National Climate Change

Adaptation Issues

In

Belize

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TABLE OF CONTENT

1.0 Introduction

1.1 Physical Geography

Belize is located on the Central American mainland, forming part of the Yucatan Peninsula and lying between 15°45' and18°30'north latitude, and 87°30' and 89°15' west Longitude. It is bounded to the north by Mexico, to the west and south by Guatemala and to the east by the Caribbean Sea. (See map of Belize – Annex 1) The total land area is 22,960 sq km (8,867 square miles) of which 95 percent is located on the mainland and five percent is distributed over more than 1060 islands. Total national territory (including territorial sea) is 46,620 sq km (approximately 18,000 square miles).

Most of the northern half and much of the southern third of the country, plus the entire coastal area and all the islands, are flat and low-lying. (See map of Coastal Areas – Annex 2) Large sections of the coastline have an elevation of less than 1m to a distance of several miles inland. In the north, the land rises to a maximum of approximately 250 metres above sea level (asl) in the extreme west of the country. The central part of the country is dominated by the Maya Mountain/Mountain Pine Ridge massif, rising to 1124m asl (3688 ft) at its highest point.

Belize is a sovereign state governed under the principles of parliamentary democracy based on the Westminster model. The Prime Minister and Cabinet form the executive branch while the National Assembly forms a bicameral legislature comprising a 29-member elected House of Representatives and an 8-member appointed Senate. There are six administrative districts (Corozal, Orange Walk, Belize, Cayo, Stann Creek, and Toledo) but no representative district councils. Belmopan and Belize City have nine-member elected City Councils and the other urban areas have locally-elected seven-member Town Boards. Village Councils, which incorporate the traditional Alcalde or mayoral system, assist in local administration.

1.2 Local Climatology and Related Phenomena

Northern Belize has a subtropical climate with an annual rainfall of 1500 mm (60 inches). Southward, the climate becomes increasingly tropical and annual rainfall increases to 3800 mm (150 inches). The climate is characterized by a marked wet and dry season separated by a cool transitional period. The rainy season begins in the south in the middle of May and arrives in the north in mid June. It continues through to November but most locations experience a drier period in August. Some 60 percent of annual precipitation occurs during this season, produced primarily by tropical systems including tropical cyclones. The cool transition period occurs from November through February. Rainfall declines and approximately 12 cold fronts cross the country during these months. The true dry season is from February to April and is produced by strong anticyclones in the Atlantic that generate a persistent stable southeasterly airflow across the country.

Average maximum temperatures are near 85°F and the lows are in the low 70's. Summers are about 8 degrees warmer than winters. The diurnal temperature range in the interior is greater than that along the coast, where it is moderated by the sea breezes. For example, minimum temperatures in the interior are about 5 degrees cooler than those at coastal locations. The mountainous regions are also cooler, exhibiting a fall in temperature of 10 degree Celsius per km (5°F/1000 ft.). Humidity hovers around 80 percent throughout the year, although somewhat lower during the months of the dry season.

Belize lies within the hurricane belt. Historically, tropical storms and hurricanes have affected the country once every three years. Belize City, the former capital was destroyed twice by hurricanes in the 20th century. Hurricanes can affect any part of the country but are more frequent in the north.

1.3 Important Ecological/Biological Attributes

The geology of Belize is calcareous over the entire northern part of the country and the Maya Mountains. Granites and metamorphic rocks occur elsewhere. The natural vegetation is predominantly moist and wet subtropical broadleaf of forest, including mangroves on the coast. Savannas and open pine formations, subject to frequent burning, occur on some granites and wherever Pleistocene alluvia cover the underlying

limestone. There are also large wetland areas on the low lands and costal plains. Apart from having a long, low-lying coastline, Belize has over 1060 small offshore islands, and the Belize Barrier Reef is the second largest in the world and the largest in the Western Hemisphere. The greater part of its extent lies in Belizean territorial waters.

The most striking characteristic of Belize is that over 70 percent of the country remains under natural vegetation cover. (See map of Belize Land Cover – Annex 3) The utilization of natural vegetation is therefore a crucial part of national land use.

Seventy three (73) percent (approximately 1.3 million ha) of this natural vegetation comprises high broadleaf forest formations. High mangrove formations add another percentage point. Thickets (which at least in northern Belize have been shown to carry a surprisingly high biomass content) comprise a further 3.5 percent. Closed and open pine forests comprise another 7.5 percent of natural vegetation cover.

Belize's documented biological resources on the mainland as of September 1998 includes 576 bird species, 163 species of mammals, 122 species of reptiles, 116 species of total land fish, 4 species of freshwater fish, 158 species of mollusks, 42 species of amphibian 288 species of butterflies, 176 species of odonata, and 10 species of other insects. Two amphibians and one reptile are documented as endemic. There are an estimated 4,000 species of native flowering plants of which 2,500 are dicotylendons and 1,500 are monocotyledons. To date 615 species of these plants have been found to have medicinal value.

The coastal zone of Belize contains 75 percent of the Mesoamerican Barrier Reef System, and is host to 594 genera and 1,040 species of organisms; while in marine areas there is 634 genera and 1302 species.

1.4 Socio-Economic Profile

Belize has an open economy, primarily based on agriculture and services. Its stable currency is one of the attractions for foreign investments. Since 1976, the exchange rate has been pegged to the United States Dollar at US$1.00 = BZ $2.00. The 1996 per capita income was BZ$4, 616 (US 2, 308) as compared to BZ $3,328 (US$1,664) in 1989, a growth of 38.7 percent at current prices. The

GDP, at current prices, increased by 67.0 percent from 306 million dollars in 1989 to512 million in 1996, while the population grew by 20.6 percent. The GDP realized a real growth rate of 1.5 percent in 1996, as compared to the previous year's rate of 3.8 percent. The inflation rate as measured by the Consumer Price Index is relatively low in comparison to neighbouring countries. The Consumer Price Index was 2.8 percent in 1995 and increased to 6.4 percent in 1996. The average for the previous five years was 3.2 percent.

Belize 's economy has historically been dominated by agricultural exports, which include sugarcane, citrus, concentrate, bananas, and marine products. These accounted for 77 percent of total domestic exports in 1998. Belize also relies heavily on forestry, fishing and mining as primary resources which, when combined with agriculture, accounted for 21.8 percent of the GDP.

Of note is that, currently, tourism is fast becoming one of the largest contributors to the economy.

In 1991, the population of Belize stood at 189,392, rising to 211,000 in 1994 and again to 230,000 in 1997. The population is also culturally diverse. In the north (Corozal and Orange Walk), it is predominantly Mestizo and Spanish speaking. In the Belize District, it is English-speaking Creole. The Cayo District in the center of the country is more mixed. All four districts have Mennonite communities, which form a distinct German-speaking cultural element. In the south, the majority population in Stann Creek is Garifuna while more than 60 percent of the inhabitants of the Toledo District are Maya. Three Mayan languages are spoken across the country. Another important statistic is that 40 percent of the population lives in the coastal zone most vulnerable to climate change impacts.

In 1991, 90,000 people (48% of the population) lived in nine towns; 44,000 lived in the main economic center, Belize City, and the remainder in urban centers ranging from 11,000 to 1850 people (Orange Walk and San Pedro respectively). Rural population densities in the districts ranged from 11.8 to 2.6 per square kilometer (Corozal and Belize Districts respectively), averaging at 5.2/square kilometers. This is low but disguises the fact that the population is concentrated in the better agricultural areas. There the population densities are

comparable to those in neighbouring countries such as Honduras. Conversely, large areas are practically devoid of inhabitants through inhospitable terrain, difficult access, or land ownership patterns. In fact only 33 percent of the country is considered suitable for agriculture and half of that requires careful management. The population is distributed accordingly. This results in localized pressure, and marginal lands are being brought under agriculture where such pressures occur.

