU) is responsible for the quality monitoring of surface and ground water. Three treatment plants for surface water exist at the Fuluasou, Alaoa and Malololelei intakes on Upolu, utilizing slow sand filtration and chlorination processes. The surface intakes for water supply are complemented by 19 boreholes around the island. Savai'i has a lone surface intake with a treatment plant at Palauli. The rest of the Savai'i's supply is supplemented by 23 boreholes around the island.

Testing is undertaken both on-site and at end points to monitor both chlorine and bacteria levels. The range of chlorination of 0.1 – 0.25 mg/litre are assured to maintain zero percent presence of bacteria, e-coli, and coliform. WHO standards have been adopted to develop a national standard of high maintenance and quality assurance. While the EBU is responsible for the monitoring of water quality at these stations, it also extends its professional

services to local commercial water vendors. One other commercial water vendor also offers water quality analysis services. It is envisioned that the EBU will become a commercial, specialized service independent of the SWA in the future.

13.4 Space-based observations

There are no space-based observations or activities currently undertaken by Samoa.

13.5 Additional difficulties encountered in providing information

Very few problems were encountered in the compilation of this report and none considered as particularly significant. Of those encountered worth mentioning, the Meteorology Division networks were well documented but lacked station location maps, and updated records to changes in detail of their networks. In addition, much of the stations in the hydrological and climate networks have data records largely undigitized. Overall it provided some difficulty in searching for precise begin dates of stations, the length of data accumulated and its continuity over the record, including evidence of analysis reports. Aside from this, those concerned in providing the information were extremely helpful in the compilation of this report.

14 Education, Training and Public Awareness

1. Introduction

Education and public awareness is important as it helps to build understanding of climate change issues and to strengthen Samoa's capacity to adapt to the adverse impacts of climate change. The Ministry of Natural Resources, Environment and Meteorology (MNRE) which is primarily responsible for the sustainable management of Samoa's natural resources and environment is also the key agency responsible for Samoa's national climate change work, including education and public awareness activities. Since Samoa ratified the UNFCCC and Kyoto Protocol, a number of programmes have been conducted both at the national and local level to help promote public awareness and understanding of climate change issues. The National Policy on Combating Climate Change and the NAPA has highlighted key strategies on awareness to help mitigate and adapt to the effects of climate change. In addition the Canadian Funded project – Capacity Building for the Development of Adaptation Measures (CBDAMPIC) 2002 – 2005 also contributed in highlighting Climate change issues at the local level particularly in two vulnerable communities Saoluafata and Lano.

This chapter will focus primarily on the level of awareness locally and nationally on climate change and its adverse impacts.

It will also look at some of the planned and implemented initiatives and other measures put forward by the Government through MNRE and various organizations to increase awareness amongst the people on climate change. Some of the gaps, needs and priorities relating to climate change information dissemination and awareness will also be covered.

Level of Public Awareness

The establishment of the Climate Change Unit within MNRE has resulted in the dissemination of information which been locally produced to cater to the growing need of the general public and schools and universities. Since Samoa ratified the UNFCCC in 1994, programmes and activities dedicating to the raising of awareness on climate change were developed. Such included the National Management Strategies (NEMS) endorsed by cabinet which mainly focused on environmental concerns.

For the last ten years the Ministry has been promoting awareness through National Environment Events such as the commemoration of the National Environment Week and the Annual Climate Change Awareness day which focuses primarily on promoting awareness and dissemination of information about climate change to the public and schools. A significant contribution of these
events has led to the level of public awareness which is gradually increasing through schools, projects and communities through various consultations conducted under the NAPA and CBDAMPIC.
National efforts have focused mainly on the compilation of reports such as the initial National Communication, NCSA, NAPA, CRP which have documented information that have helped improve the level of awareness and knowledge on climate change issues and thus lead to more informed decision making at the national level. At the local level these reports and plans provided scientific facts that climate change is happening and its effects are being felt by vulnerable communities and has helped in improving the communities' capacity to adapt to the adverse effects of climate change.

2. Education and Training

Within the national education curriculum climate change issues have been fragmented to suit the level of education whether in primary, secondary and tertiary levels. The current Primary School Curriculum does not contain any specific topics on climate change, however, there are related topics under the Science and Social Science curriculum with the focus on the environment and the surroundings in general. The Secondary Curriculum for years 9 -11 (form 3 – lower 5) covers certain related topics under the Science and Social Science in which CC issues can be addressed. As such the year's 9-11 social studies on "Place and Environment" and "Development and Change" are some of the areas in which the teacher can use to address climate change and using it as a case study can be optional for Years 12 and 13 IA Research.
The Years 12-13 (forms 5-6) Geography Curriculum, covers related topics (several strands are available) to (teach) climate change under Environmental Issues. In this strand, students can learn about climate change as a consequence of interactions between cultural environment and the atmospheric system and the different perspectives and responses to climate change.

In addition resource materials were developed and distributed to schools to help supplement teaching materials available at schools, for e.g., climate change booklet, mangrove kit and many other educational resources. A notable level of partnerships and strong cooperation with line Ministries and agencies have also established efforts to promote the use of environment education to foster the values and behavior required of our young generation for a sustainable future. The "Environment Resource Education Guide for Years 7 to 10" have been completed which aims to support the implementation of environment education initiatives in our schools. It is a compilation of instructional resource materials developed to enhance general understanding, information sharing and learning at the primary and secondary levels. A key focus of this Environment Resource Guide is the need to

integrate environment 'education for sustainable development' (ESD) into the national curricula which promotes learning to empower our young generation to take on responsibilities for the environment. The Guide will be used as a supplementary material for schools to introduce related topics on: marine ecosystems, biodiversity, water resources, waste management, mangroves and climate change.

