



Small islands and climate change: analysis of adaptation policy in the Cayman Islands

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Abstract

Small, low-lying islands are highly vulnerable to the effects of climate change and development of effective adaptation strategies is regarded as an urgent need. Through an analysis of existing and emerging climate adaptation policies, this paper assesses the climate adaptation response in the Cayman Islands. Despite its strong economic status and several developments in the areas of Planning, Environment and Tourism, alongside a draft Climate Change Policy, the study reveals a focus on symbolic policies and a lack of adopted “concrete” climate change adaptation policies. Although the draft National Climate Change Policy (2011) contains a comprehensive range of substantial policies, none has been formally adopted by the Cayman Islands Government. The practical implications of this situation in the face of climate change-related hazards are assessed in the context of Seven Mile Beach, the most heavily developed stretch of the Cayman Islands coast. Here, the prevailing response to shoreline change is stabilisation and, despite several opportunities to change the situation, recent policy developments have not stimulated changes in practice.

Keywords Cayman Islands · Adaptation · Small island nations · Climate change policy

Introduction

Small islands are highly susceptible to the effects of a changing climate; climate change is expected to create new vulnerabilities and exacerbate existing ones (Nurse et al. 2014; Duvat et al. 2017; IPCC 2018). Sea level rise is a particular threat to low-lying islands (Oppenheimer et al. 2019; Martyr-Koller et al. 2021), as the twin issues of shoreline change and flooding threaten coastal infrastructure and populations (Lewsey et al. 2004; Ng et al. 2019). This vulnerability is exemplified by extreme weather events such as hurricanes during which wind, storm surge and wave activity threaten human interests. Issues related to ocean acidification are

also important threats in the tropics and subtropics, where carbonate production and diagenesis are important components of the physical coastal system and there has been much debate about the likely biophysical response of reef-related coastal systems to climate change (Perry et al. 2018).

The 2015 Paris Agreement (Article 7) recognises adaptation as being a critical component of the global response to climate change (United Nations Framework Convention on Climate Change (UNFCCC 2015), recognising that “global adaptation is as important as global mitigation” (Magnan and Ribera 2016 p. 1280). Because of the particular risks to human populations and the supporting biophysical systems in small island nations, developing effective adaptation strategies is of high importance (Nalau et al. 2015); Measham et al. 2011). A particular challenge is to avoid “maladaptation” (Magnan et al. 2016), where the adopted measures exacerbate, rather than reduce the climate change-associated risks to humans, the built environment and the natural environment. Whilst there has been much focus on the issues facing Small Island Developing States (SIDS), especially in the tropics (e.g. Thomas et al. 2018), “the situation of the numerous other vulnerable island territories has been relatively neglected” (Petzold and Magnan 2019 p.145). The variability in the physical and socio-economic character of small islands imparts a diverse set of climate change risk

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profiles (Nurse et al. 2014). The risks arising from climate change in a particular place, and thus the need to adapt, depend on the hazards, the exposure to those hazards and vulnerability, which in turn depends on social, economic and governance factors (Forino et al. 2017; Boda and Jerneck 2019). With this in mind, we examine adaptation in the Cayman Islands, a British Overseas Territory in the Caribbean, whose physical geography and exposure to climatic hazards, but not the governance or economic status, is similar to several of the small island developing states in that region.

Initial climate change adaptation efforts in the Cayman Islands between 1988 and 2002 were studied by Tompkins (2005); efforts included amending the Building Code in 1995/96 to increase resilience against tropical cyclones in the built sector and changes to the Development and Planning Regulations to increase coastal setbacks in Hotel/Tourism zones from 100 to 130 ft, in 2002. Seven Mile Beach lies within a Hotel/Tourism zone. These changes were also supported by the production of an annual comprehensive hurricane preparedness plan. These efforts were commended as they promoted “anticipatory planning for environmental risks

and reduction of social, economic and physical vulnerability” (Tompkins 2005 p.142). Through an analysis of existing and emerging policies, the aim of this paper is to describe and analyse subsequent and ongoing adaptation measures and strategies in the Cayman Islands. To do this climate adaptation policies are identified, categorised and assessed. The relationship between adaptation policy and its practical outworking is then investigated using the economically important resort area of Seven Mile Beach as a case study. The study provides an account of the situation in a developed small island economy that serves as a comparison for the situation in other small island developing nations (Nurse et al. 2014; Fitton et al. 2021).

Study area and climate change context

The Cayman Islands (Fig. 1) comprise three islands (Grand Cayman, Cayman Brac and Little Cayman) and are part of the Greater Antilles chain, located in the north-western Caribbean Sea (19° N 81° W). Totalling only 164 km², these low-lying islands represent peaks of the Cayman Ridge



Fig. 1 Locality Map showing situation of Cayman Islands (inset)

which extends from the Sierra Maestra mountain range of Cuba to the Bay of Honduras (Roberts 1994). They are formed entirely of calcareous marine deposits and are flat, and very low-lying (Jones 1994). The islands are separated from Jamaica by the Cayman Trench, the deepest part of the Caribbean basin at more than 7.2 km (Cayman Islands National Climate Change Committee 2011). Grand Cayman (Fig. 2) is the largest of the islands, covering 122 km²; it has an average elevation of 1.8 m and a maximum elevation of 28 m. The islands have a population of 69,914 (ESO, Cayman Islands Government 2019). Seven Mile Beach (Fig. 2) is a 9.3-km semi-continuous stretch of beach, located on the leeward, western coast of Grand Cayman (Seymour 2000). It is the focus of tourist-related activities and is lined by near-continuous beachfront development. It was voted the 6th best beach in the world by Trip Advisor in 2021 (Insider 2020) and is the most heavily developed tourism area on the islands. Erosion on Seven Mile Beach is identified as a climate change-related threat (Cayman Islands Government 2011; Hurlston-McKenzie et al. 2011).