In 1994, the labour force (i.e. those in, available for or seeking employment) stood at 70,870 people or 33 percent of the population. Of these, 13 percent were unemployed. Mean income was US$385 per month (median US$ 310 per month) and some 70 percent of the labour force was male. On a national basis, 25 percent of all households were poor and 10 percent extremely poor. Pockets of severe poverty were identified in the Cayo and Toledo Districts, reflecting the distribute of the most economically disadvantaged groups in Belizean society, recent Central American immigrants and the Maya Indian population (which also includes recent immigrants). Unemployment and income are directly related to levels of education. It has also been found that the poorest groups have less access to education and training opportunities, reducing the chances of escaping poverty in the next generation.

Belize has seven government and two private hospitals. There is also a network of, health centers and rural health posts, supplemented by mobile clinics. These mobile clinics account for 40 percent of primary health care. The infant mortality rate is still considered unacceptably high and varies greatly across the country, reflecting disparities in living conditions and services. In 1994, there was 100 percent coverage of adequate and safe potable water in urban areas, falling to 69 percent in the countryside. Meanwhile, 39 percent of the population had adequate sanitation facilities; for the rural population alone the figure was 22 percent. Available information suggests that the incidence of infectious diseases associated with deficiencies in water supply and sanitation is increasing. Malaria had been thought to be under control but increased dramatically during the 1990s and Belize now has the highest reported infection rate per capita in Latin America, believed to cost the country US$ 800,000 per year in control costs and lost productivity. Cholera and dengue have both recently re-appeared as sporadic outbreaks while diarrhea is also a problem. As in all the

social indicators, Cayo and Toledo stand out as being particularly affected.

1.5 Other Factors/Phenomena

Lying within the tropics at the western end of the Caribbean Sea, Belize is prone to the direct and indirect effects of hurricanes. Several major hurricanes have struck the country, and during the past 100 years, Belize City was destroyed twice. The most devastating and deadly factor of these hurricanes was the storm surge, which was estimated at 10 to 15 feet above sea level.

Reliable hurricane records for the Caribbean dates back to 1871. During that period, Belize has been struck over 40 times by tropical cyclones, ranging from tropical depressions to hurricanes, a return period of three years. The country's vulnerability increases from south to north, hence, the return period for Punta Gorda was 5.73 years falling to 3.7 years at San Pedro, Ambergris Caye.

While only coastal locations are vulnerable to hurricane force winds from a Category I hurricane, the entire country is vulnerable to hurricane force winds from a Category 5 hurricane.

Belize is especially vulnerable to storm surge. The continental shelf is about 15 miles from the mainland providing a shallow bathymetry, which allows a high wave to be generated by the low pressure and strong onshore wind. Coastal Belize is also very flat. This allows the storm surge to move several miles inland before it meets any significant elevation. The coastline also has several bays, which funnels the water inward creating even higher local surges. A storm surge of 20 feet is predicted for Belize City for a Category 5 hurricane. Other locations could get storm surges approaching 25 feet.

Belize is a net remover (sink) of Green House Gases (GHGs) from the atmosphere. In 1994, tree growth in logged forests, plantations, and on cleared lands absorbed approximately 6000 Gigagrams of CO2 per year, against a total emission of all GHGs estimated at just fewer than 3000 Gigagrams.

Of the five sectors in the inventory, land use change was the greatest single contributor (68%) to total GHG emissions, primarily from release of CO2 by burning during clearance and from the soil during cultivation. The energy sector was the second largest contributor (21%), primarily from the fossil fuel use in road transportation and energy production. It should be remembered that the inventory year (1994) predates the introduction of the Mollejon hydroelectric facility. Waste management contributed 9%, and agriculture 2%. The contribution from industrial processes was insignificant, at less than 0.1% of total nation emissions. This pattern reflects conditions of a country with an extensive logged forest estate and relatively small economy dominated by agricultural production and services rather than heavy industry.

2.0 Key Issues with respect to Climate Changes

Biodiversity

Belize's biodiversity is highly vulnerable to climate change:

- New combination of species will arise since species have different competing abilities, migration rate and response capacity to disturbances. This "reorganization" composition has an unknown consequence for ecosystem functioning.

- Many species may be able to disperse fast enough to keep up with projected climate change provided they can disperse through continuous, relatively undisturbed, natural systems. This emphasizes the important consequence of the fragmentation of natural systems.

- Depending on the rate of climate change, other niche parameters may not change at the rate as climate, resulting in novel habitat combinations.

- Changes in relative timing of seasonal events during the yearly cycle may have strong, negative impacts on many species, especially migratory ones.

- Invasion of alien species into natural ecosystems is an increasing problem worldwide which is likely to be exacerbated by climate change. Disturbance and dieback will probably increase as more long-lived organisms such as trees are displaced from their optimal environmental envelopes and are subject to increasing pressure from land use change. An increase in disturbance will lead to more ecosystems in early success ional states, resulting in a generally "weedier", structurally simpler biosphere with fewer systems in more ecologically complex, old growth.

- Markedly different effects of climate change on species composition will occur within individual landscapes because of local effects on soil, land use, and topographical variation.

Ecosystem

Belize's ecosystems are also vulnerable to climate change. The coastal wetlands and mangrove forests are sensitive to sea level rise and storms. Island ecosystems are also sensitive to sea level rise and storms, but also to temperature changes. Coral reefs are sensitive to sea surface temperature and storms. Tropical forests are sensitive to drought, seasonality, fire regimes and hurricanes.

There are no coastal or inland beaches in Belize above one meter. If sea level rise were to occur at a rate of 2 cm per annum, the following impacts can be anticipated:

- The disappearance of sandy beaches as habitat for benthic organism which would be displaced,
- The displacement of biodiversity (flora and fauna)

Those strictly marine

Those strictly of the inter-tidal zone (black and white mangrove)

Those strictly of freshwater

- The displacement of associated fauna of the mangrove ecosystem which are the basis of the food-chain of the coastal and marine ecosystems,
- The displacement of the agriculture industry with an estimated capital investment of approximately BZ$32.4 million and annual estimated production of BZS 1 3 million,
- Protected Areas which are strictly marine will be less impacted by climate change than those with mangrove components,
- 35 species of documented Ascidians (of high bio-prospecting value in cancer research) in Belizean waters will be impacted by temperature rise unless these organisms, evolve and are able to adapt during the next 50 years,
- The reef ecosystem will be impacted. Surveys after hurricane Mitch reveal that the reef was heavily impacted. It was very difficult to distinguish between the physical damage produced by Mitch, coral bleaching and disease,
- Higher sea surface temperatures will increase the incidences and extent of coral bleaching episodes. Bleaching induces partial tissue mortality which may decrease the structural integrity of the reef framework and decrease the ecological competitiveness corals and other symbiotic organisms,
- Commercial fishing presently-valued at BZ$3 9.4 million per year will be
  impacted.

Hydrology

Climate change is expected to intensify the hydrological cycle in Belize. Precipitation, evaporation and transpiration are likely to be affected. However, there is great uncertainty about the extent and magnitude of the changes. The variation in the components will impact on the availability and quality of water throughout the country.

Changes to the hydrological cycle will affect the main hydropower facility on the Macal River and its proposed storage facility upstream, several micro facilities, and a proposed facility in the Toledo District. Increased rainfall will increase the volume of water available for generation. However, the volume of silt and other obstructive

materials in the flow will also increase, reducing the efficiency of the generating facilities. A reduction in rainfall will decrease the flow. The flow would be further reduced if the demands for agriculture or potable water were given higher priority and water is drawn off upstream.