Furthermore the national reports prepared by the Ministry such as the First National Communication, NAPA, NCSA Climate Change Thematic Report, CRP etc have also been used for research purposes, other information are made available through the Ministry's website. www.mnre.gov.ws .
The media publicity on climate change issues have also contributed to a wider audience and increase in number of people and students being informed of CC concerns compared to 10 years ago. A significant example was the Ministry's Climate Change Quiz 2006 prior to the Climate Change Awareness day, which was the first televised competition amongst form six students to test their knowledge of Climate Change and other related issues. The feed back from the general public was a huge success however financial support is needed to broadcast these programmes which hinder the progress.
At the national level, the Ministry continues to promote awareness through country - wide consultations, seminars, workshops to continue to engage communities and vulnerable settlements. Education programmes for village communities targeting village leaders and school students were also conducted.

As a pilot demonstration under CBDAMPIC, education activities were also implemented within the two selected communities at Lano and Saoluafata targeting primary school students and village leaders. This initiative focused on the use of presentations, from the Meteorology Office, Capacity Building, Red Cross and other members of the National Climate Change Country Team to further enhance the capacity of the whole village in dealing with climate change. A documentary was developed under this project which is in English with Samoan Subtitles and focuses on the vulnerabilities of the communities to climate change , impacts on the lives and the measures of adaptation that were put in place.

In terms of staff development, a number of individuals from the Ministry not restricted to the Climate Change Section are often sent abroad for necessary trainings, seminars and workshops through funds from the UNFCCC or from other various organizations. Specific in-country trainings with the media were conducted to help increase awareness and understanding of the media to better report on CC issues. In the process of completing the Samoa's Second National Communication, the NCCCT is the main driving force in the formation of the working Groups from the different SNC components. This has resulted in the output of many reports from the different experts from each ministry which also shows the high level of awareness and knowledge of climate change issues within the different ministries. While undertaking these activities, consultation workshops and training sessions are often held for local stakeholders where information compiled by the team and climate change section is processed and presented to the stakeholders. This is a good way for stakeholders to learn and gain knowledge on the adverse impacts of climate change.

3. Implemented and Planned Initiative

Implemented

Since the Government of Samoa ratified the UNFCCC (1994) and since the Kyoto Protocol came into effect in 2005 a number of developments to promote awareness and understanding of CC issues have been implemented by the Ministry. The formulation of the National Policy on Combating Climate Change was conducted through a consultative process with relevant stakeholders. Other key National Reports such as the NAPA, SNC, and NCSA were also compiled through various community consultations and seminars in which the focus was on increasing awareness and understanding on the wider population on strategies to mitigate the effects of CC and adapt to its impacts in an effective and sustainable manner.

Cabinet have also endorsed the commemoration of environment events during the year to highlight various environmental concerns such as the 'National Climate Change Awareness Day' in July and the 'National Environment Week' in November. During the climate change awareness day, consultation seminars are held focusing on all aspects of climate change including the causes and effects, vulnerability and adaptation, and mitigation. Activities and competitions such as quizzes, poster competitions, essay writing and other educational activities targeting school students are also conducted. These are annual events in which displays are put on show providing an opportunity for the public to learn more about climate change.
In-country trainings and workshops for sectors affected by climate change are also carried out in working groups and often include Agricultural, Heath, Water, Biodiversity, Fisheries and the Infrastructure sector. Climate change stakeholders and working groups are often formulated to participate in workshops and training sessions discussing mitigation options, vulnerabilities and adaptation measures, Samoa's greenhouse gas inventory and education and awareness. Overseas **The Pacific Islands Framework for Action on Climate Change** allows for the development and strengthening of partnerships for the implementation of national and regional initiatives to address climate change through regional trainings and workshops. Samoa has also participated in other regional climate change projects, such as the Pacific Islands Climate Change Assistance Programme (PICCAP) in 1997-2000, a capacity building project designed to assist Pacific island countries to develop their first national communication.

Training workshops for the media was also conducted in collaboration with SPREP to build networks/partnerships with the media and thus engaging their involvement to better report on CC issues. Given the scope of circulation and presentations as well as interviews regarding climate change the amount of information in the public, the role of the media becomes very significant. A number of media agencies as well as the National Climate Change Country Team were involved in the Formulation of the CC Communication Strategy which was held in collaboration with SPREP on December 2006 which targets various groups and the relevant message made available to each target audience

In addition, the Ministry (Capacity Building Section) provides a Children's Environment Column: "Our Environment Our Heritage" published weekly in the local newspapers (Samoan Observer & Newsline every Sunday). The Sunday articles provides an array of environmental issues as (re reserved for MNRE's articles whereby) each division takes turn to share information in their respective (in presenting their) field (in the newspaper,) including the climate change section. For example (Climate change currently occupies two months of) articles (focusing) on the science of climate change, its impacts on the different aspect of the country, the mitigation options and other articles relating to the climate change issue in Samoa. There were also articles presented regularly in the

Tapu magazine; a sub regional magazine based in Samoa and is distributed throughout Hawaii, Australia, New Zealand, Niue, American Samoa, Tokelau and the USA.
There have also been a series of occasions whereby the Meteorology Division where Climate Change section is housed is visited by school trips and students seeking information. Climate change fact sheets, brochures, and other related information are distributed during these visits

4. Public Access to Information

The climate change section of MNRE is the primary source of information for all climate change issues relating to Samoa, however the Capacity Building Section houses a library which some of the locally produced information can also be obtained. The SPREP and UNDP offices also have information as well as a wide range of educational materials that the general public and students can access. However there is no existing database which can be accessed freely by the public but data has been kept. As previously mentioned the office is often visited by students and individuals' seeking information on climate related risks and the section has already compile information and data to accommodate this. Other information is also available from other stakeholders and sectors taking part in the climate change programme, it involves the agricultural, health, fisheries, forestry, water sectors among others.

The downside of data storage and information dissemination is the poor facilities for data storage and a limited access to information. This is caused by a limited expertise in the area of database management and a poor networking and coordination systems.
Information distribution also faces a number of constraints; there is a lack of available equipments and database to store all data and information, the idea of unwillingness to share information with others, and custodian or ownership of data and information.

5. NGOs and Academic Institutions Contribution

Non-Governmental Organizations (NGOs)

The Ministry has continued to work closely in partnerships with other agencies, NGOs and institutions in the implementation of various activities pertaining to Climate Change.