The beach is fronted by subtidal reefs. At depths greater than 40 m, the reefs drop away into near-vertical walls which reach depths greater than 2000 m (Manfrino et al. 2003). Seven Mile Beach lies within a marine protected area (Marine Park and Replenishment Zone) (Cayman Islands Government 2007). The shoreline is experiencing long-term recession at its north and south extremities and accretion in its central sector.

In 1998, the Cayman Island's Government commissioned a Coastal Engineer (Ralph Clark) to assess the erosion problem on Seven Mile Beach and to recommend both policy and programmes to guide and inform management of the beach system. Clark's (1988) report presents the results of an investigation of beach erosion conditions on Seven Mile Beach and includes specific recommendations for its management noting (p.49) that "the preservation of this beach resource should be proclaimed a public policy and coastal construction regulations should be adopted to assure the preservation of the beach". Associated recommendations, based on erosion likely to be associated with an 8-foot (2.4 m) storm surge, included amending the Development and Planning Regulations to reflect minimum coastal setbacks of 45 and 61 m (150 and 200 feet), depending on location, to protect the dune ridge and allow the beach/dune system to survive storm impact through episodic erosion and subsequent recovery. By 2003, however, the lack of adequate protection for the beach provided by the Development and Planning Laws & Regulations was still noted as a concern (Clark 2003). At this time, developments were being permitted on the active beach and historic building practices had involved the removal of large quantities of beach and beachridge sand for construction material (Clark 2003 p.17).

The Cayman Islands are a self-governed UK overseas territory, with the Government operating under the framework of democratic governance through a parliamentary system. Executive power is exercised by the Government consisting



Fig. 2 Morphology of Grand Cayman (main figure) and detail of Seven Mile Beach

of the Governor as Her Majesty's representative and a locally elected Cabinet. With no direct taxation, the islands are a well-established financial centre. The financial services sector accounted for approximately 33% of GDP in 2019 (ESO 2020). Tourism is also a mainstay of the economy. Grand Cayman is a popular cruise destination, with over 1.8 million cruise arrivals in 2019 (Economic and Statistics Office 2019). The stayover tourist industry is aimed at the luxury market with over 500,000 arrivals in 2019 (ESO 2020). Its resident population has grown rapidly from 10,068 in 1970 to 69,914 in 2019 (ESO 2020). This growth has been accompanied by high levels of infrastructure and residential development. The Islands have a high gross domestic product per capita of approximately USD\$ 91,392.60 in 2019, which is significantly greater than other small Caribbean Islands such as The Bahamas (USD\$28,607 in 2020) and Turks & Caicos (USD\$23,879 in 2020). It is also significantly higher than North America (USD\$63,543 in 2020 and the United Kingdom (\$40,284 in 2020) (World Bank 2021). In 2006/2007, 3.7% of the population (3.1% of households) was living below the vulnerability line (Kairi Consultants Ltd. 2008). The highest level of income vulnerability is in Cayman Brac.

The climate is tropical with two seasons: summer (May to October) and winter (November to April). Air temperatures average 27.1 °C per annum with the hottest month over a 30-year average being July at 28.8 °C, and the coolest month on average is February at 25.1 °C (National Climate Change Committee 2011). A Climate Study of the Cayman Islands (University of the West Indies 2014) predicted that by 2100 the minimum, maximum and mean air temperatures will increase in the Caribbean, irrespective of the climate change scenario used. Climate change projections suggest future changes in, temperature (+ 3.1–4.3 °C by 2080s), rainfall (decline in annual totals but heavier rainfall events), hurricane (stronger hurricanes) and sea level (rise near-global mean) (Hurlston-McKenzie et al. 2011).

Interpolated sea level reconstruction grids at different Caribbean island sites showed that between 1950 and 2009, the Caribbean sea level rise was around 2 mm/year (Palanisamy et al. 2012). Using two greenhouse gas emission scenarios (SRES A2 and SRES B2) and three different climate sensitivity levels for each scenario the Model for the Assessment of Greenhouse-gas Induced Climate Change (MAGICC) predicted sea level rise between 12 and 80 cm (0.14 to 0.91 cm per year) from 2011 to 2099 (National Climate Change Committee 2011). More recently, IPCC (2019) estimated global sea level rise figures of between 29 cm and 1.1 m by 2100.

The Cayman Islands fall within the Caribbean hurricane belt. During the Atlantic Hurricane Season (June to November), between 1887 and 1987, one tropical storm passed directly over Grand Cayman every 12.5 years, within 50

miles every 4.3 years and within 100 miles every 2.7 years (Clark 1988). More distant storms, such as Category 5 Hurricane Mitch in 1998, which was 324 km away at its closest point (HURDAT2 2020), have also caused damage. Data indicate that there has been a reduction in the frequency of all storm categories from 1958 to 2019.

Whilst in recent years the frequency of hurricanes has reduced, the intensity has increased. From 1851 to 2019, 72% of hurricanes were category 1 or 2, 10% were category 3 and 18% were category 4 or 5. From 1958 to 2019, 54% were category 1 or 2, 12% category 3 and 35% category 4 or 5. From 2000 to 2019, category 1 or 2 hurricanes dropped to 46%, 8% were category 3 and 40% were category 4 or 5. In the past 11 years, no hurricanes have passed within 400 km of Grand Cayman, and in the past 9 years, no tropical storms have passed within 200 km (HURDAT2 2020).

Current projections using the IPCC's (2019) A1B scenario (University of the West Indies 2014) suggest no change, or a slight decrease, in the frequency of Atlantic hurricanes, but an increase in the frequency of category 4 and 5 events over the next 80 years. During the period 2000 to 2019, there was an increase in the percentage of storms from the south-west (over 25% of storm activity from this direction) and north-west (over 10%).

