

Report to the Cayman Islands' Government.
Adaptation lessons learned from responding to
tropical cyclones by the Cayman Islands'
Government, 1988 - 2002

Emma L. Tompkins
and Lisa-Ann Hurlston

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Emma L. Tompkins¹,
Lisa-Ann Hurlston²

¹Tyndall Centre for Climate Change Research and School of Environmental Sciences, University of East Anglia, Norwich NR4 7TJ, UK.

²Department of the Environment, Government of the Cayman Islands, Marco Giglioli Building, Grand Cayman, Cayman Islands, BWI.

Email: e.tompkins@uea.ac.uk

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Acronyms

AOSIS	Alliance of Small Island States
CAREC	Caribbean Epidemiology Centre
CARICOMP	Caribbean Coastal and Marine Productivity Programme
CITES	Convention on International Trade in Endangered Species of Wild Flora and Fauna
CPACC	Caribbean Programme on Adapting to Climate Change
EXCO	Executive Council of the Cayman Islands' Government
IMO	International Maritime Organisation
NGO	Non-government organisation
NHC	National Hurricane Committee
PAHO	Pan American Health Organisation
SPAW	Protocol on Specially Protected Areas and Wildlife
WHO	World Health Organisation
UKCIP	UK Climate Impacts Programme
UN	United Nations
UNFCCC	United Nations Framework Convention on Climate Change
UNEP	United Nations Environment Programme

“In 1988 prior to Gilbert we did our first Hurricane Preparedness Exercise. We were disorganised because it was our first attempt. It took us 16 hours to get 70% of the hurricane shutters onto the government buildings complete. Even so this exercise helped us when Gilbert hit. Even though we weren’t as effective as we are now, we were better prepared than we were before we did the preparedness exercise. Since then we have held an exercise every year. We can now protect all Government buildings in 6 hours. The Andrew’s, Gilbert’s, Michelle’s and Mitch’s have helped to keep us focussed and prepared.” Respondent 17, 020705.

1. Introduction

The Cayman Islands’ Government has enhanced its capacity to respond to severe tropical cyclones over the past 15 years. This report explores what changes have been made within the Cayman Islands’ Government to enable it to achieve the improvement in the effectiveness of its tropical cyclone response described by Respondent 17 above. Specifically, the purpose of this report is to explore some of the drivers of change and to highlight the key factors that changed the response capacity in the Cayman Islands’ Government between 1988 (when they were affected by Hurricane Gilbert) and 2001 (when they were affected by Hurricane Michelle). By identifying these factors, it may be possible to better understand how governments respond to seasonal and inter-annual weather variability¹. Specifically this report identifies:

- 1) Recent experiences of severe tropical cyclones in the Cayman Islands;
- 2) Changes in the Cayman Islands’ Government in response to tropical cyclone risk;
- 3) Motivating factors for formal institutional change;
- 4) Lessons for adapting to climate change.

Many factors lead to institutional change and it is an almost impossible task to separate those factors that are driven by awareness of severe tropical cyclone risk, from those driven by other economic, social or environmental pressures. Many different domestic and international influences have affected the structure and direction of the Cayman Islands’ Government since 1988. External to the Cayman Islands there have been changes in international banking laws (Roberts, 1995), changes in international governance structures (Kersell, 1998), and a proliferation of international treaties. Within the Cayman Islands there have been numerous changes including: improvements to the Owen Roberts International Airport runway facilitating international travel and tourism; enhanced banking and trust regulation that have supported the steady development of the offshore financial industry. These factors, which have contributed to the economic development of the islands, have also had an indirect effect on the management of natural resources and resource management planning processes.

Society, economy and environment are highly interdependent in small islands, and the Cayman Islands are no exception. Rapid economic growth in the Cayman Islands in the

¹ This project is being undertaken as part of a larger project ‘Developing a Theory of Adaptive Capacity’, funded by the Tyndall Centre for Climate Change Research. The larger project will draw lessons learned from institutional and behavioural responses to climate change at different scales: the community level; the national government level; the regional level and the international level. Case studies will be undertaken at both the community and national level in two countries (the Cayman Islands and the UK), two regions (the Caribbean and the European Union).

1980's and 1990's created a number of unique social pressures. The population base has both shifted, with the percentage of Caymanian residents declining from 79% of the total population in 1979 to 53% in 2000, and expanded from 17,018 in 1979 to 41,800 in 2000 (Government of the Cayman Islands, 2000). The changing and expanding population has changed the demand for local environmental goods and services, for example increasing recreational demand for beach and coastal resources, and changing patterns of human interaction with the local environment, such as increasing rates of expatriate fishing activity. Other changes include developments in areas previously undeveloped, some developments now exist in areas known to be prone to flooding. Clearly there have been a range of economic, social and environmental pressures that the Cayman Islands' Government has had to manage over the past 15 years, many of these have created unexpected impacts both on the local environment, for example erosion on parts of Seven Mile Beach, and on the direction of development on the islands.

In order to understand what motivates formal institutional adaptation to tropical cyclone risk, insights were elicited from key individuals on the motivating factors for institutional change between 1987 and 2001. During June and July 2002, nineteen interviews were held with heads of departments in the Cayman Islands' Government to identify the factors that have enabled and constrained institutional adaptation within the government to seasonal and inter-annual weather variability, specifically to tropical cyclone threats. A copy of the interview protocol is attached as Annex I. The interviews were structured around five main areas:

1. access to information, the role of information in decision making processes and mechanisms for changing planning processes to take into account new information;
2. the flexibility of development planning processes and institutional and individual ability to respond to changing environmental conditions;
3. institutional lessons learned from responding to previous extreme weather events;
4. the role of local and international institutions in creating adaptive capacity;
5. perceptions of vulnerability to climate change.

Respondents represented the main areas of government. To preserve anonymity respondents have been grouped according to their general area of interest, these can be summarised as: promoting economic development; managing an aspect of social welfare; finding balance between conservation and development; allocation of natural resources; and conservation (see Table 1).

Table 1: Distribution of interviewees by departmental area of interest

Area of interest	Numbers interviewed
Economic development	6
Social welfare	6
Resource allocation or conservation	4
Conservation and development	3

Given the nearly equally distributed split between those respondents representing departments that focussed on economic development, social welfare and resource management, it was felt that a range of perceptions would be identified.

Where acceptable, interviews were recorded on cassette, the remainder were recorded in note form by the interviewer. All interviews were transcribed, and the transcriptions were sent back to the interviewees to confirm accuracy. Once the transcripts were approved the text was coded according to key themes that arose.

2. Recent experiences of severe tropical cyclones² in the Cayman Islands

During the Atlantic Hurricane Season, which runs from 1st June until 30th November, it has been estimated that between 1887 and 1987, one tropical cyclone³ passed within 100 miles of Grand Cayman every 2.7 years (Clark, 1988). Clark estimates, for the same time period, that tropical cyclones passing within 50 miles of Grand Cayman occurred every 4.3 years, and that a tropical cyclone passed directly over Grand Cayman every 12.5 years. More recent data (Minor and Murphy, 1999) suggest that 128 tropical cyclones passed within 250km (155 miles) of Grand Cayman between 1886 and 1996, creating an average return period of every 0.9 years, i.e. 1.2 tropical cyclones every year.

In terms of intensity, since 1969 there have only been three Category 5 tropical cyclones on the Saffir-Simpson scale (see Table 2) that have affected the Caribbean. The Cayman Islands have been affected by two of these: Hurricane⁴ Gilbert (8th – 20th September 1988), and Hurricane Mitch (22nd October - 5th November 1998). The Cayman Islands were also affected by a Category 4 storm: Hurricane Michelle (29th October – 6th November 2000).

Table 2: The Saffir-Simpson scale

Scale number	Central pressure (mb)	Windspeed (m s ⁻¹)	Surge (m)	Damage
1	> 980	33 – 42	1.2 – 1.6	Minimal
2	965-979	43 – 49	1.7 – 2.5	Moderate
3	945-964	50 – 58	2.6 – 3.8	Extensive
4	920-944	59 – 69	3.9 – 5.5	Extreme
5	< 920	> 69	> 5.5	Catastrophic

There are several environmental impacts associated with tropical cyclones notably strong winds, heavy rainfall and storm surge. Tropical cyclones can easily deposit around 250 mm of rainfall in a 12 hour period causing freshwater flooding (Smith, 2001), although storm surges often cause the most damage and problems for coastal populations, creating infrastructural damage and affecting coastal resources (beaches, reefs, fisheries etc..).

² Severe tropical cyclones are categorised as *tropical storms* when winds are at least 18 m s⁻¹, *hurricane-force tropical cyclones* when winds are at least 33 m s⁻¹, and *intense hurricane-force tropical cyclones* when winds exceed 50 m s⁻¹.

³ In this document the term 'tropical cyclone' is the generic name referring to tropical depressions, tropical storms and hurricanes.

⁴ The term hurricane refers to a tropical cyclone of specific intensity. The term 'hurricane' is commonly used in the Atlantic basin, other regions use the terms Typhoon and Cyclone to refer to the same phenomena.

Debate exists as to whether climate in the Caribbean is changing or if recent fluctuations are a result of a cyclical decadal pattern. Recent studies undertaken suggest that the between 1995 and 2000, tropical cyclone activity in the North Atlantic reached the highest level on reliable record (Goldenberg, et al., 2001). Others, such as (Elsner, et al., 1999; Landsea, et al., 1999) suggest that the increased activity is part of a decadal pattern. In terms of specific evidence of climate change, (Nurse, et al., 2001) review data that suggest that Caribbean islands have experienced an increase in temperature exceeding 0.5°C since 1900. Work is on-going to disaggregate these findings for individual countries. Further work will be required to determine the regional distribution of the impacts of this change and also the specific causes of the change. Despite speculation that climate change is a driving factor, there is little empirical evidence available to confirm this. Nonetheless, there is general agreement (see for example IPCC, 2001, and Nurse et al, 2001) that climate changes will create unique challenges for small island states in the future, through four potential changes.

1. Slow changes in mean conditions such as sea level, air temperature and precipitation rates;
2. Increased seasonal and inter-annual variability;
3. Increased frequency of extreme events;
4. Abrupt systems changes.

In short, uncertainty associated with the risks from climate change in the short term and the long term is likely to increase.

The intimate interconnectedness of economic growth and ecosystem health on small islands mean that high levels of uncertainty about wave direction and sea levels, precipitation rates, and storminess could have significant consequences for both the economy and the environment. Understanding how small islands respond to existing environmental risks can provide lessons for how to prepare for future risks associated with climate change. Hence the following section considers the response of the Cayman Islands' Government to tropical cyclone risk from 1988 to 2002.

3. Changes to the Cayman Islands' Government between 1988 and 2002 in response to tropical cyclone risk

Small islands with open, small, undiversified economies are extremely vulnerable to external economic shocks, see (Briguglio, 1995; Kakazu, 1994). The Cayman Islands, like most other small Caribbean islands, are highly import dependent. In 2000, the visible trade balance in the Cayman Islands reached CI\$-556.7 million, although this deficit position was offset through export of services, notably tourism and international finance. These two sectors provide the skeleton of the Cayman Islands economy, around which the muscle and tissue of the support industries, such as ground and air transport, construction, communications, retail, wholesale, and utilities, grow.