NGOs with an environment focus continue to be involved in the implementation of government led environment activities. Their role lies in advocacy for environmental management in areas of education and public awareness and highlighting local environmental issues. There are only three NGOs taking part in Samoa's Climate change programme and all members of the National Climate Change Country Team (NCCCT). The NCCCT acts as a steering committee for all the climate change activities in Samoa and is made up of all relevant stakeholders. Below are some of the responsibilities and interests of the three NGOs

<u>Matua-i-le-oo Environment Trust Inc (METI)</u>

METI is an independent Samoan Environment Trust set up in June 2000 and provided valuable support to the Climate Change Projects especially to the CBDAMPIC and NAPA project. Under the Awareness and Education

Component of the CBDAMPIC Project METI was one of the leading organizers, they conducted awareness and demonstration particularly with Coral Gardening in Saoludafata and Lano.
They also participated widely in the NAPA Team with the consultations with the country – wide consultations.
They are also active members of the Climate Change Country Team (NCCCT)

O le Siosiomaga Society Inc (OLSSI)
OLSSI is an active environmental NGO and an important stakeholder for all climate change activities in Samoa

Samoa Red Cross Society Inc
Samoa's Red Cross Society Inc is mainly involved in pre-disaster planning and post-disaster. A member of the NCCCT. In collaboration with MNRE, it conducts disaster preparedness training and climate change awareness in village communities' relief work

Academic Institutions
Academic Institutions have also played major roles in raising public awareness on climate change. Environmental courses and other related courses to climate change are available for students interested in environmental fields. These are the main institutions available in Samoa.

The National University of Samoa (NUS)
NUS provides education courses relevant to the climate change issue. It enhances the individual's knowledge on environmental issues and other global phenomenon's. NUS also provided support and in the preparation of Samoa's SNC. Assisted with undertaking research work on monitoring of air quality and wastewater treatment

The University of the South Pacific
USP provides in detail education, research and training courses for all regional and international students wishing to pursue and enlarge and widen their knowledge on issues affecting the Pacific region. The USP center in Alafua focus primarily on agricultural training and courses and has a strong agriculture research and training program, which is highly relevant to the adaptation component of the SNC. The Institute of Research, Extension Training and Agriculture (IRETA) is part of this campus.

Institute of Higher Learning
The School of Technology the merging of Samoa Polytechnic and NUS is responsible for organizing and delivering post-school education and training to prescribed standards. Focuses on teaching of horticulture and involves the use of fertilizers and pesticides and a refrigeration course which involves maintenance, service and disposal of waste. Also offers courses on business administration and IT.

6. Gaps, needs and Priorities in Climate Change Information

Gaps

Over the years constraints and gaps relating to availability and dissemination of information have been identified and addressed , this is due to the amount of information, policies etc that has been compiled over the years as well as awareness campaigns being carried out by the Ministry.
Previous development initiatives such as the CDI 2000 (need to add more)
The NCSA 2007 have documented the fact that Samoa continues to encounter a number of obstacles in terms of trying to meet some of the obligations under the UNFCCC and the Kyoto Protocol. These include insufficient funds, lack of data & poor information management, inadequate physical resources and human resources. For Samoa to fully maximize awareness opportunities in climate change information, activities needs to emphasize creating enabling environments at both the local and national levels to encompass regulatory frameworks, information, knowledge and technologies and these to be fed back to communities for improved decision making and improved environmental management.

Another issue that needs to be addressed is the use of resources and the dissemination of information in such a manner that the students of all levels understand and apply it to whatever level of education they are in. Climate Change is not reflected as a subject because its's not a core subject but can be introduced as supplementary materials to support existing topics in the national curriculum.
Collaboration between MNRE and MESC is strongly required to address the issue.
Lastly there are barriers in the dissemination of the right information to each target audience and the use of appropriate terminology during consultation and awareness programmes. There is a need for all Environmental Terminology including climate change to be translated into the Samoan language so that the most affected and vulnerable people can understand the urgency of the matter.

Needs and Priorities

Efforts should be focusing on using Climate Change information available to a wider audience and perspective. MNRE to continue partnerships with MESC and other key agencies to use schools, consultations, media, community groups, seminars, teaching materials and many other avenues to promote awareness and to support the existing programmes currently being implemented within the Ministry to highlight CC issues.
The new SDS now highlights CC as one of the key environmental concerns. This is more a priority at the national level that should also be noted.

Current awareness activities and programmes should be evaluated for their effectiveness and the only way to complete this is to carry out a national survey on how aware Samoans are on climate change. There is a need for MNRE to cooperate with the Statistics Division of the Ministry of Finance for a survey to assess the public's awareness on climate change
There is a need to improve the existing information systems to improve information sharing and networking. Funding for the purchasing of necessary equipments and devices is needed to overcome such problems.
Again cooperation between government ministries, agencies and NGOs is also essential for the effectiveness of proposed awareness programmes and activities
Funding is also needed to produce education materials on Samoa regarding climate change both in English and Samoan. Funding should also be provided for the training of appropriate staff in the area of environment

education. Another effective way of addressing climate change is by explaining the issue of climate change in Samoan

Information regarding climate change needs to be stored in a central database where the public can access through the internet and develop protocols to facilitate and govern data sharing between stakeholders. Funding should be allocated to the training of staff members in managing and maintaining of data and information.