A study by the Caribbean Catastrophe Risk Insurance Facility (CCRIF 2010) assessed present day and future expected losses on the Cayman Islands from hurricane-induced winds, coastal flooding from storm surge and inland flooding from hurricanes and tropical storms under three climate change scenarios. The potential losses were estimated using an approach similar to that applied for calculating insurance premiums, with 45% of losses attributed to coastal flooding. The study found that annual expected losses (already high at 5% of GDP) could increase to 7% by 2030 under a high climate change scenario. The Cayman Islands was one of the highest loss jurisdictions in the Caribbean and many properties are close to the "limit of insurability" (CCRIF 2010).

The Cayman Islands' narrow economic base, lack of local direct taxation and the economic dependence on natural resources to support its high-end tourism industry contribute to economic vulnerability to climate change. Direct hits from hurricanes have had serious socio-economic consequences. Hurricane Ivan in 2004 severely impacted the southern and eastern coasts of Grand Cayman leaving total losses of CI\$2.8 billion equivalent to 183% of the country's GDP (ECLAC 2005). In November 2008, Hurricane Paloma caused total losses of CI\$154 million (ECLAC 2009).

Land-use planning in Cayman is based on a Euclidean zoning system. As with most small islands, the Cayman Islands' critical infrastructure (seaports, airports, major arterial roads, fuel terminals, utilities, emergency response and key government facilities) and economic activities that

support the main population centres have developed along, or in close proximity to the coast, many in hazard-prone areas (Hurlston-McKenzie et al. 2011).

Development & Planning Regulations (2018) provide for development setbacks on Seven Mile Beach. The rationale for defining these setbacks, however, is unclear. Setbacks are defined based on the type of coastline (beach, mangrove or ironshore (bedrock)), with some variations based on land-use zoning. The arbitrary definition of coastal setbacks does not take into account factors such as historic patterns of shoreline change, the nearshore and offshore environmental conditions, seasonal and episodic changes in sediment transport patterns and beach morphology, and projected sea level rise and climate change scenarios (UNESCO 1997).

In common with other Caribbean Island nations, the main physical vulnerabilities for the Cayman Islands that are directly linked to climate change are sea level rise and extreme weather events, e.g. hurricanes and storm surge (Murray et al. 2021). These are exacerbated by the decline of coral reefs due to elevated ocean temperatures and ocean acidification which results in compromised coastal protection and sediment supply. Pressure from coastal development, economic dependence of the tourism industry on Seven Mile Beach, rapid population growth and insurability issues for development place additional pressures on the coastal environment (Cayman Islands National Climate Change Committee 2011).

Global and regional context for Cayman Islands Adaptation Policy Development

The need for explicit climate change adaptation policies has been widely recognised since the 1990s when it featured in scientific literature and was debated during international climate change negotiations (Schipper 2006). The concept of adaptation is widely used in climate change discourse and Article 7.1 of the Paris Agreement defines a global adaptation goal of “enhancing adaptive capacity, strengthening resilience and reducing vulnerability to climate change, with a view to contributing to sustainable development and ensuring an adequate adaptation response in the context of the temperature goal referred to in Article 2” (UNFCCC 2015).

The 2015 Paris Agreement (Article 7) requires all Parties, as appropriate, to engage in adaptation planning and implementation using mechanisms such as national adaptation plans, vulnerability assessments, monitoring and evaluation. It also requires that Parties to the Agreement communicate their priorities, plans, actions and support needs through adaptation communications, recorded in a public registry (UNFCCC 2015). The Cayman Islands can have the Paris

Agreement extended to it through the UK, as it is a British Overseas Territory, but to date this has not happened.

Boda and Jerneck (2019) identify two principally different types of adaptation, namely incremental and transformative. Incremental adaptation operates under the status quo, with small changes that maintain the current system or process. Transformative adaptations bring forward fundamental changes. Based on a study of issues arising at Flager Beach, Florida, they conclude that incremental changes can help to increase capacity for local collective action and lay the groundwork for more transformative adaptations in the future. This is particularly relevant in the context of jurisdictions with a lack of political will or capacity to plan for, or implement, meaningful adaptation measures.

Whilst definitions and interpretations of “adaptation” are many and varied (Cooper and Pile 2014), central to all definitions is the concept of reduction of harm and/or realisation of benefits to humans. This varies depending on the perspective of an individual or group and is strongly time- and space-dependent (Cooper and McKenna 2008). For the purposes of this analysis, “policy” has been interpreted as the policy instruments or mechanisms that Government is using to translate goals and objectives into implementable actions, which could be delivered through legislation, policies and knowledge-building activities such as research and training (Henstra 2016).

There are many and varied perspectives on what constitutes an adaptation policy or response, depending upon the context. Dupuis and Biesbrook (2013) note that when analysing a national adaptation policy framework there are two fundamental questions. First, what “concrete” policy changes have been introduced in response to climate change and, second, what are the likely outcomes of these policies in terms of their capacity to reduce the impacts of climate change. The second of these questions in particular has received limited attention in the climate change literature (Gussmann and Hinkel 2021). To answer both questions, the existing laws and policies within the Cayman Islands were reviewed and assessed through the lens of climate change adaptation as defined above.

Methods

In this paper, we present an assessment of the climate change adaptation policies of the Cayman Islands and then, using a case study of the nation’s most developed coastal sector, comment on the practical implications of these policies.

We utilise the framework for analysis of adaptation policies presented by Dupuis and Biesbrook (2013). This has been widely utilised for global and national policy analyses (e.g. Lesnikowski et al. 2015; Le 2020; Sietsma et al. 2021).