Energy

Climate change is expected to increase the demand for electricity. The increase in air temperature will increase the demand for air conditioning, increase the demand for pumping for irrigation, increase the demand for refrigerating food, and increase the electrical distribution losses. Pumping stations may have to be installed in communities vulnerable to sea level rise, which will create a new demand.

The electrical distribution system, which is primarily by overhead power lines, is vulnerable to the effects of hurricane force winds. Switching to an underground distribution system could reduce some of this vulnerability. However, sea level rise could render that vulnerable to inundation.

The country is also vulnerable to recurrent floods. Annual floods in the south frequently isolate communities for short periods. More devastating floods occur along the Belize River. Several communities and rich farmlands are threatened and require rescue and rehabilitation efforts. In the higher elevations, the runoff is rapid. However, in the flatter terrain along the coast and in the north, runoff is very slow and flooding can last for several vigorous hydrological cycle expected with climate change could increase the frequency and magnitude of these flooding events.

Aquaculture

Aquaculture activities have increased significantly in coastal Belize during the past 15 years 1989/90 a total of 160,000 white-framed shrimp tails were produced on 684 acres. In 1996, production increased to 1,136 million lbs. generating BZ$8.96 million on 1,729 acres. The trend to be toward increased farmed shrimp to lessen the pressure on marine shrimp and to satisfy the external market.

Projected sea-level rise may undermine aquaculture in fracture and displace farms inland with the retreating shoreline, increasing the pressure on the land.

Projected sea level rise of 20 to 100 cm during the new century is alarming and will undoubtedly impact on both developed and undeveloped coastal areas if appropriate adaptation measures are not implemented.

Coastal Zone

A sea level rise of this magnitude is expected to inundate wetlands and low lands, accelerate coastal erosion, exacerbate coastal flooding, threaten coastal structures, raise water tables and increase the salinity of rivers and aquifers.

Within the past two decades, the rate of development in coastal areas has increased almost exponentially to accommodate the growing tourism industry and expansion of coastal communities. This development has placed significant stress on the coastal physical resources. This is evident in the increasing instances of deteriorating water quality, inadequate waste disposal and coastal erosion consequent to sand mining from beaches and rivers and inappropriate siting of coastal structures. Today, 45% of the population resides in the coastal zone. The annual rate of population growth is projected as 6.9%. This indicates that there is a considerable demand for suitable land for housing construction and to meet the communities' expansion needs.

Shoreline erosion is identified as a critical issue in the four coastal districts, (Corozal, Belize, Stann Creek and Toledo), and on the more developed offshore islands such as Ambergris Caye and Caye Caulker. The traditional sources of sand for land reclamation and construction have been from rivers and beaches. Unfortunately, the present demand for sand and gravel far exceeds the capacity of these sources.

The projected sea level rise will cause an encroachment of the saline-freshwater upstream and narrow the freshwater lens, threatening the

water supply for urban and rural communities in the coastal zone. Coastal communities in the north and in the Independence/Mango Creek area will be especially affected. Rivers like the New River and the Rio Hondo with low gradients and straight courses will be especially affected by the encroachment of the saline-freshwater interface.

Sea level rise will also threaten the terms for the sewage lagoons in Belize City and San Pedro. Other coastal communities use septic tanks and pit latrines. Rising sea levels will drown these systems, as well as the pumping stations and sewage lines resulting in the pollution of coastal and river waters and threatening the underground supplies.

Water Resources

Projected sea level rise would also result in the encroachment upstream of the saline/freshwater interface, especially in the low-lying basins of the New River and Rio Hondo in the north. This would have dire consequences on agricultural enterprises in the Corozal and Orange Walk Districts, especially sugar production. Similar effects could occur in the Independence/Mango Creek area, impacting negatively on the banana industry.

Coastline retreat and beach inundation would transform savannahs and coastal farmlands into swamps and wetlands. Freshwater for human use and irrigation would become saline as the saline/freshwater interface shifts further upstream, contaminating surface water and phreatic aquifers. New agricultural lands and sources of potable water would have to be identified inland. This scenario would put more pressure on the limited agricultural land and could force farmers to use marginal lands and slopes, increasing the need for intensive but sustainable crop management practices.

2.1 Impact of potential change in Sea level, Hurricane Characteristics,
Storm Surge, Rainfall Patterns and Temperature on:

1. Beach and Shoreline stability:

Acknowledging that coastline erosion is already considered a major concern, it is inevitable that accelerated sea level rise would exacerbate the rate of erosion and possibly destroy all our existing beaches within this new century. Research undertaken under a US Country Studies Program Vulnerability Assessment reveal that a 4 cm rise in sea level over the next 25 years would have a low impact. A 50 cm rise would destroy over half the existing beaches, while a 100 cm rise in 100 years would destroy over 90 percent of these beaches.

Approximately 60 percent of the coastal areas are already inundated. Considering that most of the mainland coastline between the existing communities is wetland dominated, a one-meter rise in sea level would transform the wetlands to lakes. Dry land within a few meters of high tide would provide potential areas for new wetland formation

The barrier reef provides an important natural "breakwater", protecting the low-lying coastline from wave energy. Any structural loss to the reef could reduce its protective effect, leading to an increase in coastal erosion. Reduced coral growth will also lead to decreased amounts of carbonate sand produced to replenish beaches, exacerbating the higher rate of erosion expected due to sea level rise.

11. Marine Ecosystem:

Healthy corals are expected to keep up with projected sea level rise. However, they are susceptible to both high sea temperature and wave action from storms. Corals presently live at or near their upper temperature tolerance level. Thus, with just a small rise in temperature, many species of coral will respond by expelling their zooxanthellae or symbiotic algae, in a process known as "bleaching". Two mass bleaching events occurred in Belize in recent memory, in 1995 and 1998. These events coincided with elevated sea temperature, calm weather and increased solar radiation. Fifty two percent of corals were affected. Many corals suffered full or partial mortality. Bleaching weakens the coral's ability to resist pathogens and competitors. It is known that black band and coral plague diseases in corals are correlated with warmer water. Coral disease is prevalent in many areas of Belize's reefs. Future global warming

could cause an increase in the frequency and severity of coral bleaching.

The concentration of carbon dioxide is expected to double or triple by 2100. Much of the additional carbon dioxide will be dissolved in the oceans. The additional carbon dioxide could reduce the ability of the corals to deposit their limestone skeletons. This will affect the structure of the reef, which would obviously affect their ability to "keep up" with sea level rise and remain in the photic zone.

Coral reefs, particularly branching corals are very susceptible to storm damage. The Belize reefs suffered extensive damage in 1998 as a result of hurricane Mitch. Coupled with the bleaching episode, the reefs experienced "catastrophic losses". Global climate change may produce an increase in the strength, size and frequency of hurricanes.

With a loss in coral cover there will also be a related loss in biodiversity. Coral reefs are one of the most diverse systems on earth, and the reefs of Belize comprise some of the best in terms of general reef health and diversity in the Caribbean region.

Elevated sea surface temperatures may affect sea-grass beds. In addition, any increase in rainfall will result in increases of freshwater runoff, which could negatively impact sea-grass beds. In reality, however, the most important threats to this habitat are from human activities such as dredging, land reclamation and pollution.

Sea-grass beds provide important nursery areas for many fish species, including many commercially important species such as lobster and conch. The juveniles of many species are sensitive to changes in salinity and temperature. Thus, fish production could suffer if this habitat were significantly affected.

Since mangrove ecosystems are intertidal, changes in sea level will affect these communities. The most vulnerable mangroves in Belize are those that occur on the cayes, and the fringing mangroves along the coast. Generally, mangroves can cope with sea level rise where the rate of sedimentation exceeds the rate of sea level rise. Therefore, the impacts will depend on the sediment flux in the particular area. Many mangrove forests will adapt by landward migration or

compression of their zonation. However, this adaptive capacity may be limited in some areas by increasing levels of human activity such as aquaculture farms, roads and other infrastructure, which could block their landward migration.