Annex 1: GHG Inventory Tables

ANNEX:
GHG INVENTORY REPORTING TABLES

(note, tables for all years are included in the full inventory report)

1994 Base-Year (Revised)

UNFCCC Reporting Table 1. Samoa's National greenhouse gas inventory of anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol and greenhouse gas precursors (1994)

Greenhouse gas source and sink categories	CO_2 emissions (Gg)	CO_2 Removals (Gg)	CH_4 (Gg)	N_2O (Gg)	CO (Gg)	NO_X (Gg)	NMVOC (Gg)	SO_2 (Gg)
Total National Emissions and Removals	102.20	-658.56	2.25	0.05	5.41	0.92	1.07	NE
1 ENERGY	102.20		0.02	0.0009	5.41	0.92	1.02	NE
1A Fuel Combustion Activities	102.20		0.02	0.00	5.41	0.92	1.02	NE
1A1 Energy Industries (electricity generation)	8.79		0.0004	0.0001	0.003	0.02	0.0006	NE
1A2 Manufacturing Industries and Construction	NA		NA	NA	NA	NA	NA	NE
1A3 Transport (subtotal)	70.75		0.014	0.0006	5.26	0.71	0.99	NE
1A3a Civil Aviation (Domestic Aviation)	0.06		0.0000005	0.000002	0.000	0.003	0.00005	NE
1A3b Road Transport	68.45		0.014	0.0006	5.23	0.66	0.99	NE
1A3c Waterborne Navigation (Domestic Shipping)	2.23		0.0002	0.00002	0.03	0.05	0.006	NE
1A4 Other Sectors (subtotal)	22.66		0.0026	0.0002	0.144	0.19	0.03	NE
1A4 a Commercial/Institutional	1.16		0.0002	0.000011	0.0004	0.002	0.0001	NE
1A4 b Residential	11.14		0.0017	0.0001	0.003	0.02	0.00	NE
1A4 c Agriculture/ Forestry/ Fishing/ Fish Farms	10.36		0.0007	0.0001	0.14	0.17	0.03	NE
1A5 Non-Specified	NO		NO	NO	NO	NO	NO	NO
1B Fugitive Emissions from Fuels	NO		NO	NO	NO	NO	NO	NO
1C Carbon Dioxide Transport and Storage	NO				NO	NO	NO	NO
2 INDUSTRIAL PROCESSES AND PRODUCT USE	NE		NA	NE	NA	NA	0.05	NA
2A Mineral Industry	NO		NO	NO	NO	NO	NO	NO
2B Chemical Industry	NO		NO	NO	NO	NO	NO	NO
2C Metal Industry	NO		NO	NO	NO	NO	NO	NO
2D Non-Energy Products from Fuels and Solvent Use	NE		NA	NA	NA	NA	NA	NA
2D1 Lubricant Use	NE				NE	NE	0.047184769	NE
2D2 Paraffin Wax Use	NE		NE	NE	NE	NE	NE	NE
2D3 Solvent Use	NA		NA	NA	NA	NA	0.05	NA
2D4 Other (please specify)	NO		NO	NO	NO	NO	NO	NO
2E Electronics Industry	NO		NO	NO	NO	NO	NO	NO
2F Product Uses as Substitutes for Ozone Depleting Substances	NA		NA	NA	NA	NA	NA	NA
2G Other Product Manufacture and Use	NA		NA	NE	NA	NA	NA	NA
2G1 Electrical Equipment	NO		NO	NO	NO	NO	NO	NO
2G2 SF6 and PFCs from Other Product Uses	NO		NO	NO	NO	NO	NO	NO
2G3 N2O from Product Uses	NA		NA	NE	NA	NA	NA	NA
2G4 Other	NO		NO	NO	NO	NO	NO	NO
2H Other (please specify)	NA		NA	NE	NA	NA	0.002	NA
2H1 Pulp and Paper Industry	NO		NO	NO	NO	NO	NO	NO
2H2 Food and Beverages Industry	NA		NA	NA	NA	NA	0.002	NA
2H3 Other (Ammonia Use)	NA		NA	NE	NA	NA	NA	NA

UNFCCC Reporting Table 1 cont (1994)

Greenhouse gas source and sink categories	CO_2 emissions (Gg)	CO_2 Removals (Gg)	CH_4 (Gg)	N_2O (Gg)	CO (Gg)	NO_X (Gg)	NMVOC (Gg)	SO_2 (Gg)
3 AGRICULTURE, FORESTRY AND OTHER LAND USE	NE	-658.56	1.05	0.05	NE	NE	NE	NE
3A Livestock			1.05	NE				
3A1 Enteric Fermentation			0.73					
3A2 Manure Management			0.32	NE				
3B Land	NE	-658.56	NE	NE	NE	NE	NE	NE
3B1 Forest Land	NE	-658.56	NE	NE	NE	NE	NE	NE
3B2 Cropland	NE	NE	NE	NE	NE	NE	NE	NE
3B3 Grassland	NE	NE	NE	NE	NE	NE	NE	NE
3B4 Wetlands	NE	NE	NE	NE	NE	NE	NE	NE
3B5 Settlements	NE	NE	NE	NE	NE	NE	NE	NE
3B6 Other Land	NE	NE	NE	NE	NE	NE	NE	NE
3C Aggregate Sources and Non-CO2 Emissions Sources on Land	NE		NE	0.051	NE	NE	NE	NE
3C1 Biomass Burning	NE		NE	NE	NE	NE	NE	NE
3C2 Liming	NE							
3C3 Urea Application	NE							
3C4 Direct N2O Emissions from Managed Soils				0.04				
3C5 Indirect N2O Emissions from Managed Soils				0.01				
3C6 Indirect N2O Emissions from Manure Management				NE				
3C7 Rice Cultivations			NO				NO	
3C8 Other (please specify)	NO		NO	NO	NO	NO	NO	NO
3D Other	NO		NO	NO	NO	NO	NO	NO
4 WASTE	NE		1.18	NE	NE	NE	NE	NE
4A Solid Waste Disposal	NA		NE		NE		NE	
4A1 Managed Waste Disposal Sites	NA		NE		NE		NE	
4A2 Unmanaged Waste Disposal Sites	NA		NE	NE	NE	NE	NE	NE
4A3 Uncategorised Waste Disposal Sites	NA		NE	NE	NE	NE	NE	NE
4B Biological Treatment of Solid Waste	NA		NE	NE	NE	NE	NE	NE
4C Incineration and Open Burning of Waste	NE		NE	NE	NE	NE	NE	NE
4C1 Waste Incineration	NE		NE	NE	NE	NE	NE	NE
4C2 Open Burning of Waste	NE		NE	NE	NE	NE	NE	NE
4D Wastewater Treatment and Discharge	NA		1.18	NE	NE	NE	NE	NE
4D1 Domestic Wastewater Treatment and Discharge	NA		1.18	NE	NE	NE	NE	NE
4D2 Industrial Wastewater Treatment and Discharge	NA		NE	NE	NE	NE	NE	NE
4E Other (please specify)	NO		NO	NO	NO	NO	NO	NO
5 OTHER	NE		NE	NE	NE	NE	NE	NE
5A Indirect N2O Emissions from the Atmospheric Deposition of Nitrogen in NOx and NH3	NE		NE	NE	NE	NE	NE	NE
5B Other (please specify)	NO		NO	NO	NO	NO	NO	NO
Memo items(5)								
International Bunkers (subtotal)	16.12		0.0002	0.0004	0.049	0.103	0.039	NE
International Aviation (International Bunkers)	14.02		0.0001	NE	0.020	0.060	0.01	NE