With active promotion by the Government of the Cayman Islands, the tourism industry has expanded substantially since the 1970's; visitor arrivals have increased from 22,900 air arrivals in 1970, to 406,600 air arrivals plus 1,030,900 cruiseship arrivals in 2000 (Government of the Cayman Islands, 2000). The tourism industry has been built on the strength of the Cayman Islands' natural environment, particularly the marine environment, as well as a good stock of high quality accommodation. The financial industry has been actively developed over the same time period. In 1972 there were 81

banking and trust licences⁵ issued in the Cayman Islands, by 2000, this number had risen to 580 (Government of the Cayman Islands 2000). Over the same time period new company registrations increased from 990 in 1972 to 12,693 in 2000 (Government of the Cayman Islands 2000). Underpinning this growth in the financial sector have been sound tax laws, proven confidentiality, good international communication facilities and other utilities, good international transport links, and more recently a willingness to adapt to new international financial diligence regulations, such as Mutual Legal Assistance with the United States (Coleman, 2002).

By 1998 the tourism and finance sectors together directly generated 11% of government revenue⁶ and 23% of Caymanian employment⁷ in the Cayman Islands (Government of the Cayman Islands, 2000). The Cayman Islands have become used to the flow of economic and social benefits associated with a strong domestic economy that has proved very resilient to the global economic fluctuations that have occurred over the past 20 years. Unfortunately the events following September 11th, 2001 in the USA have had significant negative impacts on both the tourism and finance industries and hence on the domestic economy. The pressure to maintain the high rates of economic growth experienced in the 1980's and 1990's are very apparent in the Cayman Islands. It is at this time that development strategies need to find a careful balance between the conservation of the natural resource base on which the well-being of the population and the future development of the tourism industry depends, and economic expansion required to meet the demands of an expectant population.

Clearly there are many driving factors behind institutional change, and it is often difficult to isolate which motivating factor leads to the development of policy. Nonetheless this section reviews how the institutions of the Cayman Islands' Government responded to tropical cyclone risk (which comprise: the rules and regulations; the organisational structure; and the behaviour of those working within the various agencies) since 1988.

3.1 External influences and internal laws and regulations

Not only did the Cayman Islands experience rapid economic growth between 1987 and 2001, but they also felt the impacts of the global trend towards international environmental treaties and conventions relating to environment and development. The Cayman Islands are now subject to a variety of international and regional agreements from the United Nations, the Caribbean, Europe, and the UK, see Box 1. While these in themselves have not contributed to the Cayman Islands' Government resilience, they form the background context within which domestic changes have been made.

⁵ These licences include "A" licences that permit the holder to undertake both local and overseas business; category "B" licences that permit the holder to undertake banking and trust business anywhere in the world except the Cayman Islands (i.e. offshore banks); Trust licences permit the holder to undertake local and overseas trust business; nominee (trust) licences permit the holder to act only as a nominee for its parent.

⁶ This only includes company fees, bank and trust licences, tourism accommodation taxes, travel and cruiseship tax. Taxes arising from import duty on goods imported to service the tourism sectors needs are not included, these are likely to be substantial.

⁷ This only includes those directly employed in banking, insurance, hotels and condos. The indirect employment benefits are likely to be much larger when support industries such as air and land transport, entertainment and watersports are included.

Box 1 Examples of international conventions relating to environment and development affecting the Cayman Islands

- United Nations Programme of Action from Rio (Agenda 21)
- Bonn Convention on the Conservation of Migratory Species of Wild Animals 1979; ratified 1985
- Global Convention on Biological Diversity 1992; ratified 1992
- Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region 1983; ratified 1986 (including the Protocol on Specially Protected Areas and Wildlife (SPA) 1990 soon to be ratified)
- Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES) 1973; ratified 1976
- IMO Conventions
- UN Framework Convention on Climate Change 1992 (including the Kyoto Protocol 1997 not yet ratified),
- UN Convention on the Law of the Sea 1982; ratified 1997
- Ramsar Convention on Wetlands of International Importance 1971; ratified 1979

The proliferation of international conventions, to which the Cayman Islands' Government is obligated through its association with the United Kingdom, has implications for aspects of the Cayman economy. For example the Convention on International Trade in Endangered Species (commonly known as CITES) has restricted the potential development of an export division of turtle products from the Cayman Turtle Farm. Other conventions have had less impact, notably the United Nations Framework Convention on Climate Change (UNFCCC) to which little attention has been paid until recently.

As a UK Overseas Territory there are a range of European laws to which the UK is signatory, and hence to which the Cayman Islands are obligated, see Box 2.

Box 2 Examples of European Laws affecting the UK and Overseas Territories

- **Wild Birds.** Council Directive 79/409/EEC of 2 April 1979 on the conservation of wild birds
- **Wild fauna and flora.** Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora
- **Environmental impact.** Council Directive 85/337/EEC of 27 June 1985 on the assessment of the effects of certain public and private projects on the environment
- **Environmental impact.** Directive 2001/42 /EC of European Parliament and of the Council of 27 June 2001 on the assessment of the effects of certain plans and programmes on the environment
- **Coastal management.** Council Recommendation of the European Parliament and of the Council of 30 May 2002 concerning implementation of Integrated Coastal Zone Management in Europe
- **Bathing water quality.** Council Directive 76/160/EEC of 8 December 1975 concerning the Quality of Bathing Water

The need to meet these European directives has become more important following the release of the UK White Paper on the UK Overseas Territories in 1999 (H. M.

Government, 1999). In that paper there is a greater insistence by the UK Government that the British Overseas Territories comply with both UK and European legislation, particularly in the areas of financial regulation and environmental protection. However, due to a lack of local enabling legislation the implications of some of these conventions have not yet been seen.

The same UK White Paper on the Overseas Territories and the Environment Charter, signed by the UK Government and the Cayman Islands' Minister of Environment on 26 September 2001, contains initiatives to which the Cayman Islands are bound. The White Paper addresses the increasing pressure on habitats and environments, in the Overseas Territories, from a number of changing environmental conditions (such as increasing sea surface temperatures, and rising sea levels). The Paper urges the introduction of local legislation and establishment of management bodies to enable the UN Framework Convention on Climate Change (UNFCCC). The Environment Charter, a document born out of the White Paper, outlines the responsibilities, common objectives and cooperative approaches of the UK Government, Cayman Islands' Government, private sector, NGOs and local communities in achieving sustainable development in the Territory. It contains many guiding principles, one of which is to identify environmental opportunities, costs and risks in all policies and strategies.

Within the Cayman Islands there are a range of laws and regulations that control and guide the different government departments; regulate development in the Cayman Islands; and direct how the country's natural resources should be managed. Many of these laws and regulations have an impact on the Cayman Islands' tropical cyclone preparedness. For example the Development and Planning Law, along with the Development and Planning Regulations, dictate where and how infrastructure and physical capital developments can be constructed. Until recently it has been the case that generous planning regulations have led to construction in physically vulnerable areas which has reduced the physical resilience of the islands. As Respondent 2 020705, noted

“There is a lot of construction on the coast. We need to make sure that the first floor of these buildings can be washed through by the sewage or whatever the storm brings in. We haven't got there yet but we have started looking at set backs and making buildings stronger.”

Overly restrictive planning regulations, on the other hand, are perceived by government officials to deter private sector investment in the islands, which could impact negatively on the local economy. Planning is one of the critical areas where finding the right balance is the key to building physical resilience in the islands. Many respondents noted that because the available land area for development is limited, there is pressure to maximise use of this land, specifically on the coast:

“The [West Bay] peninsula is only 3 km wide, people feel that a couple of hundred feet [set back] on the beach is a lot, whereas in the UK it's not so much. It has more impact on small places like this [Cayman].” Respondent 1, 020705.

It was recognised that there have been significant improvements in planning regulations in recent years, such as the enhancement of the building code since 1995. Although many respondents felt that these enhancements were the first steps towards more comprehensive planning regulations such as those used in south Florida.

“In parts of Florida and other States, you have to build your habitable level some number of feet above sea level, so that flood waters can wash through. You can have certain structures at ground level such as laundry areas, but for the most part the ground

floor should be open. Some structures below but most should be above.” Respondent 2, 020705.

Several respondents remarked that there have been advances in planning regulations in the Cayman Islands in the past 10 years, regarding the height at which buildings can be constructed and the stipulations for basements and sub-ground structures. Two respondents noted that there remains a need to implement adaptive and flexible planning regulations such as those that have been developed for Florida⁸ which is also subject to annual tropical cyclone risk.

“...we have to change our set backs back to the line of permanent vegetation, but the fact of the matter is that other countries have done this (Anguilla and Antigua use the line of permanent vegetation and they have these types of zones). In fact we used to do this. Florida I believe has actually changed over time. They have an adaptive process whereby they allow you to build in the 'line of coastal control'. You are allowed to build outside of this line of control so long as you use pilings, or use other techniques. In other places, if you have built outside of a line and your structure is destroyed, you are not allowed to rebuild.” Respondent 3, 020708

“Lee County in Florida have passed Disaster Legislation that sets out a planning process that requires that any building built too close to the water, in the event that it is destroyed, cannot be rebuilt there but there is a setback provision which requires them to rebuild more inland. I thought this was quite clever. It mitigates against a repeat phenomena. Generations to come will thank you.” Respondent 7, 020626

There are other laws which contribute to the resilience of the Cayman Islands to inter-annual and seasonal weather variability. Two important ones relate to the islands' ability to cope financially, notably the Public Management and Finance Law and the Emergency Powers Act. These laws provide the Governor with emergency powers, if needed, to arrange financing to cover existing assets or to divert loans for this purpose. The laws also direct how public financial resources should be allocated in the event of a crisis or emergency and ensure that there is adequate flexibility within the system to ensure that resources can be diverted to areas of greatest need.

In the area of conservation of natural resources, the Marine Conservation Law provides for the management of marine resources. The Petroleum Law, currently being revised, describes risk strategies to be adopted regarding the storage of fuel. There are also laws that describe how environmental crises should be managed and how economically disadvantaged people should be provided for, see the Public Health Law and Poor Persons Relief Law. The Water Authority Law makes provision for the Islands' water resources under different conditions. The National Trust for the Cayman Islands Law provides for the preservation of native flora and fauna by empowering the organisation to conserve lands, natural features and submarine areas of historical or environmental importance.

Not all respondents felt that these laws were adequate to generate more sustainable development and management practices in the Cayman Islands, several respondents noted that their departments were not actually named in any legislation making it difficult for them to enforce regulations or implement new charges or fees to change behaviour.

⁸ See Lee County, FL, Ordinances 95 -14, sections 4I2e (regarding re-zoning) and Section 8 (damage buildback policy).

Four important regulatory changes, either recently completed or in progress, were noted by several respondents as creating a better management environment in which to cope with seasonal and inter-annual weather variability, see Table 3, notably:

1. an enhanced Building Code in 1995/6
2. changes to the Development and Planning Regulations to increase waterfront set back in beach front areas in 2002.
3. modifications to the Petroleum Law to increase the focus on mitigating tropical cyclone risk (on-going).
4. the development and finalisation of a National Conservation Law (on-going).