Changes in precipitation and seasonality could alter the productivity and zonation of mangroves. Studies at Twin Cayes, Belize have shown that by the accumulation of leaf litter alone, these islands have managed to keep pace with normal sea level rise. With accelerated sea level rise however, low mangrove islands such as Drowned Cayes will be eroded, leading to weakening of trees, die-back and wind throws.

In contrast, mangroves along rivers with large watersheds and thus larger amounts of sediment input will be less vulnerable to the impact of sea level rise. Examples of these are the Rio Hondo, New River, Sibun and Belize Rivers. On the other hand, mangroves associated with rivers with smaller catchments may be more at risk. These include the Sittee, Deep, and Moho Rivers and Golden Stream. Mangroves along lagoons, which receive sediment primarily from incoming tides, will be at moderate risk.

111. Hydrological Characteristics and Water Resources:

If sea level rise were accompanied by an increase in precipitation, the flood plains of the Rio Hondo, New River and Belize River would remain flooded most of the year because the higher sea level would reduce the drainage efficiency of the coastal plains. Similarly the flood plains of the central and southern plains that are in closer proximity to the inundated coastline would also experience more frequent and intense flood events.

Saltwater intrusion is a major concern on most of the offshore islands and in several communities on the coastal plains. The problem at this time is not a direct effect of sea level rise, but rather the growing demand for potable water in the coastal area-. The Tertiary sedimentary and quaternary alluvial aquifers of the coastal plains yield large quantities of brackish to saline water. In many instances the freshwater aquifers are perched above the saline water and this is the water source that some coastal communities rely on. The

projected sea level rise through the next century together with increased abstraction rates will lead to higher incidences of seawater intrusion in the aquifers. Farmers on the coastal plains who depend on river and ground water for agriculture could experience a salinity problem if the sea level rises.

The possible over-abstraction of water on Caye Caulker, Ambergris Caye, Tobacco Caye, Seine Bight and Placentia might have led to the salinization of their water tables. Some of the islands were equipped with desalination plants to avoid the problem. Villages like Seine Bight and Placentia are dependent on water piped from the water supply in Independence Village that is also vulnerable to over abstraction and salt-water intrusion.

Belize City gets its water from an area just upstream from where the water is salty during the dry season. A rise in sea level would enable saltwater to penetrate further inland and upstream in rivers, bays, wetlands and aquifers, which would be harmful to some aquatic plants and animals, and would threaten human uses of water.

1V. Food and Nutrition: Agriculture and Fisheries:

In 1998, severe flooding in northern Belize affected the quality of the sugar cane and the net production of sugar.

Hence, the inundation and salinization of agricultural lands through salt water intrusion or tidal influences in rivers from which water is abstracted for irrigation is a major potential threat consequent to sea level rise.

Aquaculture operations in Belize currently are mostly situated along the coastline that is prone to seasonal inundation. Such areas are suitable because of the favorable sediment composition and ease of water abstraction. The impact of projected sea level rise on aquaculture development is twofold. Firstly, sea level will increase coastal erosion, and erosion of dikes of some aquaculture ponds. This could in turn lead to increased turbidity and decline in water quality in the immediate area. Secondly, a higher mean sea level would facilitate the encroachment of aquaculture farms in higher and more suitable lands. Even though a higher mean sea level does not imply

higher tidal fluxes, there is the potential for cage aquaculture along certain segments of the coastline.

The impact of increased intensity and frequency of storms and increased precipitation poses a greater threat to aquaculture than sea level rise. Storms are the leading cause of pond destruction and excessive rain could readily alter the salinity of ponds and affect the net production of the farms.

Loss in coral reefs will have a severe negative effect on its role as a habitat. This will result in a related loss in fisheries production. The fishing industry in Belize was worth over BZ$43.5 million in export earnings in 1998. The industry provides substantial employment; currently involving a fleet of 354 licensed fishing boats, and 1,910 licensed fishers. Fish is also a critical source of protein for many coastal communities. It is based primarily on reef species: spiny lobster, conch, snapper and grouper.

Sea-grass beds are also important feeding grounds for manatees and marine turtles. Thus, any loss in their productivity could affect these species, and lead to a loss in biodiversity in general.

Any loss of mangrove would affect fisheries production as they provide important nurseries for many commercially important species. The effect of rainfall on shrimp production for example is well documented. Similarly, the relationship between shrimp catch and the acreage of related wetlands is well known. Furthermore, many near shore species of finfish that are dependent on mangroves are important for recreation and sportfishing. These include tarpon and snook.

V. Settlement and Infrastructure

In Belize City, residential areas such as Vista del Mar, Bella Vista, Belama and Fort George that are constructed on drained, and reclaimed wetlands are extremely vulnerable to the projected sea level rise. Similarly, the infrastructure developments in most of the other coastal communities like Dangriga, Corozal, the Placentia Peninsula, Ambergris Caye and the other offshore islands are currently threatened even by a 20 cm rise in sea level. In order for these

communities to cope with rising sea level, a constant supply of large volumes of sediment would be required. The sources of supply of natural and alternative sediment to these areas have been significantly reduced. Protecting these urban areas might require the construction of sea walls and dikes that could withstand the impacts of the projected sea level rise through the new century.

The coastal areas would become more vulnerable to flooding. A meter rise in sea level would provide a higher base for storm surges to propagate further inland. This would also enable weaker storms to have an effect on areas that would otherwise be affected only by stronger storms. Accelerated erosion along the central coastline would leave some properties more vulnerable to the local wave climate during high tides.

Belize has a population of approximately 250,000. Approximately 45 percent reside in the coastal zone. The four coastal districts of Corozal, Belize, Stann Creek and Toledo have large urban and rural development zones that are prone to seasonal flooding and inundation. All these districts have human settlements concentrated in areas that range from 0 to 5 meters above the present sea level. The projected sea level rise during the new century will permanently inundate most cayes, including the heavily populated Ambergris Caye (average elevation of 2 feet) and several kilometers inland of the mainland coastline. Flooding would seriously affect communications, infrastructure and housing. For settlements like Belize City that are dependent on surface and ground water, seawater intrusion will have a significant impact.

V1 Tourism

Belize has an intricate costal zone that consist of costal plains, lagoons, estuaries, numerous coral and mangrove islands, a 220 km long barrier reef and three outstanding atolls (Turneffe, Glover's and Lighthouse.) In addition to these spectacular tourist attractions, the necessary infrastructure and services for a vibrant tourist industry are available in the costal zone.

During the past decade there has been significant development in Belize's tourism industry. This could be attributed to several factors including the marketing of BELIZE as an eco-tourists destination, a critical link in the famous "Ruta Maya"; land of pristine rainforest, abundant biodiversity, the second largest barrier reef in the world, and a heaven for world class diving. On December 4, 1996 the Belize Barrier Reserve System was designated a World Heritage Site. This system contains examples of on-going ecological and biological processes, importance and the most important and significant natural habitats for endangered species that justified its inclusion on the list of World Heritage sites.

Today the Belize Barrier Reef is vulnerable to global warming and in particular the effects of climate change and sea level rise. Given a scenario of +/- 2 degree Celsius change in temperature, +/- 20 percent change in precipitation and 20-100 cm rise in mean sea level through the next century, one can expect significant changes in the barrier reef system. Corals are known to grow within a narrow optimal temperature range between 22-28 degree Celsius. Changes in seawater temperature outside of this range could lead to coral bleaching. Once the corals are bleached they become vulnerable to diseases, some of them may recover while most of them die.