International Water-borne Transport (International Bunkers)	2.10		0.0001	0.00040	0.029	0.043	0.029	NE
Multilateral Operations	NO		NO	NO	NO	NO	NO	NO

UNFCCC Table 2. Samoa's National greenhouse gas inventory of anthropogenic emissions of HFCs, PFCs and SF6 (1994)

Greenhouse gas source and sink categories	HFCs (Gg)					PFCs			
	HFC-23	HFC-134	HFC-32	HFC-125	HFC-143	CF_4	C_2F_6	Other	SF_6
Total National Emissions and Removals	NE	NE	NE	NE	NE	NO	NO	NO	NO
1 ENERGY									
1A Fuel Combustion Activities									
1B Fugitive Emissions from Fuels									
1C Carbon Dioxide Transport and Storage									
2 INDUSTRIAL PROCESSES AND PRODUCT USE	NE	NE	NE	NE	NE	NO	NO	NO	NO
2A Mineral Industry									
2B Chemical Industry									
2C Metal Industry									
2D Non-Energy Products from Fuels and Solvent Use									
2E Electronics Industry									
2F Product Uses as Substitutes for Ozone Depleting Substances	NE	NE	NE	NE	NE	NE	NE	NE	NE
2F1 Refrigeration and Air Conditioning	NE	NE	NE	NE	NE	NO	NO	NO	NO
2F2 Foam Blowing Agents	NE	NE	NE	NE	NE	NE	NE	NE	NE
2F3 Fire Protection	NE	NE	NE	NE	NE	NE	NE	NE	NE
2F4 Aerosols	NE	NE	NE	NE	NE	NE	NE	NE	NE
2F5 Solvents	NE	NE	NE	NE	NE	NE	NE	NE	NE
2F6 Other Applications	NE	NE	NE	NE	NE	NE	NE	NE	NE
2G Other Product Manufacture and Use									
2H Other (please specify)									
3 AGRICULTURE, FORESTRY AND OTHER LAND USE									
3A Livestock									
3B Land									
3C Aggregate Sources and Non-CO2 Emissions Sources on Land									
3D Other									
4 WASTE									
4A Solid Waste Disposal									
4B Biological Treatment of Solid Waste									
4C Incineration and Open Burning of Waste									
4D Wastewater Treatment and Discharge									
4E Other (please specify)									
5 OTHER									
5A Indirect N2O Emissions from the Atmospheric Deposition of Nitrogen in NOx and NH3									
5B Other (please specify)									
Memo items(5)									
International Bunkers (subtotal)									

International Aviation (International Bunkers)									
International Water-borne Transport (International Bunkers)									
Multilateral Operations									

2000 EMISSIONS
UNFCCC Reporting Tables

UNFCCC Reporting Table 1. Samoa's National greenhouse gas inventory of anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol and greenhouse gas precursors (2000)

Greenhouse gas source and sink categories	CO_2 emissions (Gg)	CO_2 Removals (Gg)	CH_4 (Gg)	N_2O (Gg)	CO (Gg)	NO_X (Gg)	NMVOC (Gg)	SO_2 (Gg)
Total National Emissions and Removals	146.11	-1,150.04	4.00	0.11	12.19	0.84	2.02	0.29
1 ENERGY	138.73		0.06	0.01	12.19	0.84	1.94	0.29
1A Fuel Combustion Activities	138.73		0.06	0.01	12.19	0.84	1.94	0.29
1A1 Energy Industries (electricity y generation)	28.86		0.0012	0.0002	0.006	0.08	0.0019	0.05
1A2 Manufacturing Industries and Construction	12.44		0.0005	0.0001	0.002	0.00	0.0008	0.02
1A3 Transport (subtotal)	86.65		0.029	0.0041	6.92	0.57	1.30	0.094
1A3a Civil Aviation (Domestic Aviation)	0.06		0.0000004	0.000002	0.001	0.000	0.00026	NE
1A3b Road Transport	82.41		0.028	0.004	6.86	0.49	1.29	0.086
1A3c Waterborne Navigation (Domestic Shipping)	4.18		0.0004	0.00011	0.06	0.08	0.011	0.008
1A4 Other Sectors (subtotal)	10.78		0.0318	0.0043	5.26	0.18	0.64	0.1159
1A4 a Commercial/Institutional	0.93		0.0000	0.000001	0.0003	0.001	0.0001	NE
1A4 b Residential	5.51		0.0314	0.0042	5.20	0.11	0.62	0.11
1A4 c Agriculture/ Forestry/ Fishing/ Fish Farms	4.34		0.0004	0.0001	0.06	0.07	0.01	0.008
1A5 Non-Specified	NO		NO	NO	NO	NO	NO	NO
1B Fugitive Emissions from Fuels	NO		NO	NO	NO	NO	NO	NO
1C Carbon Dioxide Transport and Storage	NO				NO	NO	NO	NO
2 INDUSTRIAL PROCESSES AND PRODUCT USE	3.71		NA	0.0005	NA	NA	0.08	NA
2A Mineral Industry	NO		NO	NO	NO	NO	NO	NO
2B Chemical Industry	NO		NO	NO	NO	NO	NO	NO
2C Metal Industry	NO		NO	NO	NO	NO	NO	NO
2D Non-Energy Products from Fuels and Solvent Use	3.71		NA	NA	NA	NA	0.08	NA
2D1 Lubricant Use	3.71				NE	NE	NE	NE
2D2 Paraffin Wax Use	NE		NE	NE	NE	NE	NE	NE
2D3 Solvent Use	NA		NA	NA	NA	NA	0.08	NA
2D4 Other (please specify)	NO		NO	NO	NO	NO	NO	NO
2E Electronics Industry	NO		NO	NO	NO	NO	NO	NO
2F Product Used as Substitutes for Ozone Dep. Subst.	NA		NA	NA	NA	NA	NA	NA
2G Other Product Manufacture and Use	NA		NA	0.0005	NA	NA	NA	NA
2G1 Electrical Equipment	NO		NO	NO	NO	NO	NO	NO
2G2 SF6 and PFCs from Other Product Uses	NO		NO	NO	NO	NO	NO	NO
2G3 N2O from Product Uses (medical uses)	NA		NA	0.0005	NA	NA	NA	NA
2G4 Other	NO		NO	NO	NO	NO	NO	NO
2H Other (please specify)	NA		NA	0.000004	NA	NA	0.002	NA
2H1 Pulp and Paper Industry	NO		NO	NO	NO	NO	NO	NO
2H2 Food and Beverages Industry	NA		NA	NA	NA	NA	0.002	NA
2H3 Other (Ammonia Use)	NA		NA	0.000004	NA	NA	NA	NA