The new Building Code, based on the South Florida Building Code, has increased construction standards to ensure new buildings are better designed to withstand tropical cyclones, the Code also requires greater site management by the Planning Department to ensure that construction follows the guidelines. The new Development and Planning Regulations have moved the point from where the set back is measured for waterfront property from the low water mark to the high water mark island-wide, and in the Hotel/Tourism zone the distance of the set back has been increased from 100 feet to 130 feet.

Table 3 Changes in laws and regulations relating to tropical cyclone impact management

Law/regulation	Change	Motivating factor	Effect
Building Code	Stricter requirement for new buildings	Internal review process and exposure	“The building code is now better. Our buildings are being designed to withstand hurricane winds of up to 130mph. Certain structures such as hospitals and shelters are being made to withstand winds of up to 150 mph.” Respondent 2, 020705
Development and Planning Regulations	Increased waterfront set back in beach front areas	Exposure to tropical cyclones and beach erosion and debate	“As a result of the current review we will see proposals that will require us to pay a bit more attention to hurricanes and indirectly to sea levels”. Respondent 2 020705
Petroleum Law	Mitigate environmental hazards	Exposure and review	“we will have an inspectorate like the Health and Safety Executive in the UK.” Respondent 5, 020704
National Conservation Law	Longer term planning for environmental management	Persuasion	“The law establishes a mechanism for creating protected areas and deals with the Environmental Trust Fund issue.” Respondent 14, 020629

New legislation such as the National Conservation Law is being developed and old legislation such as the Petroleum Law is being modified. These laws reflect the greater understanding of the threat that the Cayman Islands face from tropical cyclones,

although it should be noted that the threats themselves were not the motivating factor for changing the laws and regulations. In the case of the National Conservation Law, as well as providing greater direction for balancing conservation and development through the sustainable use of the Islands' resources, the new law will also enable international conventions such as SPAW, Ramsar and the Convention on Biodiversity, to be implemented locally.

Alongside these positive changes, it was noted by several respondents that there are no laws in the Cayman Islands that promote the precautionary principle, which some suggest is the appropriate decision rule to use when faced with environmental risks of uncertain magnitude or frequency. Several respondents expressed the view that the precautionary principle should be built more concretely into legislation through a risk management approach. One suggested:

“There needs to be statutory legislation that can be enforced, that ensures that there is a risk and hazard assessment before areas are developed. Laws that protect environmentally vulnerable areas are needed.” Respondent 11, 020710

Two respondents noted that when dealing with issues of potentially large but uncertain environmental impacts, risk management is another important concept to apply.

While the evolution and creation of new laws and regulations conceptually mark steps in the right direction, it is the implementation of the laws that is important. Without implementation, the laws by themselves are ineffective. Already regulators are facing challenges implementing the new set back regulations in those coastlines currently experiencing erosion. Some of these issues will be explored in the second and third phases of this 2 year study. Without strong commitment to enforce the new regulations, the concern is that regulators may be perceived as being ‘soft’ on implementation measures which may lead to ‘business as usual’ practices.

Supporting and guiding the laws, are several policy and planning documents. Most of these have been developed through processes of public or stakeholder consultation and with varying degrees of participation, including: National Hurricane Plan (since 1989); Vision 2008⁹; National Strategic Plan, 1999; The Development Plan (on-going); The Tourism Development Plan, 1992 and the Tourism Management Policy, 2003. An example of the change in importance of storm risk management can be seen in the inclusion of Strategy 15 in Visions 2008. Strategy 15 states:

“We will support comprehensive contingency planning for natural and man-made disasters and incidents to ensure the preservation of human life, protection of property and economic recovery of the country.” (Government of the Cayman Islands, 1999)

Strategy 15 actively incorporates contingency planning into standard development planning through the promotion of six key actions:

1. To establish a formal Emergency Management Agency to coordinate all emergency management;
2. To establish a National Disaster Fund for post-disaster recovery;
3. To create/modify legislation to support the prevention and mitigation of natural disasters;
4. To create/modify legislation to support the prevention and mitigation of man-made disasters;

⁹ Vision 2008 lays down some fundamental principles for development including: open and accountable government; infrastructural development plans; growth management objectives; disaster management; as well as objectives regarding planning for the environment, the economy and health of the population.

5. To implement a disaster management study;
 6. To prepare a comprehensive full disaster economic recovery plan.
- Although as with changes in legislation it is the degree to which policies such as these are adopted that will mark their success or failure.

The degree to which the different plans have been implemented to date is uncertain; although as Respondent 14 (020629) noted, the participatory process had left some participants frustrated as their input had been sought in the planning process, but little change had occurred. One respondent mentioned that after the Vision 2008 report had been produced, the office that had compiled the report was closed down, so there is no means of assessing the implementation of the plan, and no means of evaluating its success.

Clearly there has been a substantial growth in legislation and policy relating to environmental management in the Cayman Islands over the past 15 years. On-going external pressures from international, regional, and UK sources coupled with internal pressures¹⁰, appear to be guiding the Government of the Cayman Islands towards a better understanding of the need for more balanced development and conservation. Whether this increased awareness will be translated into action will be seen over time.

3.2 Organisational structure

There are many organisational adaptations that have occurred since 1988, some possibly prompting the regulatory changes described in section 3.1, others possibly responding to these changes, see Table 4.

Table 4 Organisational structure changes by the Cayman Islands' Government to tropical cyclone risk

Change implemented	Area	Type of change
Creation and expansion of the Department of the Environment	Environmental conservation	Formal recognition of the role of the environment in the development of the Cayman Islands.
Creation of the National Hurricane Committee	Disaster management	Awareness of the need to actively manage environmental disasters and the associated risks
Literature, media and education campaigns	Hurricane preparedness	External/ public awareness raising
Decentralisation of departmental insurance	Risk management	Internal/ government awareness raising of risk management issues
Investment in wind resistant glass at the airport; better tracking of visitors	Tourism development	Minimising potential losses from tropical cyclone impacts

¹⁰ For example, a National Environment Policy is being developed which stipulates the need to address climate change issues.

While the Cayman Islands' Government has produced a comprehensive tropical cyclone response plan since 1989, most respondents felt that the planning and preparedness of tropical cyclone risk has not been mainstreamed until recently. Now, the whole government is involved in some way preparing for the impacts of a tropical cyclone. Preceding this mainstreaming were a number of important organisational changes. One of the major changes has been the creation of a formal Department of Environment. Since 1988, the Department of Environment has evolved from the small conservation oriented Natural Resources Unit with 4 staff, to a department, integrated into the development planning process with 26 staff, and a prominent profile within the Ministry of Tourism, Environment, Development and Commerce. The awareness of the importance of environmental management issues in the Islands' development planning can be judged to some degree by the recent regular participation by the Department of Environment in governmental development planning, such as the Public Sector Investment Committee, Vision 2008, Wetlands Committee, Development Plan Review 2002, National Roads Advisory Committee, Tourism Re-Branding/Product Development Workshops; Steering Committee for the Aggregate & Fill CH2Mhill Consultancy, Aggregate Advisory Committee, Beach Review & Assessment Committee, and the Petroleum Storage & Handling Risk Management Committee. The importance of the Department of Environment in government decision making appears to have grown more rapidly than the supporting legislation. It is only now that the National Conservation Law, in the final stages of completion before it is tabled in the Legislative Assembly, defines the powers and duties of the Director of the Department of Environment, and in so doing to the Department itself.

An equally important development that took place between 1988 and 2002 was the development and mainstreaming of the National Hurricane Committee which is the central organising body for the Cayman Islands hurricane preparedness and response activities. The National Hurricane Committee (NHC) currently comprises 13 sub-committees and is chaired by the country's Chief Secretary (National Hurricane Committee, 1999). Starting with a small group of volunteer civil servants, the Committee now engages members of the public, private sector contractors, religious groups and NGO's as part of its activities to mainstream the concept of hurricane preparedness. It should be noted that there is no formal legislation establishing the National Hurricane Committee.

Clearly the expansion of these two agencies, Department of the Environment and the National Hurricane Committee, has been partly generated by, but has also reinforced, the growing awareness of the central role of the natural environment in the long term development of the Cayman Islands. The other organisational adaptations noted in Table 4 – the increase in media and education campaign, the decentralisation of departmental insurance and the investment in storm preparedness in the tourism sector – can all be seen to have emerged from the expansion of the two agencies.

Most respondents described these organisational changes either as a production of organic evolution or explicit planning. It is a difficult matter to separate out those activities that were planned from those that arose spontaneously as most respondents have different memories of the motivation for the changes. Whether planned or not, respondents were very clear about the factors they perceived to be in place to enable the organisational changes described in Table 4, these factors include: education and information about tropical cyclone risk; risk management practices; clear roles and

responsibilities; inclusion and integration across government departments. These are described in more detail in Box 3.

Box 3: Perceptions of the key elements in planning for storm risk management

Alertness/awareness of risk: “There is a constant state of alertness and preparedness for hurricanes.” Respondent 4, 020627

Clear roles and responsibilities: “Our role is to provide coordination and communication as necessary in the event of a natural disaster.” Respondent 7, 020626

Flexible decision making processes: “Coastal vulnerability mapping based on several factors, with the discretion built in for the decision makers is what is needed in planning for the future.” Respondent 3, 020708

Inclusion: “The NHC has been so successful because it has included all the different sectors and the civil servants. It doesn’t matter how good any individual is on their own success comes from working together.” Respondent 9, 020627

Integrated approach: “There is good structure, not just within this organisation, but it ties in with the overall national structure. The NHC takes over the running of the country in practical terms. Somehow we all tie into that network. Respondent 13, 020710

Learning based approach: The plan that you see today is a lot better than the one we had a one year ago, and the one from one year ago is better than the year before. We use our experience every year from actual events to make our plans better. Respondent 13, 020710

Preparedness exercises: “These people are very serious, they do an annual exercise - it showed last year, with the three hurricanes in a row, these people were doing their things day and night. Things were alright. I think given the circumstances they did an awfully good job.” Respondent 13, 020710

Risk management: “The risk management approach started in 1994 with an insurance and risk management study that identified our possible losses and what this might do for our image..... In response to this we set up a risk management advisory committee which advises EXCO on risk management.” Respondent 5, 020704

Support network: “We have a good organisation here so we have back up and we provide back up.” Respondent 7, 020626

While there have been substantial advances in the Cayman Islands’ organisational preparedness for tropical cyclones, there are still enhancements that could be made. For example a number of respondents noted that there were two important policy gaps requiring attention. One there is not enough investment in formalising disaster mitigation. Two, there is a lack of awareness of flood risk among construction contractors and the general public, see Table 5.

Several of the constraints in Table 5, notably, the line of permanent vegetation; building on flood prone land; and sub-standard rebuilding after storms by some, were thought to have arisen as a result of: a failure to utilise expertise from within various government departments; a lack of effective communication between government agencies; and political expediency in planning decisions. Irrespective of cause, the solution to these problems must include increased awareness among decision makers and developers about the possible costs of developing areas which are at high risk of exposure to a hazard (coastal or inland flooding), however this is achieved. As Respondent 14 commented:

“the private sector is not considering sea level rise when they are lobbying the government.” Respondent 14, 020629.

Awareness is often best dealt with by increasing the level of public information, and coupling that with clearer guidelines for developers about potential flood risk.

Table 5: Constraints to adaptive management of tropical cyclone risk

Issue	Perceived cause	Possible solution
Line of permanent vegetation	- Unwilling to move back line as perceived to be an encumbrance on foreign investors - Fear of compensation claims from landowners	Raise education and awareness, then change regulations
Building on flood prone land	- Unwilling to constrain foreign investors in economic growth activities - No hazard and risk assessment is required before areas are developed	Develop regulations requiring hazard and risk assessments as part of planning regulations
Rebuilding after storms	Loss of housing and sources of livelihoods in storms means rebuilding can be sub-standard due to rush	Develop planning regulations now to which people would have to comply when rebuilding
Disaster mitigation	The NHC is staffed by volunteers who are already busy and cannot also tackle disaster mitigation	Provide administrative assistance to National Hurricane Committee or establish a disaster mitigation unit
Management of storm waters	Issue affects many departments but none directly responsible	Acknowledge issue and allocate departmental responsibility

The lack of clear responsibility for management of storm waters might be better managed by placing this inter-departmental issue under the management of the existing inter-departmental National Hurricane Committee. Several respondents suggested that the remit of the National Hurricane Committee should be expanded to take into account other natural disasters to which the Cayman Islands might be exposed, as recommended in Vision 2008. Both of these changes would add to the heavy work burden of the committee. This problem could be eased by taking on permanent administrative support for the National Hurricane Committee.

Alternatively, specific hazards could be managed by specific agencies. For example, Public Works Department (PWD) currently looks at storm water management for new and existing road construction. Planning regulations require individual developments to take care of their own storm water, although this has generated some problems as there are no regional storm water management plans for the islands. In the absence of any other agency looking at the wider storm water management issues, PWD plans to develop regional storm water management plans for Grand Cayman.

3.3 Behavioural change/changes in practices

A common characteristic of small island governments is that they are resource-constrained both financially and in terms of human resources. This often leads to

government agents being required to multi-task, and a tendency to rely on small networks and volunteers. In the Cayman Islands this tendency can be seen in a positive light as it contributed to the development of the National Hurricane Committee and a strong committee ethic among civil servants. A clear benefit of developing such voluntary groups is the creation of social capital, a contested term that is often used to refer to the social networks and systems for support that we rely on outside of formal networks. The role of support networks is increasingly noted in the literature on building informal local level resilience to disasters, see for example (Berkes and Jolly, 2002) and (Paton, et al., 2001).

Many respondents attributed the increased effectiveness of the Cayman Islands' Government to tropical cyclone risk to behavioural changes that were encouraged by the National Hurricane Committee. When asked to consider what had led to the success of the National Hurricane Committee almost all respondents identified the same characteristics: the participation of committed volunteers; small group size; inclusivity across government departments; and a willingness to consider any approaches that might work. The role of a motivated leader (in the form of Mr Kirkland Nixon) was highlighted by most respondents as a central element in increasing the profile of the tropical cyclone risk issue in government and in engaging individuals across a wide range of departments. Clearly, in this case, the coincidence of exposure to the tropical cyclones that affected the Cayman Islands between 1988 and 2001, coupled with the persuasion of a respected committee contributed to the increased effectiveness of the Cayman Islands' Government response to storm risk.

In addition to the National Hurricane Committee, individual institutions within the Cayman Islands' Government are supported through their participation in other local, regional and international networks, see Table 6. These networks appear to be useful in providing information on tropical cyclone risk to many of the respondents. Respondents mentioned that the networks also proved useful in times of crisis and had been relied upon for support in the past.

Despite wide membership in these networks, it is the self-efficacy of the Cayman Islands people that seems to be an important feature in the changing behaviour of the Cayman Islands' Government. This self-reliance in the face of adversity has bred a spirit of resilience, whereby individuals are willing to work together in groups to maximise public well-being in times of crisis. As Respondent 7, 020627 notes:

“We have always worked on the belief that we are on our own. We have never relied on the possibility of help from outside. It has bred us into a self reliant little rock from day 1. So any outside relief would be an added bonus. I think this is a good thing.”

Behavioural change within the institutions of the Cayman Islands' Government has manifested itself in many ways, such as, participation and support of the National Hurricane Committee in its hurricane preparedness, willingness to engage in preparedness exercises, and willingness to develop individual departmental plans to mitigate tropical cyclone risk. Each of these activities takes individuals away from their other duties and responsibilities within their departments, but it is recognised that these activities now play an important role in development planning in the Cayman Islands. The change in perspective, which has led to the prioritisation of hurricane preparedness and response above all other priorities is a crucial change that has taken place, and

appears to be the main factor that has led to the enhanced adaptive capacity of the Cayman Islands' Government to tropical cyclone risk since 1988.

Table 6 Participation in local and international networks

Region	Area	Association/linkage
Local	Disaster funds collection	Catholic Church and National Hurricane Committee
Local	Health management	Baptist Hospital and Public Health
Local	Inter-island support	National Hurricane Committee
Local	Welfare	Cayman Islands' Red Cross links with British Red Cross and others
Regional	Coastal health	Members of CARICOMP (Caribbean Coastal and Marine Productivity Programme)
Regional	Emergency assistance	Other Caribbean islands will assist in an emergency (informal morally-based links)
Regional	Financial planning	Members of Caribbean Development Bank
Regional	Health management	Member of Caribbean Epidemiology Centre (CAREC) Trinidad. Participation in Caribbean Health Research Council
Regional	Regionalseas management	Part of the UNEP regional seas programme and Caribbean Shipping Management
Regional	Tourism planning and regional tropical cyclone assistance	Caribbean Hotel Association, Caribbean Tourism Organisation,
Regional	Water Management	Individual in Caribbean Water and Waste Water Association
International	Climate observation	Part of the Global Climate Observing System through CPACC ¹¹
International	Emergency assistance	UK Overseas Territorial rights to UK assistance
International	Health management	Arrangements in place with Pan American Health Organisation (PAHO) and World Health Organisation (WHO)
International	Infrastructural development	Members of American Public Works Association
International	Mosquito control	Professional mosquito control units in Florida
International	Planning	Professional members of Caribbean Planning Institute and American Planning Association
International	Port management	Members of the American Association of Port Authorities

Despite the success of the National Hurricane Committee and the wide participation by individuals and institutions in regional and international support networks, it was felt that there has been a changing attitude towards the environment, leading to irresponsible behaviour. Behavioural changes have not all been positive since Hurricane Gilbert. Some respondents noted that the economic pressures that have led to huge changes in the domestic economy appear to have created a rift between society and the natural environment in the Cayman Islands. This separation seems to have diminished

¹¹ UN funded programme: Caribbean Programme on Adapting to Climate Change, based in Barbados

awareness about resource scarcity, environmental stewardship for future generations, and the threats from environmental hazards (see Box 4).

Box 4. Changing perceptions about the resilience of the environment

Reduced awareness of resource scarcity: “There is a big difference in the mind set between now and when I was growing up, then the water came from a well or the rain, and you used to be pretty careful about your usage and how you used water. Now I can see my nieces and nephews whose attitude to water is that it is always here so we don't have to worry about it. That could be a challenge.” Respondent 3, 020708.

Human domination over the environment: “It's a curiosity here that you see the devastating effects of a hurricane on the islands (Cayman is just one) particularly on the coastal areas, and yet people constantly build in these vulnerable areas... Certainly in the coastal areas in the US, in the Carolinas, you'll have a hurricane which will destroy an entire coastal area and the next day people are out there with their surveyors trying to find land marks so that they can start rebuilding. There you see the interaction of nature and man -and you see who wins.” Respondent 7, 020626.

Forgetfulness about storm impacts: “After the last storm in 1988 we made steps to being more prepared, but then because 13 years lapsed we have become a bit complacent”. Respondent 8, 020626

The three examples described in Box 4 suggest that while the government institutions have expanded their capacity to respond to tropical cyclone risk, the behaviour of individuals within government, members of the public and the private sector has not changed substantially. The issue of forgetfulness about storm impacts was phrased in several ways: one respondent saw the general unwillingness to accept that the Cayman Islands might be at risk as it had “survived Gilbert with little damage” as an example of fear of facing up to the possibility of a catastrophic hit; another perceived that it might be “misplaced bravado”. This will be investigated in the next phase of this study, see footnote 1. In order to deal with the problem of declining public awareness of environmental stewardship, almost all respondents perceived that more environmental education is needed, through schools campaigns and wider education campaigns.

4. Motivating factors for change within the Cayman Islands' Government to tropical cyclone risk

Using a range of innovative approaches, notably a willingness to adopt a learning-by-doing approach, an adaptive management process, a high degree of self efficacy, and a reliance on informal networks, the Cayman Islands Government has transformed its approach to managing tropical cyclone risk over the past 15 years. Lessons can be learned from understanding what processes led to this change. The majority of respondents highlighted three critical phases in the evolution of the process:

1. growth in individual cognition and awareness;
2. emergence of collective action;
3. changes in institutional structure.

These three phases are each underpinned by different elements. The first phase, growth in individual cognition, which is critical for the entire process, appears to have developed as a result of two important criteria, persuasion and/or exposure to the environmental hazard. One or both of these two elements can raise the profile of an environmental hazard to the point where action is taken, as appears to have happened in the case of tropical cyclone risk in the Cayman Islands. It is therefore useful to explore the processes of persuasion and the exposure of the Cayman Islands to tropical cyclones to understand how the link was made between the environmental hazard and the impacts on the local economy, society and environment.

4.1 Persuasion

Persuasion, in this context, can take the form of command by the state, education, moral argument, the conviction of a strong leader, the motivation of a popular champion, or profile raising international conventions such as the United Nations Framework Convention on Climate Change annual conference of Parties, see (Young, 2002).

With regard to tropical cyclone risk in the Cayman Islands many respondents felt that persuasion had played an important role in focussing their response. Several noted the role of strong leadership of the NHC, and the diligence with which the original members of the NHC had established the committee and the hard work and effort they had invested which had motivated others to participate. Others highlighted the role of education in explaining participation in the NHC, and in motivating the Cayman Islands' Government to take tropical cyclone risk more seriously. There were also suggestions that morality played a part in enabling individuals to make the link between cause and effect.

A few suggested that command by the state had not played a significant role in the early stages of the development of the NHC, nor in raising awareness about tropical cyclone. As Respondent 3 noted:

“At present we have to rely on persuasion, there are really no laws dealing with this. We are trying to write something into the development plan that talks about precautionary attitudes. Whether or not that actually works, I don't know yet” Respondent 3, 020708.

This view was supported by Respondent 11:

“I suppose that education and awareness raising is the first step. Then when people look within themselves for direction, they will see that the proper way to go is to preserve the environment. Although at this stage laws are important....” Respondent 11, 020710.

No respondents mentioned any international organisations as playing a significant role in affecting the cognition of individuals in the Cayman Islands to tropical cyclone risk, although it should be remembered that individual members of the government are members of several international networks and information can filter through these routes.

Persuasion is just the first step towards changing institutions. As noted earlier, existing literature shows that first there needs to be individual cognition of the link between the cause of change and the impacts. Another means of enabling individuals to make this link is to experience exposure to the hazard, either directly or indirectly.

4.2 Exposure

(Arnell, et al., 1984) reveal how crises have raised the public consciousness of environmental hazards, such as flood risk in the UK. In their paper, Arnell et al suggest that the social or economic crisis created by environmental hazard can make the issue important politically, thereby motivating institutional change. The role of the Gilbert's, Mitch's and Michelle's in raising the public profile of tropical cyclone threats has not been underestimated in the Cayman Islands. Most respondents mentioned the importance of these previous tropical cyclones in raising and maintaining the high level of disaster preparedness within formal government institutions, see Box 5.

The last comment in Box 5 reveals that it is possible to learn from the exposure of other regions to environmental hazards. By supporting other nations that have experienced severe tropical cyclone impacts, the Cayman Islands have themselves learned indirectly about the potentially devastating impacts of tropical cyclone impacts and the need to be prepared.

Box 5 Raised awareness as a result of exposure to weather hazards by sector

Construction: "A lot of the new school buildings are being built to the South Florida Building code which took into account the hurricanes like Andrew which devastated Miami." Respondent 7, 020626

Development planning: "The Development Plan is reviewed at least once every five years. It was a coincidence that this current review is taking place after Michelle. However Michelle did raise awareness about the issues, particularly about the need for increased water front set backs." Respondent 2, 020705

Financial impacts: "The losses from Michelle were approximately \$40 million to the country, the claim for government is not yet settled, but the government losses could be in the region of \$16 million." Respondent 5, 020704

Health care: "Before 1987 we only had a general 2 page document about what the government would do in the event of a hurricane, not who would do what. In 1988 Gilbert hit, and we learned a lot of lessons about health services preparedness. For example, the health centres that are down in the districts, even before the hurricane season we have clearly identified which staff will be allocated to these centres, and what the centres should contain. That way ... we have a clear direction, this is better than before." Respondent 15, 020711

Infrastructural development: "One of the lessons learned came from our observation and assistance in helping the recovery in Honduras from the devastation of Hurricane Mitch. As a result we now have a heightened awareness of the possible impacts....That is why PWD commissioned a report on wind and wind borne debris." Respondent 5, 020704

Unlike persuasion, which can be used as the basis for planned adaptation, exposure to a hazard alone is not adequate to raise the profile of an issue. Exposure has to be coupled with deductive reasoning that links the exposure event to the impacts suffered, and this needs to be linked to potential future repeated events. While many people within the government have made this causal link, this deductive reasoning is not universal. Often short term economic development needs lead to maladaptive decisions, such as building in flood-prone areas, which compromises longer term sustainable development

objectives. One respondent pointed out that there are several examples where this link has not been made:

“After Hurricane Michelle the whole beach had disappeared. It’s a good example of beach erosion. There you see the interaction of nature and man and you see who wins. They have put up walls they have brought down scientists. They have put up groynes and artificial sea balls. It doesn't work, the sea simply keeps eroding..” Respondent 7, 020626.

If contractors, land developers and individual home builders cannot make the connection between their own activities (construction on an eroding shoreline) and the impacts experienced (beach erosion and coastal inundation) then education or top-down command could help them make that connection. Even with public education, some respondents felt that political decisions are sometimes made that ignore internal advice and that lead to a development, which may not adhere to planning guidelines or the overall direction of the Islands as set out in the planning documents mentioned earlier. It was felt that these decisions undermined the planning processes and made changes to planning regulations more complex. However it was recognised that political decisions are often made in difficult circumstances, for instance where there is little scientific information and decisions have to be made that are essentially subjective judgements about what is the best course of action, see the comment by Respondent 7 (020708)

“No one is saying that it is easy to be a politician and to go into the public arena and to say to people that we have to change our set backs back to the line of permanent vegetation.I think it is a matter of saying that this is our best judgement given the information and knowledge we have now we believe that this is the right and responsible thing to do and to make this decision. The longer we take to make this kind of decision the more difficult it becomes. We need to start acting now. It probably is going to cost us, but it could cost us a lot more if we don't do this.”

Even so, exposure coupled with persuasion can increase preparedness, but unexpected events still happen that can undermine the planning that has taken place. Comments were made about the major flooding that arose when a wave generated from Hurricane Michelle unexpectedly hit the Cayman Islands in 2001:

“They have tried to prepare the people and the government itself for hurricanes. Even so, Hurricane Michelle caught a lot of us by surprise by the devastation from a hurricane that passed by 200 miles away.” Respondent 10, 020627

It is recognised within the Cayman Islands and elsewhere that planning for environmental hazards can help minimise the impacts of those events that are expected.

4.3 Group action and institutional change

As noted earlier, the presence of individual cognition is just the first phase in the larger process of responding to an environmental hazard. The next phase involves individuals coming together to discuss the nature of the problem and to identify solutions. There is a substantial body of academic literature that suggests that group action or collective resource management often follows an environmental crisis, see for example (Olsson and Folke, 2001) who describe the evolution of a local fishing association as a response to a crisis in the local crayfish fishery in Lake Racken in Sweden. In situations such as Lake Racken, or the tropical cyclone hazard to the Cayman Islands in the 1980's, where there is little clear understanding of the science underlying the hazard, formal institutional management decisions are often avoided as it is difficult to determine what is the 'right' response. In these circumstances informal group action frequently emerges to fill the void left by inaction by the formal institutions. A lot of academic literature

exists which describes the conditions that are frequently found to be in place when there is successful group action. The conditions are:

- small group characteristics;
- a supportive external/policy environment;
- potentially equally distributed damages from non-participation in the group;

Most respondents revealed that all these factors were present in the informal group that coalesced in to the National Hurricane Committee. Changes are still underway in the Cayman Islands' Government response to tropical cyclone risk. It is clear however, that there has been a rise in levels of individual cognition and there has been a collective group response. This in turn has contributed to a variety of institutional changes: in the legislation that exists, in the organisational structures that operate and in the individual behaviour of the agents who operate within the departments.

What does this tell us about the ability of an institution to adapt to climate change? This three phase path: individual cognition leading to informal group action leading to formal institutional change offers us a route by which we can map out the processes of change through which institutions may need to pass to adapt to increased weather variability that can be expected with future climate change.

5. Adapting to climate change

Climate science tells us that globally the human race is emitting exponentially increasing levels of greenhouse gases, notably carbon dioxide (IPCC, 2001). The accumulation of this and other greenhouse gases (notably methane and nitrous oxide) has started to impact on the atmosphere, and this may be contributing to altered weather patterns globally. The specific impacts of climate change, resulting from the emission of greenhouse gases, are difficult to identify, and the debate continues about which changing patterns have arisen as a result of greenhouse gas emissions and which as a result of natural climatic cycles. Separating the changes that are a result of global as opposed to localised climate change adds to the confusion. There is frequent confusion among non-climate scientists about the difference between localised changes in the climate as a result of urban development and land clearance and global changes caused by emissions of greenhouse gasses. The World Meteorological Organisation states that localised warming tends to occur as a result of:

1. the use of modern building materials that change the thermal properties of the land surface,
2. increased urbanisation;
3. land clearance which reduces surface evapotranspiration and increases the amount of sunlight reflected back to space;
4. land clearance which also increases the speed of rainfall runoff which tends to produce drier and warmer climates (WMO, 2002b).

It should be noted that these changes are not linked to climate changes resulting from global warming.

Climate scientists now agree that global climate changes are exacerbated by human emission of greenhouse gases and that climate change is likely to generate visible impacts in the medium to long term, see (IPCC, 2001). Despite this agreement there is still enormous uncertainty about the timing and severity of climate change impacts. All that is known is that change will occur. On the basis of our existing knowledge, we can

assume that this means that climate change could generate a variety of impacts for small islands such as the Cayman Islands (see Box 6). Unfortunately, the specific impact of these potentially changed states on the Cayman Islands' environment, society and economy is unknown, and herein lies one of the profound difficulties in preparing for the impacts of climate change - the uncertainty.

Box 6 Small Island States: Adaptive Capacity, Vulnerability and Key Concerns

- Adaptive capacity of human systems is generally low in small island states, and vulnerability high; small island states are likely to be among the countries most seriously impacted by climate change.
- The projected sea-level rise of 5mm yr⁻¹ for the next 100 years would cause enhanced coastal erosion, loss of land and property, dislocation of people, increased risk from storm surges, reduced resilience of coastal ecosystems, saltwater intrusion into freshwater resources, and high resource costs to respond to and adapt to these changes (high confidence).
- Islands with very limited water supplies are highly vulnerable to the impacts of climate change on the water balance (high confidence).
- Coral reefs would be negatively affected by bleaching and by reduced calcification rates due to higher CO₂ levels (medium confidence); mangroves, sea grass beds and other coastal ecosystems and the associated biodiversity would be adversely affected by rising temperatures and accelerated sea-level rise (medium confidence).
- Declines in coastal ecosystems would negatively impact reef fish and threaten reef fisheries, those who earn their livelihoods from reef fisheries, and those who rely on the fisheries as a significant food source (medium confidence).
- Limited arable land and soil salinization makes agriculture of small island states, both for domestic food production and cash crop exports, highly vulnerable to climate change (high confidence);
- Tourism, an important source of income and foreign exchange for many islands, would face severe disruption from climate change and sea level rise (high confidence).

Source: IPCC (2001): 17

To begin to contemplate how we can manage some of the potential impacts and uncertainties associated with climate change we can divide potential climate impacts into four groups:

- 1) slow changes in mean conditions, such as a slow rise in mean temperature or sea level,
- 2) changes in inter-annual or seasonal variability;
- 3) increasing frequency of extreme events such as storms, precipitation events, droughts;
- 4) rapid or abrupt changes in environmental state, as might happen after melting of ice sheets.

Responding to the first two should enable countries to buffer impacts until such a time as mitigation technologies can slow the rising trends in temperatures and sea levels. Responding to the latter two may be more difficult due to the uncertainty surrounding what the new frequencies might be and what any new physical states might be. Nonetheless building resilience into economic, social and physical systems can only reduce the vulnerability of the islands to some changes. Any climate response would

ideally generate both adaptation and mitigation benefits, thereby increasing the islands' adaptive capacity and reducing the islands' contribution to greenhouse gas emissions.

The Cayman Islands can look to its current strengths and weaknesses in adapting to seasonal and inter-annual weather variability to identify ways in which it can become better prepared for climate changes. Tropical cyclones are of unknown size, severity, speed and timing, and like climate change it is difficult to predict exactly where or how badly a country will be affected, or where the impacts will be felt: socially, economically or ecologically. In terms of transferable lessons, by anticipating the arrival of tropical cyclones and preparing for possible impacts, the Government of the Cayman Islands can reduce its exposure to tropical cyclone threat. Similarly preparing for climate changes could reduce the vulnerability of the Government of the Cayman Islands to aspects of future weather risk.

This section explores the role of the three step process, i.e. deductive reasoning leading to group action leading to institutional change, for preparing for climate impacts. The one difference between tropical cyclone preparedness and climate impact preparedness is that science can not yet tell us categorically which weather changes being experienced are a result of climate change. Hence we cannot assume that being exposed to climate impacts will initiate a process of deductive reasoning by individuals, the private sector, or government. Instead planning for climate impacts, while the science is being developed must rely more heavily on persuasion.

5.1 Perceptions of vulnerability to climate change impacts

It is useful to consider for the climate change threat where in the process of deduction, action and change, the Government of the Cayman Islands is. It was clear that there is a lot of uncertainty about the science of climate change, the potential impacts, and the possible vulnerability of the islands to different impacts. Nonetheless there is some degree of awareness of the threat. Respondents were asked to note if they perceived any changes in the environment of the Cayman Islands that might be attributable to climate change. A few respondents related anecdotal evidence of their personal perceptions about the Cayman environment and climate, see Box 7, although few felt that any environmental changes were a result of climate change.

Box 7 Perceived changes in the Cayman Islands environment

Beach erosion: "Climate change will have a large impact on us. We are already seeing issues like increasing beach erosion, although we don't know whether this is related to sea level rise." Respondent 3, 020708

Changed growing seasons: "Our crop seasons are different now from how they used to be. People are noticing this. It might not be anything, we will see." Respondent 12, 020710

Changed rainfall patterns: "I think the rainfall pattern has changed, even if the amount of rainfall has not changed, the pattern of rain events has." Respondent 1, 020705

Many felt that the Cayman Islands could potentially be quite vulnerable to the specific hazards that might be posed by climate change (see Table 7). For example, many respondents were aware of the islands' vulnerability to sea level rise. Most respondents

recognised that vulnerability stemmed from either existing social causes such as poverty (contributing to sub-standard housing and the spread of disease), or from geographical factors. Most recognised that the geographically vulnerable were those who lived in the coastal zone or low lying flood-prone areas.

Table 7 Examples of individual’s awareness of the potential vulnerabilities of groups or areas within the Cayman Islands to climate impacts

Area of vulnerability	No.	Typical comment
Socially vulnerable (poor, elderly, disabled, sub-standard housing)	12	“The socio-economically vulnerable could be worst affected, through damage to sub-standard housing, risk of disease due to poor sanitation in flood conditions” Respondent 9, 020627
Coastal areas	9	“The areas around the coast are particularly vulnerable to sea level rise.” Respondent 8, 020626
Low lying areas	8	“Those in low lying or unsheltered areas face the greatest threat from sea level rise.” Respondent 11, 020710
Whole islands	6	“We are so small perhaps the whole island is likely to suffer.” Respondent 8, 020626
Livelihoods of tourism dependents	3	“People who depend on tourism could be impacted, that covers hotels, taxi drivers, restaurants, the whole lot...in fact don’t we all, to some degree, rely on tourism?” Respondent 3, 020708
Mosquito borne diseases	2	“Dengue and malaria are mosquito borne diseases that could spread with the spread of the vector”. Respondent 1, 020705

Most respondents believed that efforts should be made to reduce the vulnerability of those most likely to suffer the impacts of climate change, however there was also a feeling that those who deliberately made themselves vulnerable to the impacts should be penalised for their actions, particularly where their increased vulnerability caused problems for others who were more cautious. For example, there was widespread frustration at those who lived on the coast who re-built in the same vulnerable location after each storm as each re-build was financed by insurance companies who then increased insurance premiums for all Cayman Islands’ residents, including those who protected their properties or those who lived in less vulnerable locations.

“This cycle of build and bust has a devastating effect on society because the people whose places are destroyed are wealthy - the insurance pays them off and then they go back and rebuild. It means that homeowners who look after their properties and who build in storm protection measures find that their insurance goes up and up. This is happening here in Cayman now. People who build regular homes are now having to pay a high cost of insurance because of that 'don't care' attitude of wealthy people who want to live by the sea.” Respondent 7, 020626

This issue of deliberate exposure to climate impacts by certain groups is going to be a challenge for the government as compensation issues are likely to arise. Creating markets for hazard mitigation, encouraging risk-based insurance premiums and modifying Building Codes are all possible responses. Finding a means of making supported decisions where there are multiple interests, conflicting objectives and scientific uncertainties is a major task, however avoiding decision making because it is too difficult is likely to generate more costs in the longer term for the Cayman Islands. Managing climate risks is a challenge for all small island states as they are most likely

to be the first places to experience the changes associated with climate change. International cooperative agencies such as AOSIS (Alliance of Small Island States), or CPACC (the UN Caribbean Programme on Adapting to Climate Change) might offer guidance on best practice in these situations.

5.2 The role of information in persuading respondents about the hazards associated with climate impacts

Since exposure to climate impacts is unlikely to generate changes in behaviour, it is useful to think about the role of information in transforming behaviour. First it is necessary to gauge what information is available, how it is being communicated and the message that it is conveying. To understand the level of awareness and recognition of climate change management issues respondents were asked about their access to information about climate change. They were also asked to explain how this information informed their decision making processes. Many of those interviewed indicated that there was little information about climate change and its potential impacts available to them, see Box 8.

Box 8 Knowledge about climate change and its impacts

Bias from US media: “When you see the (American) news, it is like climate change isn’t happening. CNN is often taken as gospel, and the whole lack of awareness is a big issue here” Respondent 3, 020708

Climate change information is inadequate for decision makers: “Forecasting is very difficult. We follow hurricanes on an hourly basis but the forecast can still be off. So how good can forecasts be 10 or 100 years away?” Respondent 8, 020626

Climate information is difficult to communicate: “The problem is that meteorologists need to learn to communicate the science to the layman in a way that is easily understood. This is an uphill battle.” Respondent 11, 020710

Confusion over message from climate scientists: “..you hear that N. America is warming and then that it’s the coldest winter on record in the US. It’s really difficult when you put all these mixed messages together to know where we are going.” Respondent 8, 020626

Lack of information about climate change and its impacts: “We don’t have access to climate change information, and it is not being fed to us, so it’s not really affecting our planning decisions.” Respondent 2, 020705

No direction from government on how to respond: “There isn’t any formal channel of communication about the need to plan for climate change that is coming through the government.” Respondent 15, 020711

No proof that climate change is happening in Cayman: “For our department to take action on climate change we would need focussed scientific information. It seems that this information, on the effects of climate change, specific to the Cayman Islands doesn’t exist” Respondent 17, 020705

No proof that climate change is happening globally: “The news coming out of the US is that this isn’t an urgent issue, so I can’t pretend that I have followed this.....if pressed I could not state categorically that climate change is happening” Respondent 1, 020705

Respondents reflected that there is inadequate information available about the global consequences of climate change as well as the localised impacts in the Cayman Islands. Several of those who did have access to information about climate change expressed confusion about the mixed messages that they were receiving. Respondents commented that scientists did not seem to agree that climate change was happening, or what the likely impacts might be. Further confusion arose in the understanding of the apparently conflicting information being presented about the impacts of climate change. Some felt that a lack of clear information should not be a barrier to decision making, and that approaches such as the precautionary principle could be adopted in the absence of scientific certainty.

A few respondents perceived there is adequate information, which is disseminated through professional bodies and organisations to which they belonged or were affiliated (including: the Caribbean Tourism Organisation, Caribbean Meteorological Organisation; World Meteorological Organisation, the Caribbean Programme on Adapting to Climate Change). These respondents felt that there was clear information about climate change and its potential impacts.

The broader consensus among respondents is that there are mixed messages coming out from the scientific community which is causing confusion among those who do not work in the climate change field. This might be one of the reasons why climate information is not being used successfully.

5.3 Perceptions of priority of climate change

In light of the perceived problems associated with climate change information in the Cayman Islands, there was little recognition of the need to implement immediate policy response measures. As noted in section 5.1, there was some degree of disbelief that the environmental changes occurring in the Cayman Islands were climate related or that future climate changes would affect the Cayman Islands. This might be partly attributable to the lack of clear consistent information about climate change (see Box 8 Knowledge about climate change and its impacts); although, other explanations for this perception are provided in Box 9.

The low prioritisation of climate change issues appears to have arisen as a result of a denial of the potential risk from climate change and a perception of high resilience to climate factors. A range of reasons were given by respondents to explain why, despite their awareness of the potential impacts, their departments were not thinking seriously about climate threats. Some of the departmental inaction can be explained by a fear of maladaptation. Several respondents expressed the concern that there are only limited resources available to spend on government activities and unless more is known about the potential impacts then finite resources could be wasted.

Box 9 Importance of climate issues in policy development

Cayman is resilient: “if there were hurricanes passing through, giving 10ft storm surge, with a 15-20 foot wave top, then sea level rise of 8 – 30 cm might not make much difference and we wouldn’t need to change planning on that basis.” Respondent 17, 020705

“in Calcutta, there the temperature reaches 120°F, so an increase here from 97°F to 100°F doesn’t really make much difference.” Respondent 15, 020711

“Sea level rise isn’t really an issue in Cayman Brac in the near future due to its elevation.” Respondent 18, 020625

Climate change not happening: “The big question is whether we are in a cycle or whether we are going through a specific global phenomenon. I think it will take some time to see.” Respondent 7, 020626

Inadequate information: “There’s just not enough information, so other worries take precedence, like paying the mortgage rather than whether the sea level is going up or down” Respondent 1, 020705

No evidence: “If a link (between hurricanes and climate change) was proved then the Caribbean would immediately be interested as a lot of thought goes into preparation and mitigation for hurricanes.” Respondent 7, 020626

No role: “For climate change there is nothing that the government can do.” Respondent 1, 020705

Not thought about it: “We can see the impacts of changing weather patterns here – whether they are related to climate change or not – I don’t know. We just haven’t done much with this knowledge yet.” Respondent 6, 020708

Other priorities: “Right now we have our hands full with other issues, it wouldn’t be fair to us, or the islands, if we invested time and resources in a bunch of other things.” Respondent 2, 020705

“In all fairness, we haven’t really thought about it. As we haven’t thought about it you could almost say that we haven’t seen it as a priority at this stage in the game.” Respondent 13, 020710

Potential for maladaptation: “We are dealing with infrastructural issues, and it takes a lot of work, especially the roads and the schools. Government expenditure is needed to improve these and we have a lot of pressure today. Without clear advice it would be difficult to get climate issues prioritised...so how long do we spend thinking about climate issues? The answer is none.” Respondent 17, 020705

Social amplification of risk: “We should also be careful not to over-sell the impacts of climate change as our country’s finances are already stretched, and make climate change appear to be a priority when it is not may lead to a misuse of funds. We need to be careful to balance our investment in climate change preparation with other important issues.” Respondent 9, 020627

5.4 Responsibility for managing climate impacts

Respondents were asked who should be responsible for the management of climate change issues and what actions could be taken in anticipation of climate impacts. The discussions revealed a clear lack of consensus however about who should take the lead in responding to climate change, see Box 10, and what should be done.

Box 10 Perceptions of responsibility to take climate change issues forward

Government department: “Management of impacts should be a joint effort but a single responsible agency needs to take it forward. It could be either Planning or Department of Environment, it could even be the National Hurricane Committee, but there should be a point person.” Respondent 2, 020705

Industry: “Industry does lead policy development in this country, and the private sector is not considering sea level rise when it is lobbying the government.” Respondent 14, 020629

Individuals: “When people look within themselves they will see that the proper way to go is to preserve the environment.” Respondent 11, 020710

Inter-departmental agency: “It’s up to the government to take the initiative on climate change and perhaps get other organisations to take climate change seriously.” Respondent 8, 020626
“We need one concise report on how climate change and climate variability will affect the Cayman Islands. I would recommend that a government body is set up to coordinate this. The Department of Environment could coordinate. Individual agents won’t do this themselves.” Respondent 17, 020705

NGOs “Perhaps an advocacy group such as the National Trust, or another environmental advocacy group may need to play a primary rather than a secondary role in preparing for climate issues, and not shift the responsibility on to Government.” Respondent 9, 020627

Political leaders: “We may want to start with the politicians.” Respondent 11, 020710

This range of suggestions highlights the institutional policy gap that currently exists; there is no clearly defined agency responsible to take the climate change agenda forward. As the climate change issue is so new there are relatively few sources to turn to for advice on developing an adaptation strategy, however there are some sources. At the international level for example, the United Nations Development Programme is in the process of the developing an Adaptation Policy Framework which advises on how to plan for adaptation. Lessons can also be drawn from other country governments or from some of the regional programmes that have been established to take the climate change adaptation agenda forward.

In the UK for example, the government has invested in several different initiatives to address this question of responsibility for managing impacts. Should it be the private sector, the government or individuals who take responsibility for adapting to climate change impacts that have been caused by individual behaviour? Some of the UK initiatives include:

- the creation of the UK Climate Impacts Programme (UKCIP) to raise the profile of the climate change issue and provide support to members of the public and the private sector who want to start responding to climate impacts,

- profile raising activities within government, by the Global Atmosphere's Division, within the Department for Environment, Food and Rural Affairs,
- investment in scientific climate change research in the Hadley Centre (the UK Met Office).

There are other initiatives however those mentioned above provide an idea of the range of initiatives the UK government is attempting, and some of the groups the government is trying to engage.

Box 11 Actions to take the climate agenda forward in the Cayman Islands

External intervention: “We are starting from the premise that no one knows anything. I am in the middle, neither an economist nor a climate scientist, just an environmental manager trying to get the point across, I am not speaking from any level of expertise, so it is difficult to get any credibility when talking about this issue. This is why I think we need outside intervention to raise awareness.” Respondent 3, 020708

Impact information: “Some concise information, coordinated through a government department, on what we are planning for.” Respondent 17, 020705

Include climate scientists in decision making: “.the climate scientists should be involved (they are the ones who understand intimately what is going on. A problem with a lot of the climate research is that it has been moved out of the scientific arena, and a lot of governments are taking on how to respond in agencies separate from the met services in their countries.” Respondent 11, 020710

Industry/government partnership: “Government will have to lead by example and put money aside, and to prove that it will keep the money aside for rebuilding if it is needed. If the private sector feels the money will be spent on other things they won't contribute.” Respondent 2, 020705

Longer term planning: “The idea that we are only dealing with today and tomorrow be damned has got to stop.” Respondent 3, 020708

Public education/ raising awareness:

“What we need is education and respect for the environment...that acts as a buffer against bad weather. We have campaigns in school and we try and fund nature related tourism projects.....things like this keep people's eye on the ball with respect to the environment. It reminds them that people will travel here to see nature and that's why we should pay attention.” Respondent 6, 020708

“Because climate change has socio-economic impacts, it has ...implications for sustainable development. This issue is much larger than most people are aware. That is why we need education. Education and awareness raising are the first steps.” Respondent 11, 020710

“We are trying to raise public awareness about the risk of hurricanes at the moment. In addition to the TV and newspaper we produce the National Hurricane Handbook annually....we could do more but resources are limited.” Respondent 7, 020626

Political consensus: “People are sceptical because of the US's position versus the European position. Until there is consensus we won't be able to get the heads of Department to direct resources to solve these issues.” Respondent 17, 020705

At the regional level there are two main adaptation projects that are funded by the United Nations, which can offer insight on how to manage climate impacts in small

islands. There is the Caribbean Programme on Adapting to Climate Change (CPACC) and the Pacific Islands Climate Change Adaptation Programme (PICCAP). CPACC promotes a more top-down science-oriented approach, whereas PICCAP focuses on reducing the vulnerability of the islands' populations, through social, economic and technological solution. Whichever approach is chosen, the Cayman Islands' Government can learn from these other programmes, however any approach will need to be modified to take into account local conditions and issues.

Usually successful management approaches are identified within institutions that operate within the local social and cultural context, rather than being externally imposed. For this reason, respondents' suggestions about how the Cayman Islands' Government could take the climate agenda forward are of particular interest, see Box 11.

Respondents suggested that legislation should be modified to build in climate change risk, particularly to: mitigate against specific climate impacts such as sea level rise; modify laws for construction of roads and buildings to increase their ability to withstand every day weather; create a Disaster Fund for relief in situations of extreme weather; increase the minimum elevation for developments on reclaimed land to prevent future flooding; and develop a national energy policy. It should be noted that many of these suggestions can also be found in Vision 2008, the government's policy planning document. Most of the respondents' suggestions relate to raising the profile of the climate change issue, for example by creating an inclusive network that is driven by scientific understanding of the climate change issue. Although longer term suggestions were made, such as developing new regulations or organisational structures to manage potential problems.

5.5 The causal link between climate changes and local impacts

It is clear that there are many ways to tackle the climate change problem and that there are many different agencies who could take responsibility for the management of the Cayman Islands' response. However, it seems from the lessons that can be learned from the Cayman Islands' response to tropical cyclone risk that the most important step is beginning the process of deductive reasoning to make the causal link between climate changes and potential impacts on the Cayman Islands.

One respondent suggested that it might be necessary to raise awareness about complex technical issues such as climate change, where no in-house expertise exists, through the use of external intervention. Without such intervention the issue could potentially be ignored. Perhaps in this instance, dissemination of information about the developments of the UNFCCC and other international conventions might be a useful means of raising the profile of the issue.

Not everyone was positive about the role of persuasion. It was felt that, in some societies, persuasion could not fundamentally change social conventions or patterns of behaviour, particularly in countries where the change required would be considered extreme:

“...how will they (the US administration) persuade the energy and fuel lobby that they will have to make less money? Then you will have to persuade Americans that they will have to change their lifestyles and drive less. I just don't see it happening. In the meantime we are drilling for oil in Alaska.” Respondent 1, 020705

Planned adaptation involves reducing the vulnerability of the Cayman Islands to such events. A central concept in planning how to respond to climate change therefore requires finding a balance between investing now to reduce vulnerability to potential impacts and wisely allocating limited resources to enable both short term and long term development to continue. This is a challenge for the Cayman Islands' Government. Options that increase the resilience of the Cayman Islands' environment and society without requiring large investments that could be maladaptive are clearly preferred.

6. The way forward

The science of climate change is shrouded in uncertainty. It is recognised with high levels of certainty that climate change is happening; average temperatures are rising and human activities have contributed to this change. There is less certainty given to the interpretation of what the impacts of these increasing temperatures might be, and less still to the global distribution of these impacts. Knowing that climate change is happening, but without really understanding the implications makes responding to these threats extremely difficult.

Uncertainty about the type, distribution and size of impacts characterises the decision problem for all environmental hazards, including tropical cyclones and climate change. There is little information available about how often or how intensely small islands will be hit by tropical cyclones; the processes of beach erosion and deposition are not fully understood; the impacts of land based sources of pollution on the marine environment are not absolutely certain, although science can guide us in terms of what we might generally expect. Yet in these circumstances of uncertainty it is possible to minimise the potential threats from exposure to these hazards by adopting risk management or disaster management strategies. In this regard, climate change is no different to any other environmental hazard. The answer seems to lie in reducing society's economic, social and physical vulnerability to other pressures, thereby building resilience to other environmental perturbations.

Vulnerability reduction can be undertaken spontaneously by the private sector, or individuals or it can be guided by government. Spontaneous adaptation tends not to happen in the private sector unless it is the most economically efficient course of action, and individual adaptation tends not to happen in anticipation of impacts, adaptation tends to be reactionary. Science can not yet determine whether it is more cost-effective to adapt to climate impacts now, or to wait and react to the impacts in the future as it is disputed whether or not cost-benefit analysis is methodologically adequate to evaluate adaptation options due to the uncertainty of impacts (Tol, 2003). Hence we are forced to make a decision about climate risk without the safety net of cost-benefit analysis to guide us. This need not be an onerous task as there are other decision rules (such as the precautionary principle, safe minimum standards, weak sustainability criteria) and decision support tools (such as multi-criteria decision analysis, risk assessment) that can be applied to assist with this type of decision making, in anticipation of climate impacts.

The role of the government can be to encourage or support adaptive behaviour by individual members of society and by the private sector. Hence it can shape the decision environment, notably the laws and regulations of the country, the structure of the government organisation and the behavioural norms of the civil servants. Many

lessons can be learned as a result of the success of the Cayman Islands' Government in responding to tropical cyclones. The first lesson is that there appear to be three conditions that lead to government change in response to an existing environmental hazard. These factors are:

- the role of persuasion and exposure in developing a causal link between the environmental hazard and the impacts;
- the role of collective group action
- the creation of new institutional forms to manage the risk.

In terms of preparing for climate change, the first step is to raise awareness in the country about the risks faced and to lead by example in responding to those risks. Before this process can begin there has to be an acceptance that climate change is an issue that requires the investment of thought and resources. In terms of changing individual beliefs about climate change what can the government do? We suggest that it is important to:

1. compile clear and concise information on what is known about climate change, including information on where there are uncertainties associated with the science. Dispel myths about what weather changes can and cannot be attributed to global climate change;
2. compile clear and concise information on what is known about the potential impacts of climate change on small islands in the Caribbean, recognising that no specific information for the Cayman Islands exists;
3. integrate weather and climate information into physical planning processes to create robust infrastructure to mitigate future impacts;
4. subdivide the potential threats faced into individual environmental hazards that will affect specific groups within the population and evaluate response strategies for each hazard on each group separately;
5. engage in education and awareness raising activities for all parts of society on how to manage current and future environmental risk, through government training, school curricular, and public information programmes;
6. direct development, planning and conservation agencies to focus on building resilience into managed natural systems when investing in new projects (e.g. dykes, beaches, cleared land, coral reefs, etc..) with the explicit objective of reducing vulnerability to climate change impacts;
7. encourage government policy to target the reduction of social and economic vulnerability to development planning with the explicit objective of reducing vulnerability to climate change impacts;
8. prepare for current and future weather variability through the use of hazard assessment, vulnerability analysis, risk assessment and disaster management approaches in all areas of government planning and policy making;

Tackling the first point may be easier than expected. Literature on the science of climate change, the state of scientific knowledge, and the potential impacts on small islands already exists within the Government, or on the Internet. Most information is concentrated in the Meteorological Office, which has access to a number of up to date World Meteorological Organisation's publications relating to climate change (WMO, 2002a; b; c). Undertaking a systematic review of the literature that exists within the different departments may provide one means by which the different departments can pool their knowledge and support each other rather than having to spend resources bringing in external assistance.

The job of the Government of the Cayman Islands is to consider the risks it faces, to identify potential problem areas, to then propose and test solutions. These solutions can then be re-evaluated and changed or refined on the basis of the evaluation and then re-tested. Through this process the formal government institutions can prepare for the potential hazards. This form of management, known as adaptive management, has proven useful in other regions for managing uncertain environmental conditions, such as dynamic coastal zones. Enabling adaptive management to occur in formal institutions which are often noted for their rigid organisational structures and defining rules and regulations is a difficult process, but it is proposed that this process can be facilitated through the application of the UNDP Adaptation Policy Framework, a copy of one of the draft technical papers is attached, see (Adger, et al., 2003). This framework promotes a 5 step process:

1. What are the major hazards?
2. What are the major impacts/outcomes of these hazards?
3. What determines the type and severity of the impacts/outcomes?
4. What measures will reduce the impacts and improve the outcomes?
5. Can these adaptation measures be undertaken? If not why not?

Once achieved, how should the government institution change to ensure that it continues to respond adequately to the environmental hazard? The evolution of the National Hurricane Committee and the supporting agencies provides insight. To remain useful, supportive and responsive any agency with the remit to respond to uncertain environmental hazards must be adaptive. Existing literature in this area supports the notion of integrated and inclusive approaches that are learning based. This suggests that the agency which receives the remit to manage adapting to climate change might try to operate as:

- a learning based institution that is flexible enough to change based on new information or learning;
- inclusive of a wide range of people and groups, although recognising that there are costs associated with widespread inclusion;
- an integrated agency across government departments and institutions.

The limited information currently available and the uncertainty associated with it means that the agency charged with managing climate change preparedness activity will have to expend energy to constantly update its knowledge and potentially change its direction and advice. Thus the agency could benefit from operating as a 'learning system', i.e. by recognising in advance that it will make 'mistakes', the agency needs to be willing to learn from these mistakes and update its procedures and response capacity iteratively. A good example of a 'learning system' is the National Hurricane Committee which evaluates its successes and failures each year after the hurricane preparedness exercise to try and enhance its performance the following year.

Any institution that emerges from informal group action to meet the climate change challenge could benefit from bringing together of a wide range of participants, such as most government departments, the private sector and the public. Integration across a wide range of people and groups in a learning based institution may be an important goal, both to raise awareness and to garner support for decisions. Although since large groups can be difficult to manage, and can be costly to organise, integration does not necessarily mean large committee meetings. Other approaches include information dissemination, intermittent participation, use of public discussion fora, citizens juries. Again the National Hurricane Committee can provide guidance, as it is inclusive across

different levels of government bringing in the most senior and the most junior. The agency that responds to climate change could consider adopting this type of approach

None of these suggestions are new or novel, most have already been proposed in the Government's Vision 2008. The changes proposed above would merely require active incorporation of climate risk into the various strategies developed in Vision 2008 (Government of the Cayman Islands, 1999). For example, Strategy 10 proposes 'to develop and implement a growth management plan to achieve and maintain a balance between the natural and built environment'; Strategy 11, states that the Government will 'protect our natural environment, particularly the Central mangrove and other wetlands, the North Sound and coral reefs, from further degradation'; Strategy 15 promotes 'comprehensive contingency planning for natural and man-made disasters and incidents to ensure the preservation of human life, protection of property and economic recovery of the country'. Each of these strategies, if implemented would be steps in the right direction to begin climate change preparedness.

This report is intended to provide guidance to enable the Government of the Cayman Islands to begin to consider increasing the general coping capacity of the Cayman Islands to all types of environmental hazards. The approaches proposed herein may also contribute to the longer term sustainable development of the islands by ensuring that adaptation to environmental hazards (whatever the cause) is factored into the development process in the form of risk assessments of all future developments. Planning for climate change in this way, rather than diverting limited resources away from urgent priorities would in fact contribute to the attainment of some stated goals, such as sustainable development and contingency planning, which are already being promoted in planning documents, such as Vision 2008.

Annex 1: Interview protocol for Government of the Cayman Islands interviews

Questions posed by Emma L. Tompkins to health services, environment, environmental health, public health, medical services, planning, national hurricane committee, finance, social services, Port Authority, Water Authority, Civil Aviation Authority, tourism, meteorology, risk management, fire service, national hurricane committee, CDB, district administration, public works.

General questions:

Role of interviewee in institution

Which groups or individuals are the focus of your agency's work?

What are your sources of information about climate change and climate variability?

Specific questions:

1. Has your agency started thinking about the climate change/global warming/sea level rise/climate variability on the Cayman Islands and the risks and opportunities they may bring?
2. Do you think that climate change and climate variability are important issues that the Cayman Islands' Government should prioritise? Or should other issues take priority in government planning?
3. How could the impacts from climate change and climate variability affect your agency or the area in which you work? Will climate change and climate variability affect the way that your agency operates in the future?
4. Does your agency have to think about responding to climate or weather impacts in its every day business?
5. How were you or the people you look after affected by previous extreme weather events such as hurricanes Mitch and Michelle, or weather related events such as droughts or floods? What lessons were learned?
6. How much of your time and resources do you currently allocate to thinking about/preparing for the impacts of a changing climate or weather patterns?
7. In what ways do you think that your agency could better manage or respond to the threats and impacts of variable or extreme weather?
8. What resources do you have (money, people, technology) available to feed the knowledge about variable or extreme weather into your planning?

9. In the event of variable or extreme weather who do you rely on to support you and your clients?
10. Are there specific laws or regulations on which your agency relies to enable it to make management decisions or implement actions in the face of uncertain future weather patterns and extreme events?
11. What do you think are the strengths and weaknesses of each of these laws and regulations in terms of how they provide opportunities or constraints to you and your agency's ability to respond to the impacts of climate change and climate variability?
12. How could these laws and regulations be changed to enable you to better plan for or make better decisions in the face of weather-related threats?
13. Are there regional or international agencies or networks on whom you or your agency relies to provide you with support in the event of extreme weather events of slow changes? E.g. IMF, CARICOM, AOSIS....
14. Are there any regional or international initiatives that constrain you or the actions that you would like to take to better prepare for climate change and climate variability? Are there any initiatives that are providing you with new opportunities?
15. Which groups or organisations do you think are the most likely to suffer the consequences of climate change and climate variability?
16. Who do you think needs the most urgent attention to reduce the impacts that they might feel from climate change?
17. How do you think that the Cayman Islands Government can best respond to climate change? (Timing, cost etc..)
18. How can your department best respond?

References

- Adger, W. N., Khan, S. R. and Brooks, N. (2003) Technical Paper 7. Measuring and Enhancing Adaptive Capacity. In **AN ADAPTATION POLICY FRAMEWORK: Capacity Building for Stage II Adaptation**, eds B. Lim, I. Burton and S. Huq, National Communications Support Programme, Global Environment Facility, Geneva, Switzerland.
- Arnell, N. W., M.J.Clark and Gurnell, A. M. (1984) Flood insurance and extreme events: the role of crisis in prompting changes in British institutional response to flood hazard. **Applied Geography**, 4, 167-181.
- Berkes, F. and Jolly, D. (2002) Adapting to climate change: Social-ecological resilience in a Canadian Western Arctic community. **Conservation Ecology**, 5, 2, U514-U532.
- Briguglio, L. (1995) Small Island Developing States and their Economic Vulnerability. **World Development**, 23, 9, 1615-1632.
- Clark, R. R. (1988) **Investigation of Erosion Conditions on the Seven Mile Beach, Grand Cayman**. Florida Department of Natural Resources, Division of Beaches and Shores., Tallahassee, FL.
- Elsner, J. B., Kara, A. B. and Owens, M. A. (1999) Fluctuations in North Atlantic hurricane frequency. **Journal of Climate**, 12, 2, 427-437.
- Goldenberg, S. B., Landsea, C. W., Mestas-Nunez, A. M. and Gray, W. M. (2001) The recent increase in Atlantic hurricane activity: Causes and implications. **Science**, 293, 5529, 474-479.
- Government of the Cayman Islands (1999) **The Cayman Islands' National Strategic Plan 1999-2008. Vision 2008**. Vision 2008 project team, Government of the Cayman Islands, George Town, Grand Cayman.
- Government of the Cayman Islands (2000) **2000 Cayman Islands Compendium of Statistics**. Statistics Office, Government of the Cayman Islands, George Town, Grand Cayman.
- H. M. Government (1999) **Partnership for Progress and Prosperity: Britain and Overseas Territories**. Secretary of State for Foreign and Commonwealth Affairs, Department for International Development (DfID), H.M. Government, London.
- IPCC (2001) **Climate Change 2001: The Scientific Basis. Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change**. Cambridge University Press, Cambridge, UK and New York, USA.
- Kakazu, H. (1994) **Sustainable Development of Small Island Economies**, Westview Press Inc., Boulder.

- Kersell, J. E. (1998) Small can be smart - and smooth: the Cayman Islands' relations abroad and effects at home. **Public Administration and Development**, 18, 2, 141-149.
- Landsea, C. W., Pielke, R. A., Mestas-Nunez, A. and Knaff, J. A. (1999) Atlantic basin hurricanes: Indices of climatic changes. **Climatic Change**, 42, 1, 89-129.
- Minor, J. E. and Murphy, P. (1999) **The Hurricane Risk for the Cayman Islands, British West Indies**. APEC Consulting Engineers Ltd, George Town, Grand Cayman.
- National Hurricane Committee (1999) **Hurricane Handbook 1999**.
- Nurse, L. A., Sen, G., Hay, J. E., Suarez, A. G., Wong, P. P., Briguglio, L. and Ragoonaden, S. (2001) Small Islands States. In **Climate Change 2001: Impacts, Adaptation, and Vulnerability**, eds J. McCarthy, O. F. Canziani, N. A. Leary, D. J. Dokken and K. S. White, Cambridge University Press, Cambridge, UK.
- Olsson, P. and Folke, C. (2001) Local ecological knowledge and institutional dynamics for ecosystem management: A study of Lake Racken Watershed, Sweden. **Ecosystems**, 4, 2, 85-104.
- Paton, D., Millar, M. and Johnston, D. (2001) Community resilience to volcanic hazard consequences. **Natural Hazards**, 24, 2, 157-169.
- Roberts, S. M. (1995) Small Place, Big Money - the Cayman Islands and the International Financial-System. **Economic Geography**, 71, 3, 237-256.
- Smith, K. (2001) **Environmental Hazards: Assessing Risk and Reducing Disaster**, Routledge, New York.
- Tol, R. S. J. (2003) Is the uncertainty about climate change too large for expected cost-benefit analysis? **Climatic Change**, 56, 3, 265-289.
- WMO (2002a) The Global Climate in 2001. **World Climate News**, 21, June 2002, 5.
- WMO (2002b) **Reducing Vulnerability to Weather and Climate Extremes**. World Meteorological Organization, WMO-No.936, Geneva, Switzerland.
- WMO (2002c) **WMO Statement on the Status of the Global Climate in 2001**. World Meteorological Organization, WMO-No.940, Geneva, Switzerland.
- Young, O. R. (2002) Evaluating the success of international environmental regimes: where are we now? **Global Environmental Change**, 12, 73-77.

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The Tyndall Centre is named after the 19th century UK scientist John Tyndall, who was the first to prove the Earth's natural greenhouse effect and suggested that slight changes in atmospheric composition could bring about climate variations. In addition, he was committed to improving the quality of science education and knowledge.

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- External Communications Manager
- Tyndall Centre for Climate Change Research
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