The approach involves a review of the substantiality (issue-solving) and intentionality (purposeful nature) of climate adaptation policies, utilising a matrix of policy meta-types (Fig. 3). With this framework as a benchmark, we assess the progress of the Cayman Islands government in formulating and implementing climate change adaptation policies.

In the fourfold categorisation of adaptation policies of Dupuis and Biesbroek (2013), contiguous policies are those which have limited impact on reducing climate change vulnerability and which were not designed or intended to deal with climate change impacts, i.e. they were initiated in response to other objectives, before climate change reached the political agenda. Contributive policies are those not necessarily designed to reduce climate change impacts, but can lead to reductions in vulnerability to a changing climate. These policies are best known through the platform of disaster risk reduction policies, e.g. flood risk management. They are generally shaped by past extreme events, rather than being informed by projections of future risks arising from climate change (Mercer 2010). Concrete policies are those which are intentionally designed to manage the long-term predicted impact of climate change, which could not be delivered through contributive policies. Finally, policies which have been developed to intentionally address climate change impacts yet have no concrete effects on reducing vulnerability to climate change are identified as being symbolic policies. Swart et al. (2009) note that many national adaptation strategies fall into this category, representing political agenda-setting and resulting in purely symbolic effects, unless they lead to subsequent concrete actions.

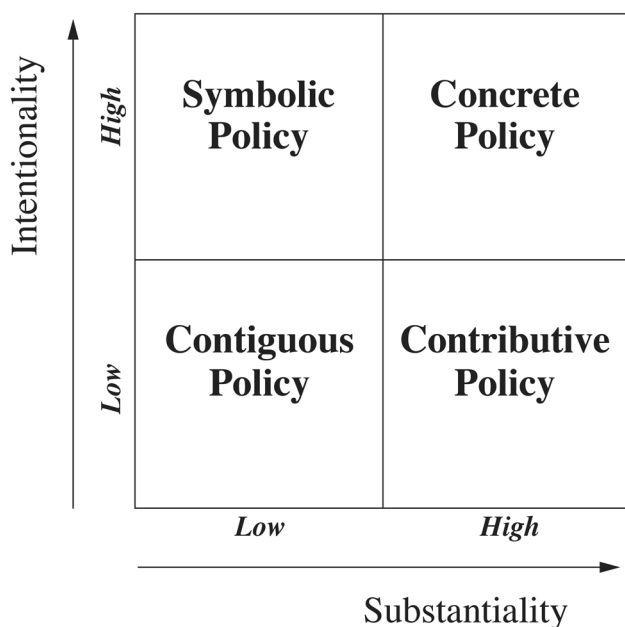


Fig. 3 Typology of adaptation policies (Dupuis and Biesbroek 2013)

A comprehensive review was undertaken of the websites of government ministries and departments that would be expected to have policies that would include reference to the vulnerabilities and risks posed by climate change, and might include adaptation responses. This review included portfolios such as water resources, agriculture, transportation, planning and development, tourism, hazard management, environment, environmental health and financial services. Policies that were reviewed fell within the governance arenas of Planning, Environment, Tourism and “Other” (Table 1). These are the only published national policies that are directly or indirectly relevant to the climate change agenda, particularly in respect of medium- to long-term strategic considerations.

Policies regarding Disaster Risk Management and Hazard Management provide emergency response planning but not longer-term strategic planning for adapting to a changing climate and were disregarded. The Cayman Islands National Hazard Response Plan, for example, provides a framework for emergency response protocols in the event of a national hazard or disaster. It is effectively an operations manual which has important utility in the immediate aftermath of a disaster, but offers no contribution to longer-term strategic considerations or adaptation planning.

Results

Review of strategic policy for the incorporation of climate adaptation

All policies relating to climate change adaptation in the Cayman Islands were categorised into those dealing with Planning, Environment, Tourism and “Other” (Table 1). Given that coastal erosion and increased hurricane risk are identified as the key climate-related vulnerabilities for the Cayman Islands (Murray et al. 2021), the contribution of these initiatives to adaptation policy development is outlined in Table 1 with further expansion below.

The Development Plan for the Cayman Islands adopted in 1997 is currently outdated and includes no reference to climate change or sea level rise. An updated plan published for consultation in 2019 (the Draft National Planning Framework) has not yet been adopted. Climate change is mentioned only six times in the 108-page consultation document. Neither the Vision statement nor the Strategic Objectives speak of addressing climate challenges, reducing risks arising from natural hazard, enhancing climate resilience or promoting low-carbon development to support a greener economy. The document does recognise climate change effects on beaches and the erosion risk to badly sited developments, but is based on only the most conservative estimates of sea level rise by 2100 (0.3 m).