Key: NA = not applicable, NE = not estimated, NO = not occurring

UNFCCC Reporting Table 1 cont (2000)

Greenhouse gas source and sink categories	CO_2 emissions (Gg)	CO_2 Removals (Gg)	CH_4 (Gg)	N_2O (Gg)	CO (Gg)	NO_X (Gg)	NMVOC (Gg)	SO_2 (Gg)
3 AGRICULTURE, FORESTRY AND OTHER LAND USE	0.0039	-1,150.04	2.58	0.10	NE	NE	NE	NE
3A Livestock			2.58	NE				
3A1 Enteric Fermentation			2.13					
3A2 Manure Management			0.44	NE				
3B Land	NE	-1,150.04	NE	NE	NE	NE	NE	NE
3B1 Forest Land	NE	-705.27	NE	NE	NE	NE	NE	NE
3B2 Cropland	NE	-444.78	NE	NE	NE	NE	NE	NE
3B3 Grassland	NE	NE	NE	NE	NE	NE	NE	NE
3B4 Wetlands	NE	NE	NE	NE	NE	NE	NE	NE
3B5 Settlements	NE	NE	NE	NE	NE	NE	NE	NE
3B6 Other Land	NE	NE	NE	NE	NE	NE	NE	NE
3C Aggregate Sources and Non-CO2 Emissions Sources on Land	0.0039		NE	0.103	NE	NE	NE	NE
3C1 Biomass Burning	NE		NE	NE	NE	NE	NE	NE
3C2 Liming	0.0004							
3C3 Urea Application	0.0034							
3C4 Direct N2O Emissions from Managed Soils				0.08				
3C5 Indirect N2O Emissions from Managed Soils				0.02				
3C6 Indirect N2O Emissions from Manure Management				NE				
3C7 Rice Cultivations			NO				NO	
3C8 Other (please specify)	NO		NO	NO	NO	NO	NO	NO
3D Other	NO		NO	NO	NO	NO	NO	NO
4 WASTE	3.67		1.36	0.0027	NE	NE	NE	NE
4A Solid Waste Disposal	NA		0.03		NE		NE	
4A1 Managed Waste Disposal Sites	NA		0.03		NE		NE	
4A2 Unmanaged Waste Disposal Sites	NA		NE	NE	NE	NE	NE	NE
4A3 Uncategorised Waste Disposal Sites	NA		NE	NE	NE	NE	NE	NE
4B Biological Treatment of Solid Waste	NA		NE	NE	NE	NE	NE	NE
4C Incineration and Open Burning of Waste	3.67		0.12	0.0027	NE	NE	NE	NE
4C1 Waste Incineration	NE		NE	NE	NE	NE	NE	NE
4C2 Open Burning of Waste	3.67		0.12	0.0027	NE	NE	NE	NE
4D Wastewater Treatment and Discharge	NA		1.21	NE	NE	NE	NE	NE
4D1 Domestic Wastewater Treatment and Discharge	NA		1.21	NE	NE	NE	NE	NE
4D2 Industrial Wastewater Treatment and Discharge	NA		NE	NE	NE	NE	NE	NE
4E Other (please specify)	NO		NO	NO	NO	NO	NO	NO
5 OTHER	NE		NE	NE	NE	NE	NE	NE
5A Indirect N2O Emissions from the Atmospheric Deposition of Nitrogen in NOx and NH3	NE		NE	NE	NE	NE	NE	NE
5B Other (please specify)	NO		NO	NO	NO	NO	NO	NO
Memo items(5)								
International Bunkers (subtotal)	22.28		0.0003	0.0006	0.048	0.116	0.018	NE
International Aviation (International Bunkers)	20.91		0.0001	0.0006	0.029	0.088	0.01	0.01

International Water-borne Transport (International Bunkers)	1.37		0.0001	0.00004	0.019	0.028	0.004	0.003
Multilateral Operations	NO		NO	NO	NO	NO	NO	NO

Key: NA = not applicable, NE = not estimated, NO = not occurring

UNFCCC Table 2. Samoa's National greenhouse gas inventory of anthropogenic emissions of HFCs, PFCs and SF_6 (2000)