Loss in the percentage of coral cover with a concomitant loss in reef-related species of invertebrates and fishes will lead to a general loss in the attractiveness of reef sites used for snorkeling and SCUBA diving. Presently, the majority of tourism in Belize is marine based, with approximately 70 percent of hotels located in the coastal zone. Over 60 percent of visitors are interested in visiting the cayes. Tourism accounts for over 15 percent of GDP, is the largest source of foreign exchange earnings, and generates significant employment. Thus, any decline in marine tourism will have a direct effect on the economy of the country.

Considering that most of the cayes and parts of the mainland are low-lying it is expected that inundation will be more prominent and costal erosion will be accelerated. An increase in erosion rates could lead to an increase in the net availability of suspended sediment that could suffocate the coral polyps and contribute to reef degradation.

It is important to note that the impact of climate change on tourism is not as direct as that of climate change on agriculture, forestry and water resources to mention a few. In summary, the potential impact of climate change on Belize's tourism sector is through the degradation of costal water quality, loss of beach, coral reef degradation and subsequent decline of fish stocks. Undoubtedly, a decline in coral reef health would lead to poor aesthetic value of the reef, reduction in world class diving and fishing potential and hence to a probable decline in tourist arrivals.

V11. Human Health Implications:

Concern for human health is the most compelling reasons to study the effects of global climate change. Health is a focus that will reflect the combined impacts of climate change on the physical environment, ecosystem environment and society.

Climate change is likely to have wide-ranging and potentially serious health consequences. Some health impacts will result from direct-acting effects (e.g changes in patterns of infectious disease, in freshwater supplies, and in food availability).

At the beginning of the 21 century, environment changes on an unprecedented, global scale have begun to impinge upon human health simultaneously, and often interactively. This spectrum of "global environment" hazards to health includes:

* Global climate due to the accumulation of greenhouse gases in the lower atmosphere;
- Stratospheric ozone depletion (a process that will probably increase for several decades, after which a slow recovery is expected); this will influence skin cancer rates, cataracts, and perhaps, immune systems suppression;
- Loss of biodiversity – this is occurring at a rapid rate, and entails both the disappearances of useful species and genes and the weakening of various ecosystems thereby reducing the flow of nature's life-supporting "goods and services";
- Desertification, depletion of fertile soil, groundwater and natural fisheries; this is undermining the productivity of food-producing

ecosystems, thereby offsetting expected gains from genetically modified organisms, precision farming and aquaculture; and now being recognized as persistent and globally pervasive. Some appear to affect neurological, immune and reproductive systems, and can no longer be considered to have specific and limited toxicity.

Many important diseases are transmitted by insect or tick vectors. These organisms are sensitive to changes in climate. Many vector-borne diseases that are likely to be affected by climate change have been ranked by WHO as the most important tropical diseases in the world. The human impact of these diseases is enormous. They affect productivity and cause a vicious spiral of poverty and disability. The distribution and seasonality of many of these diseases may be influenced by climate change. Increases in temperature would tend to accelerate vector life cycles and would also decrease the incubation period of the parasite or virus. Impacts on health would entail the emergency of a disease in new as the extension of the transmission season in areas where it is present.

Hence, malaria is one of the world's most serious and complex public health problems and it has now been identified as the disease most likely to be affected by climate change. Countries that are at greatest risk from malaria owing to climate change are those at the fringes of its current distribution, particularly where malaria control programmes have broken down. Also, dengue is the most important arboviral diseases transmitted by mosquito. More than half the world's populations live in areas at risk of infection and up to 100 million cases of dengue occur annually.

Predictive models for dengue transmission project a net increase in the latitudinal and altitudinal range of dengue and increased duration of the transmission season in temperate locations.

With a meter rise in sea level, none of the remnant cayes in Belize will have a source of potable ground water. Some of the costal plains will experience high levels of seawater tables. This will lead to a drastic decreased in volume of fresh water lens and intensify the potential for contamination of the fresh water from domestic and industrial waste.

Human health depends on an adequate supply of potable water. By reducing fresh water supplies, climate change may affect sanitation systems and lower the efficiency of local sewerage systems, leading to increase concentrations of pathogens in raw water supplies. Changes in rainfall patterns may reduce the water available for drinking and washing. Water scarcity may force people to use poorer quality sources of fresh water, such as rivers, which are often contaminated. All these factors could result in an increase incidence of diarrhoeal diseases.

With a meter rise in sea level, none of the remnant cayes in Belize will have a source of potable ground water. Some of the coastal plains will experience high levels of seawater intrusion and rising water tables. This will lead to a drastic decrease in volume of the fresh water lens and intensify the potential for contamination of the fresh water from domestic and industrial waste. Surface water sources could be enhanced only if the climatic variation favors an increase in rainfall in the country.

V111. Other Key Concerns:

Mangroves are being lost to urban expansion for residential development, coastal tourism development and coastal subdivisions. In former mangrove areas that have been filled, oxidation of peat can lead to a decline in the land level, making such areas even more susceptible to flooding.

Deforestation, primarily for agriculture but also for other economic ventures especially on the coast, occurs mainly at the expense of these vegetation types. Ministry of Agriculture statistics used in the GHG Inventory indicate that clearance averaged 3505 ha per year over 1984-94. A 1994 study (White, et al, 1994) however, gave much higher rates (25,000 ha per year) for the end of the period, suggesting either that the Ministry of Agriculture figures underestimated clearance, or that clearance was accelerating, or that both conditions applied. Furthermore, some 9 percent of the deforestation was

identified as occurring in the protected areas, indicating a general inadequacy of resources to implement policy.

The use of GWP shows that Belize, although a net GHG sink, still contributes to Global warming by emitting approximately 9.5 million GWP units but absorbing million. This is almost entirely due to methane emission from waste management, and especially from septic tanks, which outweighs the effect of CO, uptake through tree growth. The contribution of industrial waste could not be assessed properly and therefore could not be taken into account, but the indications are that it is an even more important source of methane emission than the domestic waste sector.

Essentially, the key sectors in Belize are Land Use Change/Forestry and
Wasted by Energy. Management, followed by Energy.

2.2 Identification of Priorities

Ranked Listing of Issues

Issues	Rank	Reason (s)
Tourism	1	Highest single foreign exchange earner; greatest single contributor to GNP; responsible for 1 in 4 jobs.
Agriculture and Fisheries	2	Traditional mainstay of Belize's economic growth over the past 20 years. Negative effects of climate change can seriously affect production and overall economy.
Land Use	3	Social and economic development activities are impacting negatively on this sector. e.g. residential sub-divisions, agricultural expansions and industrial growth.
Environmental and Human Health	4	Important high impact sectors; extremely vulnerable to effects of climate change.
Water & Sanitation	5	Basic and Fundamental for health and sustainable economic development.
Settlement & Infrastructure	6	Developmental policy/strategies (housing projects, urban renewal, agricultural diversion etc) increases need for rapid expansion in these areas.
Public Education	7	Essential for minimizing and maximizing adaptive capacity through improving social awareness and preparedness.

3.0 Institutional and Legal Arrangement for Responding to Issues

Belize's response to the various Climate Change Issues, should be viewed within the content of the following four main implications, from its National circumstance:

(1) The population is increasing; expenditure to meet social requirements may therefore also be expected to rise if poverty is to be alleviated and the general well being of the people is to be enhanced. At the same time, the economy is small, fragile, and increasingly challenged. Furthermore, the country is vulnerable to climate change impacts. This provides strong incentives to pursue new opportunities presented by mechanisms of financial and technical resource transfer developed under the UNFCCC and direct them towards national sustainable development priorities. Given the vulnerability of the country, it must take particular interest in approaches that offer speedy and reliable benefits.

(2) Given its forest cover, the greatest opportunities for Belize lie in the land use and forestry sector including maintenance of the sequestered stock. Applying the aboveground woody biomass data of 141 tC/ha found in northern Belize to the entire country (and so certainly underestimating given the higher forest types in the south), the high forest formations represent a standing stock in the order of 183 million tC in the wood alone. This is not secure regardless of a national policy that assumes maintenance of a relatively high proportion of forest cover as long as resources are inadequate to implement that policy. Tactical considerations may indicate that other types of mitigation action should be emphasized at this stage, but forestry and indeed the more controversial sequestration should remain as present and future options where the Projects are rigorously designed.

(3) Belizean development policy emphasizes broad participation by civil society and creation of an enabling environment for private investment and enterprise. In fact, it is explicit that responsibility for achieving development goals is shared between government, the private sector, and society at large. This ethos favours use of flexible mechanisms, market based approaches, and private sector initiatives in implementing mitigation and adaptation measures.

(4) Notwithstanding the points made above, the vulnerability of the country to the foreseeable adverse physical, environmental and economic impacts of climate change indicate that priority attention be directed towards adaptation measures. Mitigation options are desirable where they offer means to address national development goals, but adaptation is of paramount importance. Lack of specific information on the exact (as against the general) nature of the threats, however, represents an important constraint on the design of appropriate actions at this time.

The beginning of Coastal Zone Management (CZM) in Belize dates back to a workshop held in San Pedro in 1989. At this time, it was recognized that an integrated, holistic approach to management of our coastal resources was necessary to ensure their use and protection in the long-term. The participants at this meeting recommended that a CZM Unit be established under the Fisheries Department. This Unit initiated the integrated CZM programme required, taking a multi-sectoral approach that links the effects of land-based activities on the marine environment.

By 1990, the small CZM Unit was functioning and the CZM Technical Committee was established. Although this programme made good progress, it clearly needed expanding and strengthening, but funding was required. In early 1993, the GEF/UNDP CZM Project was launched, providing significant financing that has made integrated CZM in Belize a permanent and well-established national programme.

The CZM Act was passed in April 1998, and became operational in May of that year. It provides for the institutional arrangement for CZM in Belize through the establishment of a CZM and its technical arm, the CZM Institute.

The Act also establishes an Advisory Council, appointed by the Authority. This council is comprised of a board representation from the government, private sector, NGO community and academia. Its function is to advise the institute on technical matters pertaining to coastal issues and to facilitate coordination among agencies.

The Act also provides for the preparation of a Coastal Zone Management Plan and for the introduction of fiscal measures to support the work of the Authority and Institute.

3.1 Allocation of Responsibilities

Allocation of Selected Coastal Management Responsibilities

Coastal Management Function	**Agency/Department Responsibilities**	**Government Ministry**
Biodiversity Conservation	(CZMA) Coastal Zone Management Authority/Fisheries/Forestry/Department of Environment.	Ministry of Agriculture and Fisheries/Ministry of Natural Resources
Coastal Zone Resources Inventory	Coastal Zone Management Authority	Ministry of Agriculture and Fisheries
Coral Reef Monitoring	Fisheries Department/Coastal Zone Management Institute	Ministry of Agriculture and Fisheries
Water quality Program	Coastal Zone Management Institute/Fisheries Department	Ministry of Agriculture and Fisheries
Potable Water Source Monitoring	Public Health Bureau/WASA	Ministry of Health
Tide Gauge Monitoring	National Meteorological Service	Ministry of Public Utilities, Energy and Communication

(b) Legislation **and Statutory Provisions**

Belize has a remarkable amount of legislation relating to the environment, and much of this directly or indirectly has an impact in

the costal zone. In addition there are a number of policies and guidelines that have been, or are in the process of being, adopted which help to direct activities in the costal zone towards the process of sustainable management. This section provides an overview of the legislative and policy framework that currently exists for costal zone management. It is worthy of mention that Belize has some 40 pieces of primary legislation and many subsidiary pieces and guidelines that governs a wide variety of costal zone activities, and over 10 Ministries have some form of responsibility.

Existing Legislation Governing Coastal Management

Title	Objectives	Agency/Ministry Responsible
1. Coastal Zone Management Act. (No. 5 of 1998)	The Act provides for the institutional arrangements for Coastal Zone management in Belize	Ministry of Agriculture, and Fisheries Cooperatives
2. National Lands Act, 1992	Stipulates the procedures, and conditions under which national lands (including the sea bed) may be leased, granted or reserved.	Ministry of Natural Resources and Environment.
3. Land Utiligation Act, 1981	Controls the submission of private land, allows for the declaration of special development areas.	Ministry of Natural Resources and Environment.
4. Aliens Landholding Act, 1973	The Act discourages land speculation, and includes conditions to protect the environment.	Ministry of Natural Resources and Environment.
5. Water and	Established WASA,	Water and Sewerage

Sewerage Act, 1971	which is responsible for the maintenance of sewerage systems and has pollution prevention powers over all water bodies.	Authority.
6. Environment Protection Act, 1992	Covers the prevention protection and improvement of the environment, the rational use of Natural Resources and the prevention of pollution both at sea and on land.	Ministry of Natural Resources and Environment.
7. Abandoned Wrecks Act, 1990	Established and confers authority on the abandoned wreck authority to regulate and license the exploration and excavation of wrecks more than 50 years old.	Ministry of National Resources and Environment.
8. Housing and Town Planning Act, 1947	Authorizes the Central Housing and Planning Authority to declare areas subject to town planning regulations.	Ministry of Housing Urban Renewal and Home Affairs.
9. Fisheries Act, 1948	This Act applies to all territorial and costal waters, rivers and inland waters, and regulates the exploration of fish, commercially important aquatic invertebrates and turtles.	Ministry of Agriculture and Cooperatives.

10. Belize Port Authority Act	Regulates shipping in port, areas, designates ports and definition of their limits.	Belize Port Authorities
11. Petroleum Act, 1991	Covers petroleum prospecting and drilling.	Geology and Petroleum Office.
12. Public Health Act, 1943	Covers sobs and liquid waste disposal and issues related to general public health, including the qualities of drinking water.	Ministry of Health.
13. Registration of Merchant Ship Act, 1989	Allows for the regulation and control of shipping activities, in particular relating to international vessels that may have an environment impact.	Office of The Attorney General.
14. Local Government (District Boards) Act, 1939	Provides for the establishment of bye-law and regulations of an environment nature, among other things.	Ministry of Local Government.
15. Maritime Area Act, 1992	Provides extensive general regulatory powers in the marine environment, in accordance with the UN Law of the Sea Convention.	Ministry of Foreign Affairs.

3.2 Other Relevant Institutional Considerations

Belize signed the United Nations Framework Convention on Climate Change (UNFCCC) in 1992, and ratified it in 1994. In view of the possible opportunities presented by mechanisms developed under the Convention, Belize has attempted to keep abreast of developments to the degree its resources permit. There are Belizean representatives on the IPCC working groups, and delegates regularly attend IPCC meetings. Delegates also attend Conferences of the Parties and Subsidiary Body Sessions of the COP of the UNFCCC and most regional meetings involving the Central American and CARICOM states. The National Meteorological Service is the focal point for all matters related to climate change.

Since ratification, Belize has participated in actions under the Convention in two ways:

i) Assessment and monitoring of climate change impacts. Vulnerability assessments have been undertaken on staple crop yields, coastal vulnerability to sea level rise, and on the water resources of the Belize River Valley. In the first two cases, negative impacts are foreseeable while the results of the third are ambivalent. Belize is also participating in the "Caribbean: Planning for Adaptation to Climate Change" (CPACC) project, initiated by CARICOM with the

support of the Organization of American States and the Global Environment Facility. The Belizean contribution to this regional project lies in coral reef monitoring. Other components include regional monitoring, assessment of coastal resources, assessment of coastal vulnerability, economic valuation of coastal resources, and formulation of economic and regulatory proposals to deal with the issue.

ii) *Participation in The Pilot Phase for Activities Implemented Jointly (4IJ)*

The Rio Bravo Carbon Sequestration Pilot Project was established in 1995, field managed by a Belizean NGO with funding from six North American energy sector companies passed through an international NGO as funds manager. This project was the first Land Use Change/Forestry project under the Pilot Phase to be fully funded. From the Belizean viewpoint, participation was intended to explore the potential for such projects to generate credible GHG benefits, equitably share between interested parties through private sector partnerships. It has shown that at the individual project level the overall concept is robust and can deliver sustainable development gains; CO, benefits can be measured reliably on the ground; and that in certain projects; at least, the circumstances allow issues of "leakage" and additionally to be adequately addressed. While respecting contrary views, the experience indicates that well designed and implemented forestry based projects, including sequestration projects, are a viable approach that can quickly produce GHG benefits. It is also accepted that, being cheaper, they may divert attention from other forms of approach and are therefore probably best used as part of a balanced portfolio of project types delivering a spread of development, GHG mitigation, and climate change adaptation benefits.

Belize recently completed its **First National Report to the Convention on Biological Diversity (CBD) and National Biodiversity Strategy and Action Plan.**

Belize is also a member of the Regional Committee of Water Resources (CRRH), for the Central American Region.

4.0 Towards An Adaptation Policy

Belize has been identified as one of those countries most vulnerable to the adverse impacts of Climate Change. It is therefore imperative that adaptation measures be identified for its most vulnerable sectors and that steps be taken for implementation of the more viable options.

The following guiding principles and specific options are proffered to underpin a broad adaptation strategy to deal with those issues of national concern.

4.1 Guiding Principles

(1) Beach and Chore line Stability:

Activities such as beach and sand mining and the destruction of coral reefs, which will enhance the threat of increases erosion posed by climate change and sea-level rise, should be strictly controlled and regulated.

(11) Marine Ecosystem:

The GOB's current policy to promote tourism as one of the country's main income earner, places the management of Belize's biodiversity as a top priority. The impact which climate change may have on the prime resource so essential for Belize's long-term sustainable development needs careful attention and planned research.

(111) Hydrological Characteristics and Water Resources:

Planned water resources management is essential for the preservation of the environment, the equitable distribution, the preservation of quality and quantity, and conservation of our water resources, in mitigating the impact of climate change.

(iv) Food and Nutrition/Agriculture and Fisheries:

The long-term development strategies for sustainable agriculture must maintain a focus on the adequate use and management of the natural resource base upon which agriculture depends.

(v) Settlement and Infrastructure:

Seeing that development activity has placed significant stress on the costal physical resources, and that 45% of Belize's population resides in the costal zone, there is considerable demand for suitable land for housing construction and to meet the communities expansion needs. Hence, the sustainable use and development of the physical resources of the costal zone are critical to the economic and social well being of the country.

(vi) Tourism:

Given that the Coastal Zone is a national treasure, containing the second largest Barrier Reef in the world, and that eco-tourism is an important industry in Belize, every effort must be made to protect the reef and other vital ecological resources.

(vii) Human Health Implications:

Strategies to deal with the impacts of climate change on health, necessitates intersectoral, and cross-sectoral adaptation measures and collaboration, if they are to achieve any level of success; as adaptation is a key factor in minimizing any such impacts.

The protection and improvement of population health must be recognized as a central goal of environmentally sustainable development.

4.2 Specific Options

1 Coastal Zone Adaptation and Mitigation Options

Activity	**Benefit**
1. Establish setbacks for underdeveloped coastal areas	Reduced incidence of property loss due to erosion and inundation
	Allow coastline to adapt autonomously
	Allow ecosystems to migrate
	Maintain aesthetic value of coastal area
2. Construct and improve seawalls	Reduce property damage and loss

	Shoreline protection of developed areas
3. Beach Nourishment	Maintain economically important beaches
	Maintain intrinsic character of areas and their communities
	Provide shoreline protection
4. Relocation of vulnerable coastal communities	Reduce disaster risks residents
5. Prepare post-disaster reconstruction plans	Discourage reconstruction on severely damaged coastal properties
6. Monitor relative sea level rise and local wave climate	Data would assist in making informed decisions
	Reliable wave data is necessary for prediction of sediment transport and engineering coastal structures
7. Monitoring shoreline	Determine rates of shoreline erosion or accretion

ll Marine Ecosystem Adaptation and Mitigation Options

Activity	**Benefit**
1. Official adoption of National Protected Areas System Plan (NPASP)	Maintenance of ecological structure and processes
	Reduced fragmentation and destruction of habitats
Enforcement of the laws regulating conservation and use of biological resources in the	Reduced anthropogenic pressure

marine and terrestrial ecosystems	
	Long-term survival of species
3. Establish and maintenance of Protected Areas	Long-term survival of species
	More effective coverage of important species
	Improved land use and conservation of watershed
	Additional acreage available as a carbon sink
	More sites available for eco-tourism
4. Inclusion of biodiversity conservation into adaptation strategies of other sectors	Coordinated implementation of adaptation strategies
	Raised level of awareness among developers to balance development and conservation

lll Hydrological Characteristics And Water Resources:

Adaptation And Mitigation Options

Activity	**Benefits**
1. Develop a national water management system	Coordinated and sustainable use of water resources
2. Obtain comprehensive knowledge of nation's water resources	Most appreciate use of water resources
3. Prepare a national water resource plan	Prioritize usage based on availability and demand
4. Promote effective and efficient	Reduced cost and waste

use of water	
5. Develop local management and technical expertise	Improved management of water resources
6. Relocate point source of portable water in the coastal zone to points above influence of saline intrusion	Safeguard water supply
7. Encourage use of cisterns	Alternate source of water
8. Relocate waste disposal sites above influence of sea level rise	Reduce risk of contamination of aquifers
9. Adopt agricultural practices based on availability of water	Improved yields
10. Cooperate with neighbouring countries in the management of shared water resources	Equitable protection and use of water resources

lV Food And Nutrition: Agriculture And Fisheries

Adaptation And Mitigation Options

Activity	**Benefit**
1. Strengthen national research institutions	Identification of crops, cultivars and practices suitable for new climates
2. Relocation of agriculture activity away from the coastal zone	Safe guard investments and reduce losses
3. Provision of timely and reliable agroclimatological and seasonal forecasts	Increased yield and reduction in losses

4. Introduce changes to the traditional planting and sowing dates	Increased yields and reduced losses
5. Introduction of new varieties or species	Increased yields and reduced losses
6. Reduction in tillage	Reduced cost
	Maintain soil fertility and conserves soil
	Sequesters GHGs

V Settlement and Infrastructure

Adaptation And Mitigation Options

Activity	**Benefits**
1. Discourage construction of new township in coastal areas	Reduced impact on coastal zone
2. Discourage construction of new residences within inland coastal plains	Protection of water resources
3. Creation of economic and commercial activities away from coastal areas	Encourage population to move inland away from vulnerable coastal areas. Protection of fragile coastal zone
4. Education and Public awareness	Informed public would recognize need for adaptation measures
	Decision makers would incorporate adaptation measures in sectoral development strategy

VI Tourism

Adaptation And Mitigation Options

Activity	Benefits
1. Coastal Zone Vulnerability Assessment	Short/medium/long term benefits from specific coastal protection interventions more easily determined. Both Coastal and tourism populations benefit. Coastal Zone management/ planning facilitated.
2. Land use monitoring	Control of indiscriminate land use.
3. Water resources management	Sustained availability and improved water quality.
4. Waste management	Protection of Human Health and prevention of environmental pollution.
5. Public Awareness	A more enlightened and sensitized population including tourist population.