Table 1 Summary of Cayman Islands climate change adaptation policies

Review of adaptation planning in the Cayman Islands			
Planning	Environment	Tourism	Other
<p>Current policy Development Plan (1997)—no reference to sea level rise (SLR) or climate change Development & Planning Law (2017 Revision) – no reference to SLR or climate change Development & Planning Regulations (2018) – no reference to SLR or climate change. Defines coastal setbacks for development as “horizontal distance between the high water mark and any building or structure on the parcel” Seven Mile Beach (SMB) is a predominantly Hotel/Tourism zone and therefore development setbacks are a minimum of 130 ft (39.6 m) from high water mark. North end of SMB is residential zone with minimum setbacks of 75 ft (23 m) International Building Code (2009). No reference to SLR. Includes hurricane rating for buildings Emerging policy Draft National Planning Framework (Cayman 2019) Threats to Cayman’s beaches recognised as including: Inappropriately sited coastal development; Predicted climate change effects, such as frequent and more intense storms, hurricanes and Global sea level rise. However, the document states that “based on a very conservative predicted sea level rise of 1 foot [0.3 m] by the year 2100 which translates to 4 inches by the year 2030, the predicted shoreline recession is 33 feet by 2030” This is incorrect with latest IPCC (2019) predictions being between 0.95 feet (0.29 m) and 3.61 feet (1.1 m) by 2100 Section 9.2 CZM Goal 1, Objective 3: Identify and implement remedies to prevent beach erosion, especially where development has encroached below the original vegetation line <i>Action Items</i> • Define clear setbacks for coastal development sites based on the line of natural vegetation and revise the existing planning regulations, if necessary</p>	<p>Current policy National Conservation Law (2013) – defines an adverse effect as: (h) alterations that may increase losses of the area from a rise in the sea level with respect to the surface of the land, whether caused by an actual sea level rise or land surface subsidence [allows s.41 to provide guidance on development that would have an adverse effect or direction adjacent to a Protected Area] (k) alterations that may impair the capacity of a beach ridge to function as a protective barrier and as a reserve of sand for beach nourishment during storms [allows s.41 to provide guidance on development that would have an adverse effect or direction adjacent to a Protected Area]</p>	<p>Current policy Tourism Law (1995 Revision)—no reference to SLR or climate change National Tourism Plan 2019 to 2023. Introductory sections copy full text from draft climate change policy re tourism and cc effects, including SLR & coastal erosion. Tourism vision, goals and strategies make no reference to any aspect of climate change</p>	<p>Emerging policy Draft Climate Change Policy (2011): <i>Marine & Coastal Resources</i> A) amend development & planning legislation to address climate change to include: + increasing site-specific coastal construction setbacks to take account of climate change; + new coastal developments to incorporate measures to mitigate the impacts of climate change e.g. wash-through ground floors + require coastal setbacks to be determined from a setback line, rather than the HWM; + revise Planning Law to include inadequate setbacks & climate change risk management measures as reasons for refusing applications (to avoid compensation claims) B) Develop a SMB re-nourishment contingency plan <i>Best Management Practices</i> - Utilise the Environmental Protection Fund for conservation of vulnerable coastal & marine resources - integrate hazard mapping & cc risk management as part of the physical planning process <i>Tourism</i> <i>Best Management Practices</i> - require tourism facilities to develop, implement & test disaster and climate change risk Management & business continuity plans – attached to licensing of business - Require cc risk assessment as part of inspection & licensing of tourism properties - cost-share beach nourishment projects with all beach front property owners <i>Insurance & Financial Services</i> <i>Policy</i> - reduce the exposure of the CI insurance and financial services sector by updating the Building Code to address climate change risk</p>

In the absence of an up-to-date adopted development plan, development control is mainly guided by the Planning and Development Law (2017) and Regulations (2018) and new development is required to be built in compliance with the International Building Code (2009). None of these explicitly considers the threats presented by climate change to the built environment and public realm.

The National Conservation Law (2013) is the only environmental legislation in the Cayman Islands and it is primarily focused on the protection and conservation of endangered, threatened and endemic flora and fauna. The plan identifies and seeks to prevent adverse effects of development on natural coastal features (especially beach ridges), recognising their role in coastal resilience

to storms. It makes no specific reference to risks from climate change.

Tourism is guided by the Tourism Law (1995 revision) and the adopted National Tourism Plan (2020). However, despite the country's economic dependence on tourism and the importance of providing a visitor experience that is memorable and unique, the National Tourism Plan (2019–2023) does not identify the risks and vulnerabilities presented by exposure to climate change effects. The National Tourism Plan's vision, goals and strategies do not include a single reference to any aspect of climate change.

A National Climate Change Policy was formulated based on extensive stakeholder consultation (National Climate Change Committee 2011) through the Cayman Islands participation in the ECACC Project (*Enhancing Capacity to Climate Change in the UK Caribbean Overseas Territories*). This 36-month project was funded by the UK Department for International Development (DFID) and was managed locally by the National Climate Change Committee (NCCC), "a multi-agency, public–private sector steering committee". The draft policy contains important climate change-related objectives, including amendments to the planning and development legislation, increases in setback lines, the ability to refuse development permission based on climate change risks and measures to implement good practice in coastal resource management, tourism and insurance. Although this policy has been finalised, it remains in draft form and has not been formally adopted by the government of the Cayman Islands.

A categorisation of Cayman Islands' climate change adaptation initiatives (Table 2) illustrates that many of these policies are in the symbolic category. The main concrete policies are contained in the draft climate change policy (2011), which is the single most comprehensive effort to produce a consolidated adaptation plan. The policy provides a roadmap for the islands to transition to a low-carbon climate-resilient economy, with clearly defined interventions in the arenas of legislative and policy actions, research, monitoring and education, and environmental best practices, within a 5-year timeframe. It offers a holistic approach to many local climate change issues including enhancing the resilience of critical infrastructure, creating a more environmentally responsible tourism industry and minimising the vulnerability of insured and mortgaged properties. This plan, however, remains in draft format and has not yet been taken forward to Cabinet for adoption (Cayman Compass 2000). The adoption of the International Building Code is also regarded as a concrete policy in terms of improving resilience against storms and hurricanes. The National Conservation Law (2013) has the potential to provide concrete influence on climate change adaptation, but only in certain situations (e.g. if the action is adjacent to a protected area).

The National Tourism Plan (2019) provides symbolic support for the issue of climate change adaptation by including excerpts of the draft climate change policy, yet it contains no concrete policies, goals or actions which address any aspect of climate change. The Development and Planning Law & Regulations (2018) prescribes minimum setbacks for development on a blanket basis, i.e. there is no consideration of offshore conditions (orientation to prevailing wind and wave conditions, bathymetry, presence of wave attenuating features such as coral reefs, seagrass beds) or historic shoreline changes.

The National Tourism Plan and National Conservation Law are largely symbolic in terms of their contribution to adaptation policy. Whilst they contain some policies that potentially contribute to adaptation, they are not identified as such nor is climate change identified as a driver. The draft Climate Change Policy does provide a series of concrete adaptation measures that could provide a valuable framework and clear actions to help the Islands increase their resilience to the effects of climate change. It includes provision for accommodation through changes to building codes and for future risk reduction via reappraisal of development setbacks, but it does not contain strategic guidance on high-level decisions regarding the relationship between natural processes and infrastructure for example. It resulted from engagement in a UK overseas territories initiative which, coupled with the fact that it remains in draft form after a decade, suggests that it is regarded as a low priority by the government.

Application to Seven Mile Beach

To test the practical outworking of current adaptation initiatives, a review of developments along the key infrastructure and tourism location of Seven Mile Beach was undertaken. Whilst land along Seven Mile Beach is already largely developed (Figs. 2 and 4), recent changes in the Planning and Development Law and Regulations allow for increased building heights (up to 10-storeys high). This has created an impetus for redevelopment of low-rise properties to take advantage of the permitted height increase and the potential financial gains that it brings (Cayman Islands Government 2018).

At the same time, a number of properties along Seven Mile Beach are affected by coastal erosion due to poor historical planning practices. Some property owners are exploring engineering options to attempt to stabilise and promote the recovery of the beaches. By way of example, Table 3 details a sequence of engineered options for which permission has been sought in efforts to defend the Marriott Hotel. This property has experienced ongoing issues of erosion since the development of the hotel some decades ago, with erosion in the last 10 years being chronic. This

Table 2 Analysis of substantiality and intentionality of Cayman Islands’ climate change adaptation policies (following the scheme of Dupuis and Biesbrook 2013)

Symbolic

- o **National Conservation Law (2013)** – guidance (or direction adjacent to a Protected Area) can be given on:
 - + alterations that may increase losses of the area from a rise in the sea level with respect to the surface of the land, whether caused by an actual sea level rise or land surface subsidence
 - + alterations that may impair the capacity of a beach ridge to function as a protective barrier and as a reserve of sand for beach nourishment during storms. *SYMBOLIC UNLESS ADJACENT TO A PROTECTED AREA THEN CONCRETE*
- o **National Tourism Plan 2019 to 2023 (2020)** Introductory sections copy full text from draft climate change policy (2011) for tourism and climate change effects. However, tourism vision, goals and strategies make no reference to any aspect of climate change
- o **Draft NPF (2019)** Identify and implement remedies to prevent beach erosion, especially where development has encroached below the original vegetation line
- o **Draft NPF (2019)** Define clear setbacks for coastal development based on the line of natural vegetation and revise the existing planning regulations, if necessary

Concrete

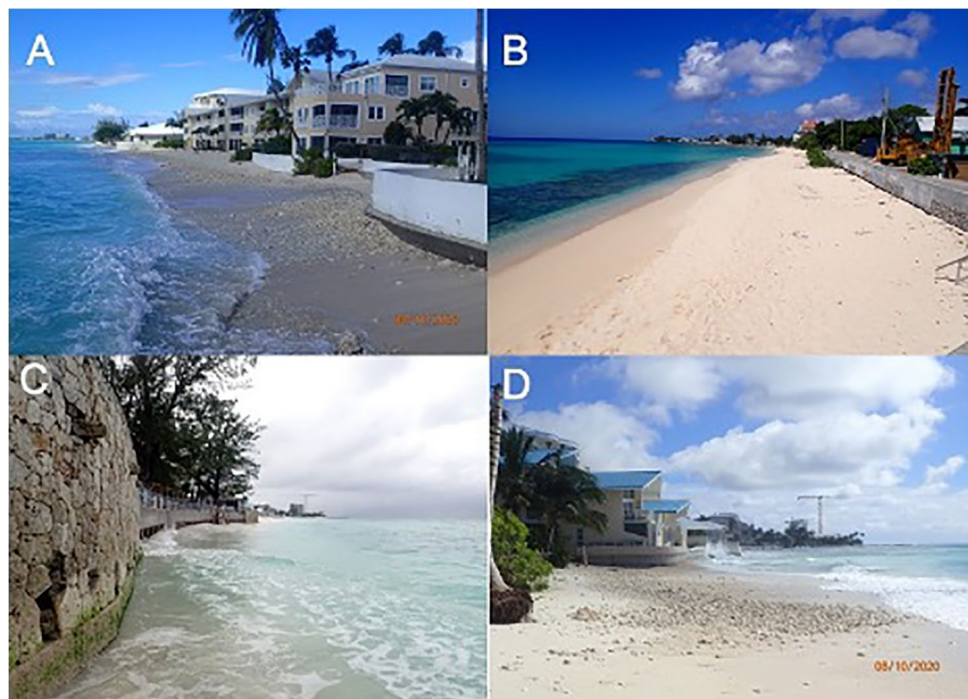
- o **International Building Code (2009)**. Hurricane rating for buildings
- o **Draft Climate Change Policy (2011):**
 - + increase site-specific coastal construction setbacks to take account of climate change
 - + new coastal developments to incorporate measures to mitigate the impacts of climate change e.g. wash-through ground floors
 - + require coastal setbacks to be determined from a setback line, rather than the HWM
 - + revise Planning Law to include inadequate setbacks & climate change risk management measures as reasons for refusing applications (to avoid compensation claims)
 - + Develop a SMB re-nourishment contingency plan
 - + integrate hazard mapping & climate change risk management as part of the physical planning process
 - + require tourism facilities to develop, implement & test disaster and climate change risk Management & business continuity plans – attached to licensing of business
 - + reduce the exposure of the CI insurance and financial services sector by updating the Building Code to address climate change risk

Contiguous

Contributive

- o **Development & Planning Regulations (2018)** minimum coastal setbacks of 130ft (39.6 m) in Hotel/Tourism development zone & 75 ft (23 m) in residential
- o **Draft Climate Change Policy (2011):**
 - + Utilise the Environmental Protection Fund for conservation of vulnerable coastal & marine resources
 - + Require climate change risk assessment as part of inspection & licensing of tourism properties
 - + cost-share beach nourishment projects with all beach front property owners

Fig. 4 Ground photos of Seven Mile Beach showing: **A** beach-front development behind the narrow sandy beach; **B** seawall construction; **C** absence of beach in front of the seawall; **D** buildings at risk from shoreline change



can be predominantly linked to a strong, seasonal influence on beach width; the south end of the beach is typically widest from February to June and narrowest in September to December. Seasonably, wind and wave activity from the south to south-westerly quadrant moves sand from southern Seven Mile Beach in a northerly direction. During the winter cold fronts, wave activity from the north and north-westerly quadrant redistributes sand from the northern sections of the beach to the southern end. The erosion issues are also amplified by the built footprint of the hotel and its ancillary structures, e.g. swimming pool, dining deck and seawall being constructed on the “active” beach (Seymour 2000; Clark 2003).

In late 2002, submerged reef balls were deployed at the Marriott Hotel in an attempt to restore the eroded dry beach. There is no evidence that these submerged reef balls have provided any net benefit to the beach along this shoreline, and they are still in place today. Prior to this, in 2009, the property also installed artificial seagrass mats as an attempt to dampen wave energy and lessen the erosion; within a period of approximately 12 months, these mats had dislodged from the seabed. Other interventions outlined in Table 3 have not yielded any medium to long-term

contribution to the ongoing chronic erosion that is being experienced in places.

Discussion

The Cayman Islands are a developed Caribbean nation with a high exposure to climate change risks arising from sea level rise and increased hurricane intensity. Existing policies on planning, conservation, and tourism, however, take little account of the threats from climate change. Two draft policies, dealing with the National Planning Framework and Climate Change Policy that do specifically address adaptation remain in draft form, the latter since 2011, and have not been formally adopted. The absence of implementation strategies in these policies indicates that climate change is not being mainstreamed into the national planning framework.

The reasons for this are unclear, but, in local discourse, it has been contended (Cayman Compass 2020) that Cayman suffers from “policy implementation deficit disorder” in which resources are expended in formulating policy, but implementation plans are poorly conceived or absent. A lack of funding for implementation and/or lack of focus (political

Table 3 Sequence of proposed and implemented shoreline stabilisation works at Marriott resort, Seven Mile Beach

Date	Proposal	Decision	Outcome
Sep 1997	Permission sought for 1000 cu yds of beach nourishment (upland source of sand)	Coastal works licence issued 13 Oct 1997	Works conducted late Oct 1997 & 5 months later permission was sought again as sand did not remain on the beach
Mar 1998	Permission sought for 1000 cu yds of beach nourishment (offshore source of sand)	No permission given	No works
Oct 1999	Permission sought for installation of 7640 sq ft of beach stabilisation mats (polypropylene strips attached to an anchoring matrix to function as seagrass)	Permission granted	Mats installed Nov 1999 ¹ . Oct 2000 mats torn off seabed and found floating in the sea (Cayman Compass, 2000 ²)
Sep 2000	Permission sought for 1300–1400 cu yds beach nourishment using offshore sand sources	No permission given	No works
Sep 2002	Permission sought for installation of 200 concrete reef balls to form an artificial breakwater	Permission granted and reef balls installed in Oct 2002	No notable change to the beach profile and the reef balls are still in place
Oct 2002	Permission sought to re-nourish beach using 1600 cu yds of upland sand	No permission given	
May 2003	Permission sought for an additional 32 reef balls	Permission granted	No installation took place
2005	Cayman Islands Government undertook major beach re-nourishment at Marriott Resort (approx. 5,350 cubic metres)	N/A	Significant shoreline enhancement due to direct placement of sand onto the beach
2019	Permission sought for installation of geotubes, sand mattress and beach nourishment	Awaited	Awaited

¹ 18 November 1999, Cayman Compass

² 5 October 2000, Cayman Compass

will) is also cited as reasons for a lack of implementation. Additionally, in a jurisdiction with no taxation, there is limited revenue for day-to-day operations, therefore to dedicate a budget to a threat which is likely perceived to be in the distant future is unlikely to be considered a politically desirable priority for the government of the day. The lack of political desire and/or commitment to advancing the climate change agenda is indicative of a vulnerability in respect of local governance.

The situation in the Cayman Islands concurs with that reported by Birchall et al. (2021) that even when there is an agenda for climate change adaptation (manifest in the national Climate Change Policy), it is often peripheral and marginalised (Kithiia and Dowling 2010; Carter et al. 2015), as evidenced by a lack of formal adoption.

This means that in the Cayman Islands, a climate change policy vacuum exists with the draft climate change policy (2011) having already become outdated before its formal adoption and the draft National Planning Framework (Cayman 2019) being an ineffective alternative instrument to deliver sustainable adaptation responses. The integration of climate change adaptation into mainstream sectoral policies remains a pressing need. Despite the acknowledged risks associated with climate change, the development of adaptation strategies appears to have been largely reactive and consequently symbolic.

Murray et al. (2021) identified the need for organisational strengthening of key government agencies in the Caribbean to address climate change risks.

Because climate change will affect most sectors, there is a widespread realisation that adaptation should be integrated into the policies of various sectors of government or “mainstreamed” (Massey and Huitema 2013). This would require climate change to sit within a Government portfolio that can ensure that it is integrated into the work and roles of all of the many and varied ministries, for example the Cabinet Office or Office of the Premier. In the Cayman Islands, this review and case study show that adaptation is not currently mainstreamed and the draft Climate Change Policy is the only policy that explicitly addresses adaptation. Its limited ability to effect change can be gauged by the Seven Mile Beach case study.

Much of the development along Seven Mile Beach occurred before widespread awareness of climate change. It was guided by a range of development controls that still pertain to the present day. This existing development, however, affects the development of new adaptation policies that take cognisance of sea level rise and climate change. As the “jewel in the crown” of the Cayman Islands stayover tourism product, the importance of managing this natural asset has been highlighted on a number of occasions over the decades (Clark 1988, 2003; Seymour 2000). However, these

recommendations have not led to the development of any concrete policy instruments. A reduction in hurricane and storm activity in the past decade may even have resulted in climate change adaptation receiving a lower priority among political agendas.

Strategies for adapting to shoreline change (Rangel-Buitrago et al. 2018; IPCC 2019) include the following:

- Protection of built infrastructure through hard and soft protection measures;
- Modifying construction techniques and land uses to accommodate the threat of shoreline change;
- Planned retreat through re-positioning of built infrastructure.
- Coastal advance through reclamation

The options for implementation of each of these strategies, however, depend to a large extent on past development practices. At Seven Mile Beach, existing policy and practice enabled extensive beachfront development with little explicit regard for the effects of future climate change or sea level rise. Adherence to international building codes means that buildings are structurally sound and implementation of setback lines may have limited the extent of issues related to shoreline change in the recent past. The setback lines, however, are arbitrarily derived and take no account of potential shoreline changes in response to future sea level rise or changes in intensity of extreme events that affect the shoreline. As a result, owners of properties that are perceived to be or are actually at risk from shoreline change have adopted measures to attempt to stabilise the shoreline (Table 3); there is no mechanism to implement any other adaptation response. This restriction of adaptation options leads to a de facto “maladaptation” (Magnan et al. 2016) or climate change “resistance” (Cooper and Pile 2014) involving direct human intervention in the natural shoreline that damages the coastal system (Cooper and Jackson 2019) and reduces its resilience. Armouring the coastline allows for the short-term protection of property, but to the detriment of the beach (Pilkey and Cooper 2014). This is particularly evident at the north and south extremities of Seven Mile Beach, which have experienced high rates of erosion and where seawall construction has led to the loss of the active beach. This situation is a consequence of poor historical planning but all recent efforts to adapt to shoreline change have involved interventions designed to stabilise the shoreline and to protect buildings. There is no explicit recognition that shoreline change may be climate change induced.

In such instances, the presence of adjacent intensive beachfront development limits the options for future

adaptation and usually results in an expansion in shoreline stabilisation whether by hard armouring or beach replenishment (Pilkey and Cooper 2014). This, in turn, leads to a progressive transformation of the shoreline from an original natural state into a coupled human-natural system in which continued human intervention is required to maintain a human-specified state (Malvarez et al. 2021). It is sometimes possible in such situations to accommodate climate-related shoreline change (flooding and shoreline variability) through modifications to buildings. This can be done by retro-fitting of existing buildings and amended design and construction codes for new buildings. If, however, the building is physically threatened by progressive shoreline retreat, such options are limited. To enable retreat on such developed shorelines requires removal of hard structures to permit space for the coastal system to adjust to rising sea level and changes brought about during storms. Whilst this is universally acknowledged to be difficult (Gibbs 2016), it may be possible with strong political leadership, appropriate adaptation strategies and an effective legal framework and increasingly so as the ongoing costs of holding the shoreline are realised (Lawrence et al. 2020), even on small islands. Managed retreat is being explored in Hawaii, for example as part of its climate change adaptation strategy, utilising future sea level rise predictions (State of Hawaii Office of Planning 2019).

Magnan and Duvat (2018) highlight the need to control the urbanisation process to reduce anthropogenic pressures on tropical island coasts and enable a move away from a hard structure-dependent coastal defence strategy. They note, however (p.393), that this would involve a radical change in the way coastal development strategies consider environmental issues (hazards, resources and services) and showed that neither decision-makers nor the population is “ready to accept potentially constraining policies that will have benefits only in the future”. The changes in Cayman Islands planning regulations that now permit high-rise development create an opportunity for redevelopments to be guided by environmental best practices and incorporate the principles of climate change adaptation when determining setbacks for redevelopment sites and any undeveloped lands. They could also potentially be used to bring about changes in building design to accommodate the impacts of future climate changes. However, this opportunity seems to have been missed.

This analysis provides some insight into the nature and effectiveness of climate change adaptation policy in the Cayman Islands as a whole and, in particular, on the intensively developed Seven Mile Beach locality. Draft policies that have yet to be adopted could improve the situation, but this will require a higher priority to be given to climate change adaptation. As the effects of climate change become more apparent, this situation might change. For example, in an

analysis of 41 high-income countries, Lesnikowski et al. (2016) noted a temporal change to more concrete adaptation initiatives between 2010 and 2014. At present, however, despite its developed economy, the Cayman Islands share with many less developed small island states (e.g. Maldives, Gussmann and Hinkel 2021), a situation where adaptation policies are ill-prepared for climate and sea level change.

Conclusions

Current policy in the planning, environment and tourism sectors in the Cayman Islands contain little or no provision regarding adaptation to climate change. A specific national Climate Change Adaptation Policy, developed through public consultation and in response to international drivers, remains in draft form after more than a decade and has not yet been formally adopted. Current adaptation policy in the Cayman Islands comprises mainly symbolic measures that are ineffective in improving resilience to the major climate change-related issues of coastal erosion and increased storm intensity. The lack of formal adoption of policies suggests a lack of political will and/or a low priority for climate change adaptation. Changes in the planning regulations provide opportunities for improving resilience to climate change, but these have yet to be realised.

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