Greenhouse gas source and sink categories	HFCs (Gg)					PFCs			
	HFC-23	HFC-134	HFC-32	HFC-125	HFC-143	CF_4	C_2F_6	Other	SF_6
Total National Emissions and Removals	NE	0.00012	NO	0.00008	0.00009	NO	NO	NO	NO
1 ENERGY									
1A Fuel Combustion Activities									
1B Fugitive Emissions from Fuels									
1C Carbon Dioxide Transport and Storage									
2 INDUSTRIAL PROCESSES AND PRODUCT USE	NE	0.00012	NO	0.00008	0.00009	NO	NO	NO	NO
2A Mineral Industry									
2B Chemical Industry									
2C Metal Industry									
2D Non-Energy Products from Fuels and Solvent Use									
2E Electronics Industry									
2F Product Uses as Substitutes for Ozone Depleting Substances	NE	0.00012	NO	0.00008	0.00009	NE	NE	NE	NE
2F1 Refrigeration and Air Conditioning	NE	0.00012	NO	0.00008	0.00009	NO	NO	NO	NO
2F2 Foam Blowing Agents	NE	NE	NE	NE	NE	NE	NE	NE	NE
2F3 Fire Protection	NE	NE	NE	NE	NE	NE	NE	NE	NE
2F4 Aerosols	NE	NE	NE	NE	NE	NE	NE	NE	NE
2F5 Solvents	NE	NE	NE	NE	NE	NE	NE	NE	NE
2F6 Other Applications	NE	NE	NE	NE	NE	NE	NE	NE	NE
2G Other Product Manufacture and Use									
2H Other (please specify)									
3 AGRICULTURE, FORESTRY AND OTHER LAND USE									
3A Livestock									
3B Land									
3C Aggregate Sources and Non-CO2 Emissions Sources on Land									
3D Other									
4 WASTE									
4A Solid Waste Disposal									
4B Biological Treatment of Solid Waste									
4C Incineration and Open Burning of Waste									
4D Wastewater Treatment and Discharge									
4E Other (please specify)									
5 OTHER									
5A Indirect N2O Emissions from the Atmospheric Deposition of Nitrogen in NOx and NH3									
5B Other (please specify)									
Memo items(5)									
International Bunkers (subtotal)									
International Aviation (International Bunkers)									
International Water-borne Transport (International Bunkers)									
Multilateral Operations									

Key: NA = not applicable, NE = not estimated, NO = not occurring

2007 EMISSIONS
UNFCCC Reporting Tables

UNFCCC Reporting Table 1. Samoa's National greenhouse gas inventory of anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol and greenhouse gas precursors (2007)

Greenhouse gas source and sink categories	CO_2 emissions (Gg)	CO_2 Removals (Gg)	CH_4 (Gg)	N_2O (Gg)	CO (Gg)	NO_X (Gg)	NMVOC (Gg)	SO_2 (Gg)
Total National Emissions and Removals	177.41	-785.07	5.66	0.1598	10.14	0.90	1.83	0.29
1 ENERGY	178.22		0.05	0.01	10.14	0.90	1.73	0.29
1A Fuel Combustion Activities	170.98		0.05	0.01	10.14	0.90	1.73	0.29
1A1 Energy Industries (electricity generation)	44.07		0.0018	0.0004	0.009	0.12	0.0030	0.08
1A2 Manufacturing Industries and Construction	16.24		0.0007	0.0001	0.002	0.00	0.0011	0.03
1A3 Transport (subtotal)	98.45		0.030	0.0047	7.35	0.62	1.38	0.113
1A3a Civil Aviation (Domestic Aviation)	0.00		NO	NO	NO	NO	NO	NO
1A3b Road Transport	92.99		0.030	0.0045	7.28	0.51	1.37	0.102
1A3c Waterborne Navigation (Domestic Shipping)	5.46		0.0005	0.00015	0.07	0.11	0.015	0.010
1A4 Other Sectors (subtotal)	12.23		0.0169	0.0023	2.778	0.16	0.34	0.0666
1A4 a Commercial/Institutional	1.39		0.0000	0.000002	0.0004	0.002	0.0001	NE
1A4 b Residential	5.20		0.0164	0.0022	2.701	0.06	0.32	0.06
1A4 c Agriculture/ Forestry/ Fishing/ Fish Farms	5.64		0.0005	0.0002	0.08	0.09	0.02	0.0101
1A5 Non-Specified	NO		NO	NO	NO	NO	NO	NO
1B Fugitive Emissions from Fuels	NO		NO	NO	NO	NO	NO	NO
1C Carbon Dioxide Transport and Storage	NO				NO	NO	NO	NO
2 INDUSTRIAL PROCESSES AND PRODUCT USE	4.14		NA	0.0004	NA	NA	0.10	NA
2A Mineral Industry	NO		NO	NO	NO	NO	NO	NO
2B Chemical Industry	NO		NO	NO	NO	NO	NO	NO
2C Metal Industry	NO		NO	NO	NO	NO	NO	NO
2D Non-Energy Products from Fuels and Solvent Use	4.14		NA	NA	NA	NA	0.10	NA
2D1 Lubricant Use	4.14				NE	NE	NE	NE
2D2 Paraffin Wax Use	NE		NE	NE	NE	NE	NE	NE
2D3 Solvent Use	NA		NA	NA	NA	NA	0.10	NA
2D4 Other (please specify)	NO		NO	NO	NO	NO	NO	NO
2E Electronics Industry	NO		NO	NO	NO	NO	NO	NO
2F Product Uses as Substitutes for Ozone Depleting Substances	NA		NA	NA	NA	NA	NA	NA
2G Other Product Manufacture and Use	NA		NA	0.0004	NA	NA	NA	NA
2G1 Electrical Equipment	NO		NO	NO	NO	NO	NO	NO
2G2 SF6 and PFCs from Other Product Uses	NO		NO	NO	NO	NO	NO	NO
2G3 N2O from Product Uses (medical uses)	NA		NA	0.0004	NA	NA	NA	NA
2G4 Other	NO		NO	NO	NO	NO	NO	NO
2H Other (please specify)	NA		NA	0.000006	NA	NA	0.003	NA
2H1 Pulp and Paper Industry	NO		NO	NO	NO	NO	NO	NO
2H2 Food and Beverages Industry	NA		NA	NA	NA	NA	0.003	NA
2H3 Other (Ammonia Use)	NA		NA	0.000006	NA	NA	NA	NA

Key: NA = not applicable, NE = not estimated, NO = not occurring

UNFCCC Reporting Table 1 cont. (2007)