VII Human Health Implications

Adaptation And Mitigation Options

Activity	Benefits
1. Monitoring And Surveillance	Feasible and cost effective program/s. Whole population benefit. Implemented at National and Local levels.

2. Integrated environmental management	Strong local level components, whole population benefits.
3. Early warning and epidemic forecasting	Whole population benefits. Both National and local activities feasible. Few barriers and minimum costs.
4. Water quality and sanitation improvement	Local level initiation could bring positive results, at minimum costs. Targeted population centers benefits from specific interventions.
5. Public Education	Wider population more enlightened on issues. Feasible undertaking especially at local levels. Minimum costs and few barriers.

4.3 Opportunities And Constraints:

(a) Following the threat posed by Hurricane Mitch in October 1998; there has been a review of hurricane preparedness and procedures in the event of natural disasters. The scenario of a major disaster such as Hurricane Mitch, has served to sensitize the government and general pubic to climate change issues, mitigation, and especially, adaptation. A clear example of this is the planned new satellite township 30 miles inland at La Democracia on the Western Highway now under construction, away from the dangers of storm surges, floods and high tides.

However, the vulnerability of the country to the foreseeable adverse, physical, environmental and economic impacts of climate change indicate that

priority attention be directed towards adaptation measures. Lack of specific information on the exact (as against the general) nature of the threats, however, represents an important constraint on the design of appropriate actions at this time.

(b) The Ministry of Agriculture, Fisheries and Cooperatives (MAFC) recognizes the potential for an expansion of irrigation systems to increase yields, particularly for cash crop production and vegetable cultivation. The moving factor in a future irrigation policy of the MAFC is to use the most appropriate and efficient irrigation technology to produce high quality cash crops that will fetch the best price in the open market. This technology must be cost effective and at the reach of farming co-operatives or farming communities. In this way, Belize may produce cash crops like peppers, papaya and vegetable all year round, and tap niche markets for these produce.

One limiting factor identified was the procurement, in Belize, of adequate irrigation material, and sources of adequate water supply for irrigation. Under a joint FAO/MAFC project, the Ministry of Agriculture is studying the feasible of constructing micro dams on streams and rivulets at strategic sites near farming communities. This infrastructure will provide the needed water for proposed small-scale irrigation systems for the dry season cropping cycle.

5.0 Summary And Conclusions

The United Nations Framework Convention on Climate Change (UNFCCC) recognizes that Belize is one of those countries most vulnerable to the adverse impacts of climate change.

- It has a long, low-lying coastline (Art.4.8 (b))
- It has over 1060 small islands (Art.4.8 (a))
- It has the second longest barrier reef in the world and 17,276 sq. km. of forest cover, each of which support fragile ecosystems (Art.4.8 (g))
- It is very prone to natural disasters, especially hurricanes (Art.4.8d)).

Therefore, in addressing climate changes, Belize has identified the assessment of the country's vulnerability to climate change and the formulation of adaptation measures as its highest priorities.

In doing so, Belize has shown (and is showing) that it is a country that is prepared to work with the international community to identify mechanisms which will facilitate the identification and implementation of adaptation measures required to overcome the adverse impacts of climate change.

Potential adaptation measures for Belize includes:

- The relocation of point sources for potable water in the coastal zone to points above the influence of saline intrusion especially in the Mango Creek/Independence area.
- Encourage the use of cisterns for the storage of rainwater in the northern urban areas offshore communities.
- The relocation of the solid waste areas above the zone of influence of sea level rise, especially for Belize City and offshore communities.
- The development of an effective means of disposal of domestic wastewater and excreta.
- The adoption of forest management plans for protection against increased soil erosion.
- The adoption of agricultural practices based on a water availability quota system.

- The vesting of ownership of the nation's water resources in the state.
- The establishment of an extensive database of the nation's water resources.
- The establishment of an institutional framework capable of integrating water policy formulation, strategy, monitoring, control, management, development and planning.
- The preparation of a national water resources plan.
- The development of managerial and technical expertise to fulfill the obligations of the water management system.
- The development of financial mechanisms to ensure the financial viability of an effective water resources management organization.
- The promotion of the effective and efficient use of water.
- The guaranteed provision of water for domestic consumption in the event of scarce water resources.
- The promotion of cooperative mechanisms with neighboring countries for the management, development and protection of shared resources.

More specifically, and in relation to the country's ranked listing of issues, the following measures could also be considered:

Tourism:

(a) Adopt policies that promote "green" marine-based tourism. This process could be assisted by the development of appropriate standards and best practices, and by introducing incentives.

(b) Carry out EIA process of costal tourism developments.

(c) Education and public awareness – strengthen the training for tour guides to ensure proper codes of conduct for diving and snorkeling, boat handling, and arehoring. Also, carry out environmental education programmes targeting tourists, to encourage support for these codes of conduct and rules and regulations.

(d) Establish a national system of mooring buoys to minimize damage to reefs and sea-grass beds by anchors.

(e) Conduct site-specific research on carrying capacity for critical areas and marine protected areas.

Agriculture and Fisheries:

(A) Consider Seasonal Changes and Sowing Dates for crops.

Different Crop Variety or Species (heat/pests resistant varieties)

New Crop Varieties/cultivars (crop varieties/cultivars that response to CO2 enrichment)

Water Supply and Irrigation Systems

Other Inputs and Management Adjustments (Efficient use of N inputs and other fertilizers)

Tillage (minimum tillage, e.g. for basin irrigated rice cultivation)

Improve Short-term Climate Prediction (especially for extreme weather conditions)

Relocation of agriculture activities/ agricultural communities (e.g. banana, citrus, etc.) From coastal areas prone to impending sea level rise.

(B) Measures for reducing fishing pressure on heavily exploited stocks, such as limited entry and fishery reserves, being included under the revised Fisheries Act. This would help to increase the resilience of fish stocks to the effects of climate change.

Encourage diversification to exploitation of new stocks, and expand to EEZ.

Improve management to catch levels.

Education and public awareness.

Land Use:

(a) Changes in land use planning and policies should be pursued e.g. government and private subdivisions for Belize City on higher land further inland should be encouraged; formal adaptation of the master plan for Ambergris Caye should be promoted; Implementation of second town on Ambergris at Basil Jones, should be further pursued; so too should the completion and implementation of development plans for Caye Caulker and Placencia.

(b) Coastal developments should be discouraged from including any mangrove clearance. Any expansion of housing and industrial development in urban areas should avoid net land areas, and incentives granted for moving further inland. Sufficient areas should be zoned for protection that will allow for migration of mangroves inland as a result of sea level rise.

Belize has undertaken only three vulnerability studies. It is essential that additional studies be undertaken in areas such as biodiversity, health, fisheries, forestry and tourism. The major agricultural export commodities may also be vulnerable to the adverse impacts of climate change. Studies should therefore be conducted in aquaculture, bananas, citrus and sugar cane production, and recommendations made for adaptation strategies.

A recurrent theme which arose during the preparation of this Initial National Communication was the need to sensitize the general public and decision makers, especially the political directorate, on the potential impact of climate change on the

country and on the opportunities being offered by the mechanisms to address climate change. A comprehensive program on public awareness, education and training is required beyond that which is normally appended to sector specific projects.

In summary therefore, Belize is a country with extensive, low-lying, coastal areas exposed to natural disasters through tropical cyclones and flooding. Furthermore, the economy is small and concentrated, along with most centers of population, in the very areas that are most vulnerable. Following the threat posed by Hurricane Mitch in October 1998; there has been a review of hurricane preparedness and procedures in the event of natural disasters. The scenario of a major disaster such as Hurricane Mitch has served to sensitize the government and general public to climate change issues, mitigation, and especially adaptation.