Greenhouse gas source and sink categories	CO_2 emissions (Gg)	CO_2 Removals (Gg)	CH_4 (Gg)	N_2O (Gg)	CO (Gg)	NO_X (Gg)	NMVOC (Gg)	SO_2 (Gg)
3 AGRICULTURE, FORESTRY AND OTHER LAND USE	0.0045	-785.07	4.19	0.15	NE	NE	NE	NE
3A Livestock			4.19	NE				
3A1 Enteric Fermentation			3.62					
3A2 Manure Management			0.57	NE				
3B Land	NE	-785.07	NE	NE	NE	NE	NE	NE
3B1 Forest Land	NE	-777.47	NE	NE	NE	NE	NE	NE
3B2 Cropland	NE	-7.60	NE	NE	NE	NE	NE	NE
3B3 Grassland	NE	NE	NE	NE	NE	NE	NE	NE
3B4 Wetlands	NE	NE	NE	NE	NE	NE	NE	NE
3B5 Settlements	NE	NE	NE	NE	NE	NE	NE	NE
3B6 Other Land	NE	NE	NE	NE	NE	NE	NE	NE
3C Aggregate Sources and Non-CO2 Emissions Sources on Land	0.0045		NE	0.151	NE	NE	NE	NE
3C1 Biomass Burning	NE		NE	NE	NE	NE	NE	NE
3C2 Liming	0.0009							
3C3 Urea Application	0.0037							
3C4 Direct N2O Emissions from Managed Soils				0.12				
3C5 Indirect N2O Emissions from Managed Soils				0.03				
3C6 Indirect N2O Emissions from Manure Management				NE				
3C7 Rice Cultivations			NO				NO	
3C8 Other (please specify)	NO		NO	NO	NO	NO	NO	NO
3D Other	NO		NO	NO	NO	NO	NO	NO
4 WASTE	2.28		1.42	0.0017	0.00021	0.00025	NE	0.0002
4A Solid Waste Disposal	NA		0.14		NE		NE	
4A1 Managed Waste Disposal Sites	NA		0.14		NE		NE	
4A2 Unmanaged Waste Disposal Sites	NA		NE	NE	NE	NE	NE	NE
4A3 Uncategorised Waste Disposal Sites	NA		NE	NE	NE	NE	NE	NE
4B Biological Treatment of Solid Waste	NA		NE	NE	NE	NE	NE	NE
4C Incineration and Open Burning of Waste	2.28		0.07	0.0017	0.00021	0.00025	NE	0.0002
4C1 Waste Incineration	0.124		0.000008	0.000008	0.00021	0.00025	NE	0.0002
4C2 Open Burning of Waste	2.28		0.07	0.0017	NE	NE	NE	NE
4D Wastewater Treatment and Discharge	NA		1.21	NE	NE	NE	NE	NE
4D1 Domestic Wastewater Treatment and Discharge	NA		1.21	NE	NE	NE	NE	NE
4D2 Industrial Wastewater Treatment and Discharge	NA		NE	NE	NE	NE	NE	NE
4E Other (please specify)	NO		NO	NO	NO	NO	NO	NO
5 OTHER	NE		NE	NE	NE	NE	NE	NE
5A Indirect N2O Emissions from the Atmospheric Deposition of Nitrogen in NOx and NH3	NE		NE	NE	NE	NE	NE	NE
5B Other (please specify)	NO		NO	NO	NO	NO	NO	NO
Memo items (not included in national totals)								
International Bunkers (subtotal)	37.43		0.0004	0.001	0.074	0.186	0.030	NE
International Aviation (International Bunkers)	35.65		0.0002	0.001	0.050	0.150	0.025	0.011
International Water-borne Transport (International Bunkers)	1.78		0.0002	0.00005	0.024	0.036	0.005	0.003
Multilateral Operations	NO		NO	NO	NO	NO	NO	NO

Key: NA = not applicable, NE = not estimated, NO = not occurring

UNFCCC Table 2. Samoa's National greenhouse gas inventory of anthropogenic emissions of HFCs, PFCs and SF6 (2007)

Greenhouse gas source and sink categories	HFCs (Gg)					PFCs			SF_6
	HFC-23	HFC-134	HFC-32	HFC-125	HFC-143	CF_4	C_2F_6	Other	
Total National Emissions and Removals									
1 ENERGY									
1A Fuel Combustion Activities									
1B Fugitive Emissions from Fuels									
1C Carbon Dioxide Transport and Storage									
2 INDUSTRIAL PROCESSES AND PRODUCT USE	NE	0.001	0.00005	0.00053	0.00059	NO	NO	NO	NO
2A Mineral Industry									
2B Chemical Industry									
2C Metal Industry									
2D Non-Energy Products from Fuels and Solvent Use									
2E Electronics Industry									
2F Product Uses as Substitutes for Ozone Depleting Substances	NE	0.001	0.00005	0.00053	0.00059	NE	NE	NE	NE
2F1 Refrigeration and Air Conditioning	NE	0.001	0.00005	0.00053	0.00059	NO	NO	NO	NO
2F2 Foam Blowing Agents	NE	NE	NE	NE	NE	NE	NE	NE	NE
2F3 Fire Protection	NE	NE	NE	NE	NE	NE	NE	NE	NE
2F4 Aerosols	NE	NE	NE	NE	NE	NE	NE	NE	NE
2F5 Solvents	NE	NE	NE	NE	NE	NE	NE	NE	NE
2F6 Other Applications	NE	NE	NE	NE	NE	NE	NE	NE	NE
2G Other Product Manufacture and Use									
2H Other (please specify)									
3 AGRICULTURE, FORESTRY AND OTHER LAND USE									
3A Livestock									
3B Land									
3C Aggregate Sources and Non-CO2 Emissions Sources on Land									
3D Other									
4 WASTE									
4A Solid Waste Disposal									
4B Biological Treatment of Solid Waste									
4C Incineration and Open Burning of Waste									
4D Wastewater Treatment and Discharge									
4E Other (please specify)									
5 OTHER									
5A Indirect N2O Emissions from the Atmospheric Deposition of Nitrogen in NOx and NH3									
5B Other (please specify)									
Memo items (not included in national totals)									
International Bunkers (subtotal)									
International Aviation (International Bunkers)									
International Water-borne Transport (International Bunkers)									
Multilateral Operations									

Key: NA = not applicable, NE = not estimated, NO = not occurring

Annex 2: Adaptation Sectoral reports

Annex 3: