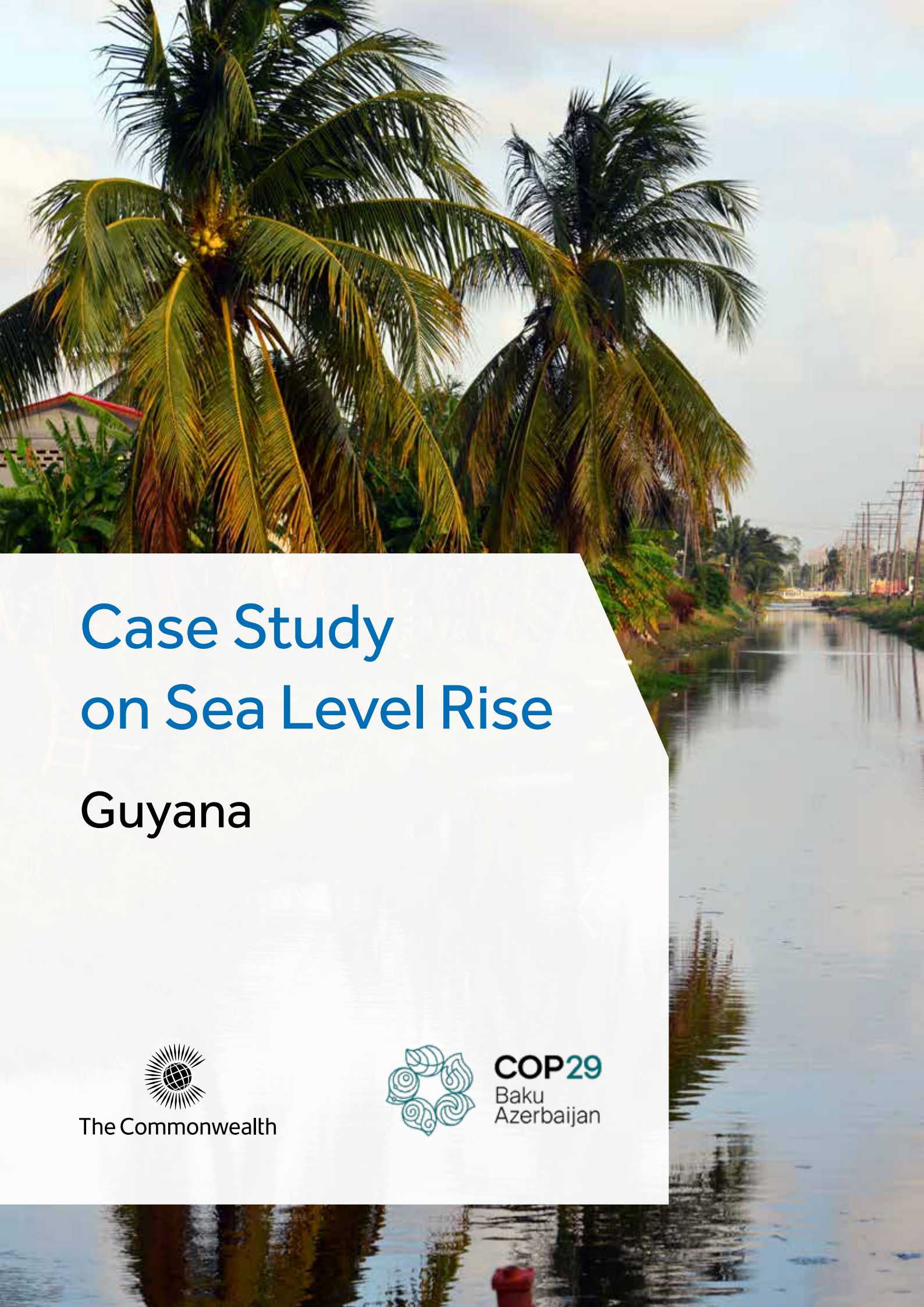




Case Study on Sea Level Rise

Guyana



The Commonwealth



COP29
Baku
Azerbaijan

Case Study on Sea Level Rise

Guyana

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Acronyms and Abbreviations

CDC	Civil Defence Commission
CDEMA	Caribbean Disaster Emergency Management Agency
CMMC	Coastal and Marine Management Committee
CRSAP	Climate Resilience Strategy and Action Plan
D&I	drainage and irrigation
DRM	disaster risk management
ECLAC	Economic Commission for Latin America and the Caribbean
EPA	Environment Protection Agency
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
GDP	gross domestic product
GIS	Geographic Information System
G\$	Guyana dollars
ICZM	Integrated Coastal Zone Management (programme)
IDB	Inter-American Development Bank
IMF	International Monetary Fund
IPCC	Intergovernmental Panel on Climate Change
LCDS	Low Carbon Development Strategy
NAP	National Adaptation Plan
NAREI	National Agricultural Research and Extension Institute
NASA	National Aeronautics and Space Administration
NCS	National Competitiveness Strategy
NDCs	Nationally Determined Contributions
NDS	National Development Strategy
NRF	Natural Resource Fund
PRSP	Poverty Reduction Strategy Paper
SIDS	small island developing states
SLR	sea level rise
UNFCCC	United Nations Framework Convention on Climate Change
USAID	United States Agency for International Development
VMACs	Village Mangrove Action Committees

About the Commonwealth

The Commonwealth is a voluntary association of 56 independent and equal sovereign states and home to 2.7 billion people. The Commonwealth Secretariat is an independent organisation working with the 56 member countries and assists them together to promote prosperity, democracy and peace, amplify the voice of small states, and protect the environment.

The Commonwealth Secretariat's Climate Change and Oceans Directorate assists its member countries to sustainably manage their natural resources, in the ocean and on land, for the benefit of present and future generations. The Secretariat provides technical assistance and supports member countries in the development of policies, laws, and strengthening national institutions.

Executive Summary

Guyana's Low Coastal Plain, situated between 0.5 to 1m below sea level at high tide, is home to approximately 90 per cent of the country's population and accounts for over 50 per cent of its gross domestic product (GDP). This case study examines the intersection of sea level rise with coastal adaptation policies, strategies and infrastructure in Guyana, drawing on published research, government documents and stakeholder engagement.

Local sea level rise estimates, based on tide gauge data in Georgetown for the period 1951 to 2010, range from 4.7 to 10.2mm per year – significantly exceeding the global average of approximately 3.5mm per year. Contributing factors include land subsidence from groundwater extraction (up to 10mm per year in some areas), coastal erosion and impediments to groundwater recharge. Projections suggest that relative sea level at the Guyana coast may increase by as much as 1.2m by the year 2100 compared to levels in 2000, placing most of the coast permanently submerged below average (mean) sea level conditions.

Guyana's coastal zone concentrates all major administrative and economic activities, including agriculture, oil and gas support services, and critical infrastructure. The flood in 2005 affected more than 70,000 households and generated economic losses exceeding 50 per cent of GDP. Asset exposure to episodic coastal flooding is estimated at US\$43.5 billion, and projected adaptation costs exceed US\$2 billion – equivalent to approximately 17 per cent of GDP in 2020. The commencement of offshore oil production in 2019 has raised economic stakes in the coastal zone while also providing new fiscal resources through the country's Natural Resource Fund.

Adaptation measures in Guyana span four main approaches: coastal protection (approximately 180 kilometres (km) of seawalls and 140km of earthen embankments), accommodation (drainage and irrigation systems, housing development, climate-smart agriculture and disaster management), ecosystem-based adaptation (mangrove restoration across more than 50 per cent of the coastline), and planned inland expansion. While national policies and strategies are moving towards more integrated approaches, key gaps remain, including the absence of comprehensive coastal-zone management legislation, uneven enforcement of building codes, fragmented institutional co-ordination and limited progress on planned relocation of settlements away from flood-prone areas.

This study identifies several priorities for action: redistributing population centres away from flood-prone areas, sustained investment in sea defences and drainage, protection and restoration of mangrove ecosystems, improved access to economic resources and insurance, protection of critical infrastructure, investment in research and data collection, improvement of environmental quality and public health, and strengthened disaster co-ordination and community organisation. Guyana's economic transformation through oil and gas presents a timely opportunity for incorporation of adaptation strategies to safeguard future socio-economic gains.

Country Profile

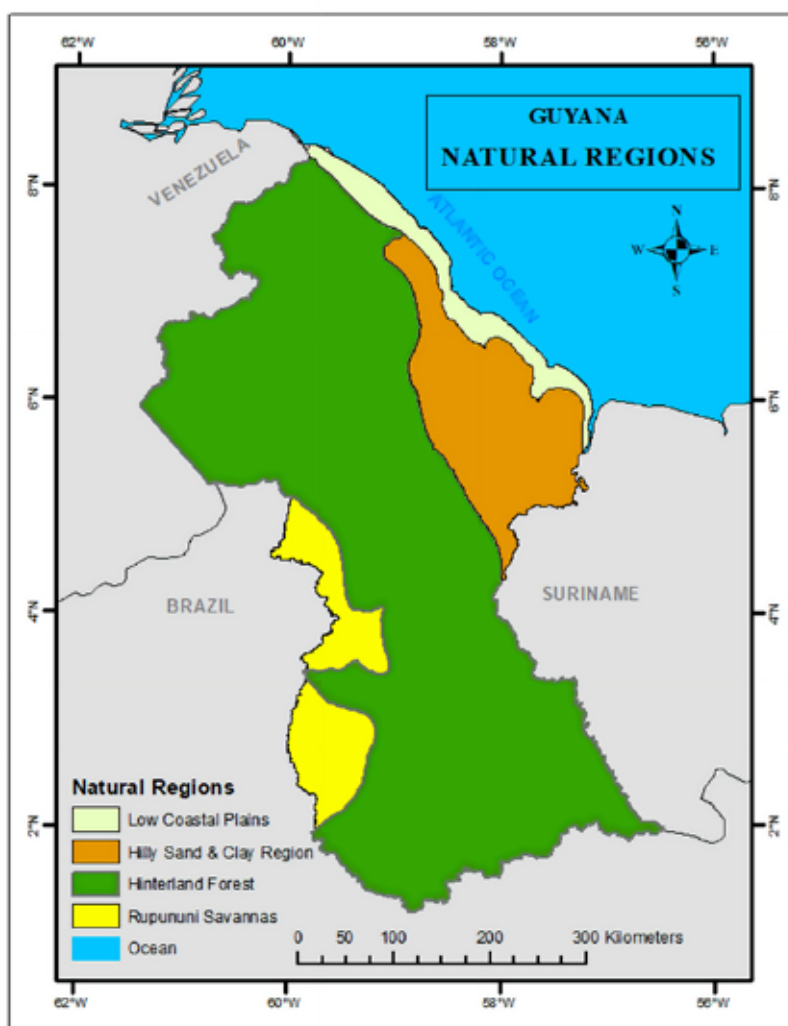
Geography, climate and natural hazard profile

Guyana is a small mainland South American country with a 425km long coastline stretching from the west at the Venezuelan border to Suriname on the east. The Guyana coast has been shaped geologically by the deposition of Amazon clay over the last 6 millennia to produce a flat low-lying coastal plain. This Low Coastal Plain, which is situated approximately 0.5–1m below sea level at high tide, is part of a chenier coast that lies between the Amazon and the Orinoco River mouths. The Coastal Plain is about 7 per cent of the total land

area and extends from 15–65km inland, where it meets the Hilly Sands and Clay Region and Hinterland Forests (Figure 1).

The Low Coastal Plain is a critically important zone to Guyana because it concentrates all major administrative and economic activities, and houses all major infrastructure, including power generation, potable water, telecommunications, health and education. The capital city, Georgetown, and other important towns, New Amsterdam, Rose Hall, Corriverton and Anna Regina, are all located within the Coastal Plain.

Figure 1. Natural regions of Guyana



Source: Guyana Lands and Survey Commission

The coast, being a low-lying zone, has a long history with flooding. Coastal flooding is the dominant and most frequent natural disaster in Guyana. The principal drivers that enhance the pervasiveness and effects of flooding include the widespread occurrence of heavy and often long-lasting rainfall, the increased intensity of rainfall over short periods, and breaching and/or overtopping of sea defences.

The historical record clearly demonstrates that the coastline is inherently vulnerable to sea incursions. This has been an issue of concern for every government, colonial or independent. In almost every decade of the twentieth century, Guyana experienced flooding because of heavy rainfall, conservancy dam breaches, sea defence breaches or a combination of these factors. In more recent history, flood frequency appears to have been elevated. There were at least 26 major coastal

flooding events during the period from 1990 to 2005 (Dalrymple 2004; Bovolo 2014), with the 2005 flood being among the most significant in recent history (ECLAC 2005). Subsequent flooding events in 2021 and 2022 further underscored the country's vulnerability. Heavy rainfall in the summer of 2015 led to flooding in several coastal regions, including administrative Regions 2 (Pomeroon-Supenaam), 4 (Demerara-Mahaica) and 5 (Mahaica-Berbice). Estimates place the economic impacts of the flood at exceeding 90 billion Guyana dollars (G\$) and severely impacting more than one-third of the population (ECLAC 2005). More recently, in May 2021, a tropical wave embedded within the Intertropical Convergence Zone (ITCZ) resulted in 0.6 m of total rainfall for the month. This was the second highest rainfall total for the month across the country since 1981 (CDEMA 2021). In June 2022, heavy rainfall caused widespread flooding in

Figure 2. Top: 2015 Flooding in the streets of Georgetown. Bottom: House in Kwakwani, located in the Hinterland region of Guyana



Photo credits: Top – GINA; Bottom - Civil Defence Commission, Guyana

hinterland and northern coastal regions, and in May 2024, flooding in Region 9 washed out roads and displaced communities (ReliefWeb 2022). Figure 2 shows the impacts of flooding in Georgetown and the Hinterland region.

Like many developing economies in the region, natural disasters in Guyana pose a great threat to economic and social gains at both the national and local levels. The shift in spending for disaster recovery has implications for national investments and the servicing of debt in countries that are already considered highly indebted. The sensitivity of the economies within the region to both external and internal shocks cannot be overstated and was evident during the COVID-19 pandemic (ECLAC 2021). Over the years, Guyana has invested heavily in coastal protection to alleviate flooding. Along with a complex system of drainage canals, pumps and sluice gates (*kokers*), coastal protection is primarily achieved through a combination of rigid, flexible and soft sea defence structures, which cover about 60 per cent of the shoreline. Most of the structures are rigid (sea walls and groynes) and soft structures (earthen embankments and mangroves), which account for about 180km and 140km of coastline, respectively. The remaining sea defence inventory is composed of flexible structures, mostly rock armour (Government of Guyana, 2018).

Seawalls are usually constructed to protect eroding sections of shoreline where the earthen embankment becomes exposed to wave action. Most of the engineered sea defences were constructed many decades ago. Guyana, since its independence in 1966, has implemented several programmes to rehabilitate the sea defences. However, these engineered structures can experience structural deterioration that repeatedly results in breaches. According to a 2015 survey (*ibid.*), about 40 per cent of the coastal protection resources are in 'fair' or less than fair condition. The rest is in 'good' condition based on the survey.

Population and demographics

Approximately 90 per cent of the population lives on the coast with about one-third residing in the coastal towns. The Guyanese population has grown from 407,000 in 1950 to approximately 840,000 in 2024 (UN Population Division 2024 revision). Of the population, 78 per cent is concentrated in four administrative regions of the country (Regions 3 (Essequibo Islands-West Demerara),

4 (Demerara-Mahaica), 5 (Mahaica-Berbice) and 6 (East Berbice-Corentyne)), which occupy a mere 7 per cent of the total land area. Based on the 2022 census, about 60 per cent of the population now resides in neighbourhood villages or towns directly adjacent to the sea. The Greater Georgetown population alone has increased by about 5 per cent from 2012 to 2022.

Major changes in coastal settlement patterns have occurred in the last 20 years with the development of a series of housing schemes, particularly low-income housing. Most of the new housing schemes were set up on previously cultivated sugarcane land and the proximity of these development areas to the shoreline concentrates exposure and vulnerability to sea level rise along the coast (McHardy and Donovan 2016). Further, there is complex feedback loop between housing development and flooding, where replacement of vegetation cover with impervious surfaces increases stormwater runoff and reduces groundwater recharge.

The national housing stock increased by approximately 42.02 per cent from 2012 to 2022, with the opening up of new lands for housing development by the government largely responsible for growth in the housing sector. Even with increased ownership over the last two decades, McHardy and Donovan (2016) estimated that Guyana had a deficit of 20,000 homes for low-income families, an annual shortage of 5,200 housing units. The housing shortage coupled with increased urbanisation rates leads to squatting settlements with no formal or social infrastructure, and subdivision of property where vulnerable open ground floors ('bottom houses') are converted into multi-family dwelling units (Pelling 1997, 1999; Mycoo 2014).

In Guyana, development of oil and gas resources could continue to drive an increase in the coastal population within flood-prone areas. As socio-economic opportunities increase within the narrow coastal zone, rural migration to urban areas is expected to continue. Further concentration of human settlement within these zones will increase the likelihood of exposure.

Economic context

Historically, the coastal plain accounts for over 50 per cent of Guyana's total gross domestic product (GDP), primarily from agriculture (~20 per cent) and services (35 per cent) (FAO 2015). The latter service industry includes trading (wholesale and retail), hotels and restaurants, transport, government, financial, professional, and personal services such as education, healthcare and real estate services. The production of crude oil began offshore in 2019 and has contributed 40–60 per cent of GDP growth since 2022 (USEIA 2024). Significant resources have been consolidated along the coastal plain to support oil production, including harbour development, corporate offices, warehouses, hotels, housing, infrastructure, and both local and foreign human resources.

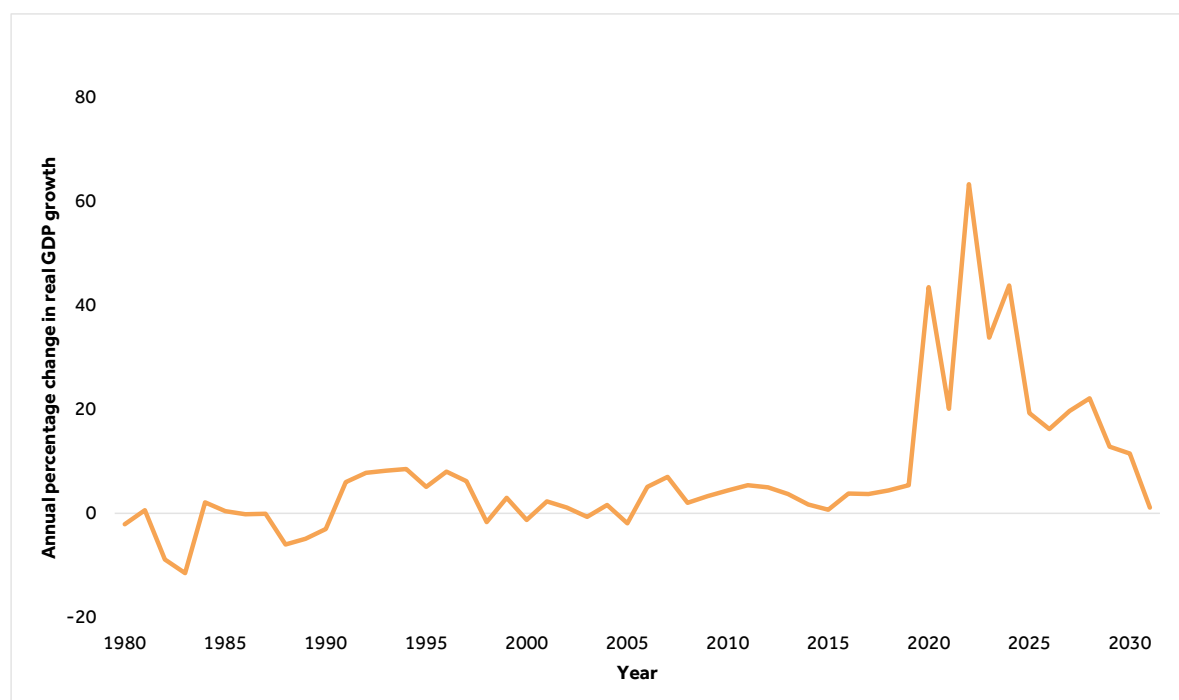
Guyana is amid a socio-economic transition fuelled by offshore oil discovery. With estimated production at 1.25 million barrels per day by 2027, Guyana is projected to become the world's highest oil per capita country. Some experts suggest the nation could become among the richest in the world (Shookoonsingh 2019). In 2025, the economy

grew an estimated 43.6 per cent. The discovery of offshore oil reserves and subsequent production are regarded as transformative for the country's economic prosperity (Figure 3).

The projected socio-economic upturn has vastly differentiated the country from its historic socio-economic classification and association with small island states of the Caribbean and Pacific. For the first time in the country's history, resources exist to address pressing challenges – including climate risk. By May 2020, Guyana had already received US\$60 million from offshore oil production. The funds were deposited into the country's Natural Resource Fund. Over the next 8 years, annual revenue estimates peak at US\$13 billion, with annual tax income is expected to average at US\$7 billion over the next 20 years (McKenzie 2020).

However, there are significant concerns over the trajectory towards the resource curse phenomenon known as 'the Dutch disease', where excessive dependence on or excessive exposure to a single sector stymies the development of other sectors while driving up the overall cost of living (Wenner et al. 2018). The government has expressed its

Figure 3. International Monetary Fund (IMF) trend of real GDP in Guyana



Source: International Monetary Fund. <https://www.imf.org/en/Countries/GUY>

Note: Data from after the year 2025 are estimates

intention to invest in the competitiveness of other economic sectors, particularly agriculture and agro-processing. Agriculture has seen a steady decline over the last 20 years, partly from climate-related impacts and flooding (Zorrilla et al. 2012; Lipper et al. 2014; Tomby and Zhang 2019). In addition, the global drive away from carbon-intensive energy sources poses some risk to Guyana's economy, which must be balanced with meeting development objectives.

Governance and institutional structure

Several factors have been found to hinder the effective implementation of coastal protection responses in the country. According to Lees et al. (2009), sea defence objectives have yet to be effectively transferred from national to sector level. Their analysis, along with the *Rapid Assessment Report* conducted in 2015, laments that a clear division of scope and responsibilities among institutions and sectors is still missing (Government of Guyana, 2018; Lees et al. 2009). In 2000, the Integrated Coastal Zone Management (ICZM) programme was conceived, but never fully implemented. McCall (2009) attributes this to several persistent and interrelated barriers: the absence of supporting legislation to give the ICZM framework legal force; a shortage of competent and committed human resources; the lack of workable mechanisms for integrated enforcement and cross-agency management; and inadequate financial and scientific support.

These challenges reflect a broader pattern of institutional fragmentation in Guyana's coastal governance, where no single entity holds overarching responsibility for coastal-zone management, and where sea and river defence legislation has historically lagged evolving policy frameworks (NIRAS 2019). While the Government of Guyana has made progress in updating disaster risk management (DRM) policies and planning – including European Union (EU)-funded efforts to modernise sea and river defence legislation – the translation of policy intent into co-ordinated, cross-sectoral implementation remains an ongoing challenge. This is compounded by competing development priorities and limited institutional capacity at the regional level.

National legislation in Guyana is currently fragmented and addresses specific resources separately. It includes legislation for sea and river defence (the Sea and River Defence Act, 2024), mangroves (the Forests Act, 2009), and environmental protection (the Environmental Protection Act, 1996). The Civil Defence Commission is currently pushing for a DRM legislation.

In 2019, the Coastal and Marine Management Committee (CMMC) was established through Guyana's Environment Protection Agency (EPA) to assist with co-ordinated management of the coastal and marine environment through inter-agency collaboration. One additional tool being developed is the Sea Defence Information Management System (SDIMS).

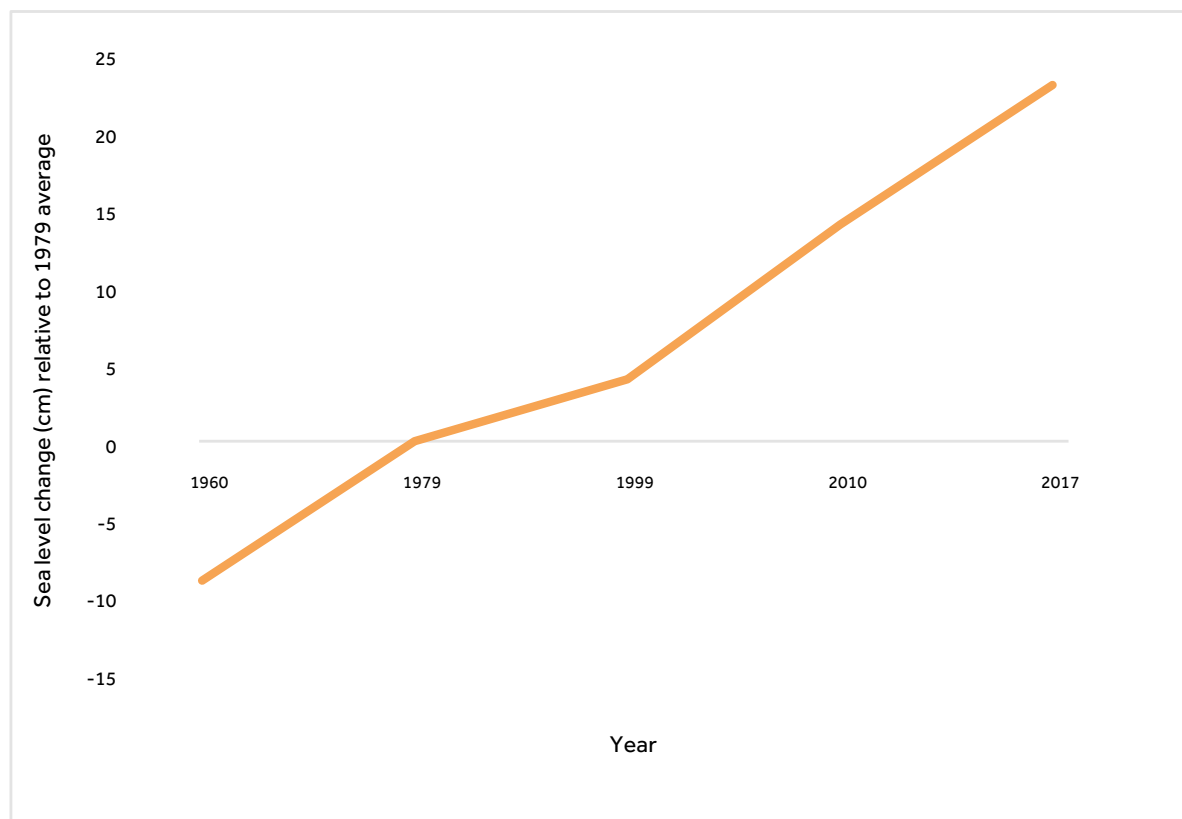
Sea Level Rise in Guyana

Local sea level rise observations (tide gauge data, satellite altimetry)

Guyana forms part of the north-eastern coastal zone of the South American continent, which is known as the Guiana coast. It extends from the estuaries of the Amazon to the Orinoco Rivers and consists of the North Atlantic coastlines of Brazil, French Guiana, Surinam, Guyana and Venezuela. Sea level rise rates in the Intra-Americas seas show intra-regional variability (Losada et al. 2013; Reguero et al. 2015). The basin average mean sea level rise from altimetry is 1.7 ± 1.3 mm per year for the period 1993–2010 (Torres and Tsimplis 2013). Historical changes within the region suggest more frequent extreme sea levels (Losada et al. 2013; Torres and Tsimplis 2013).

Based on tide gauge data from along the Guyana coast, the range of sea level rise rates from 1870 to 2010 has been estimated to be 1.2 to 10.2 mm per year (Ali 2016). These rates are deduced from analysis of three datasets: (i) 1870–1970; (ii) 1951–1979 for Georgetown; and (iii) 1970–2000. The mean sea level rise rate from 1870–1970 was 1.2 mm per year and 10.2 mm per year from 1951–1979. The most recent dataset shows a sea level rise rate of 6.07 mm per year. Analysis of tide gauge data for the period 1960–2010 suggest a rate of 4.7 mm per year. The post-1950 range of 4.7 to 10.2 mm per year is much higher than the global average rate of 1.5 mm per year during most of the twentieth century (Church and White 2011) and the rate of global mean sea level rise of 5.8 mm per year (Lindsey 2023).

Figure 4. Observed sea level change in Georgetown, Guyana relative to 1979 average



Notes: Observed relative sea-level measurements at Georgetown. The 1960–1981 period represents a reported 9 cm rise from historical tide-gauge observations; subsequent observations (1979, 1999, 2010 and 2017) are mean sea-level measurements reported by MARAD-MPI/JICA. Data are not a continuous annual time series and should not be interpreted as such. Relative sea-level change reflects both ocean-level change and vertical land movement, including land subsidence, and therefore should not be equated directly with ocean-only or global mean sea-level rise. Sources: Government of Guyana, National Development Strategy 2001–2010, Ch. 18; JICA (2017), Project for the Study on Drainage and Flood Control in the Georgetown Metropolitan Area; PSMSL, Georgetown Station 305.

Projected local sea level rise

The Intergovernmental Panel on Climate Change (IPCC) projections of global sea-level rise of approximately 5 mm per year, with a range of 2–9 mm per year, are expected to exacerbate the frequency and magnitude of flooding events in low-lying coastal areas such as Guyana (IPCC 1996; Government of Guyana 2002). Dalrymple (2004) estimated a change in return period for the high-water levels at the Georgetown shoreline from 15 years to 1 year using global, regional and estimated local sea level rise projections. This suggests that extreme events which occur every one to two decades could become annual events.

Future projections of relative sea level rise may be estimated by summation of global sea level rise, regional sea level change induced by oceanic changes over a given period, and vertical land movement. Based on these estimates, the local relative sea level at the Guyana coast may increase by as much as 1.2 metres (47 inches) by 2100 compared to 2000 levels. This projected rise would put most of the coast permanently under average (mean) sea level conditions, with some areas being as much as 2 metres under the high-tide level, and so close to the low-tide level that gravity drainage could become challenging. Hence, the projected scenario signals an increased probability and occurrence of catastrophic flooding of coastal cities and towns.

Increasing sea levels poses six primary concerns for low-lying coasts. These include: (1) permanent submergence of land; (2) more frequent or intense flooding; (3) enhanced erosion; (4) loss and change of ecosystems; (5) salinisation of soils, ground and surface water; and (6) impeded drainage (Hinkel et al. 2014). In Guyana, higher sea levels will severely impact human settlement, economic activity (including agriculture, oil and gas, tourism, etc.), coastal ecosystems and critical coastal infrastructure.

Contributing factors (subsidence, coastal erosion, land-use change)

The local sea level changes at the Guyana coast are a function of the global average, regional sea level changes (including ocean currents), vertical land displacement (mostly subsidence) and coastal erosion. Most of the sea level changes at the Guyana coast may be attributed to subsidence,

which has previously been estimated to take place at a rate of 10mm per year in some areas (Khan and Sturm 1995). Coastal subsidence is occurring because of groundwater extraction, soil compaction, impediments to groundwater recharge and drainage of wetlands. Coastal impacts from sea level rise therefore require localised assessment to capture coastal dynamics and human-induced alteration of coastal processes and ecosystems.

Further, there is complex feedback loop between housing development and flooding, where replacement of vegetation cover with impervious surfaces increases stormwater runoff and reduces groundwater recharge. The result is more frequent flooding, especially from heavy, intense rainfall, and higher flood peak flow in local areas. Even if drainage systems are upgraded, the underlying impervious clay soils, the generally flat coastal topography and the land elevation below mean high-tide levels increase flood risks. In many situations, however, drainage capacity has been reduced because of the infilling of drains (including from illegal solid waste dumping) and inadequate maintenance.

Impacts and Vulnerabilities

Coastal communities and human settlement

Approximately 90 per cent of the population lives on the coast with about one-third residing in the coastal towns. Based on the 2022 census, about 60 per cent of the population now resides in neighbourhood villages or towns directly adjacent to the sea. Guyana can be differentiated from its small island counterparts in both the Caribbean and Pacific regions, where geographic constraints severely limit inland expansion options. Guyana's vast hinterland offers a potential pathway for population redistribution that is largely unavailable to Pacific small island developing states (SIDS). However, until now, most development activities have remained concentrated along the coast, driven not only by established infrastructure and economic activity but also by strong cultural, ethnic and ancestral ties to coastal communities.

Major changes in coastal settlement patterns have occurred in the last 20 years with the development of a series of housing schemes, particularly low-income housing. Most of these housing schemes have been set up on previously cultivated

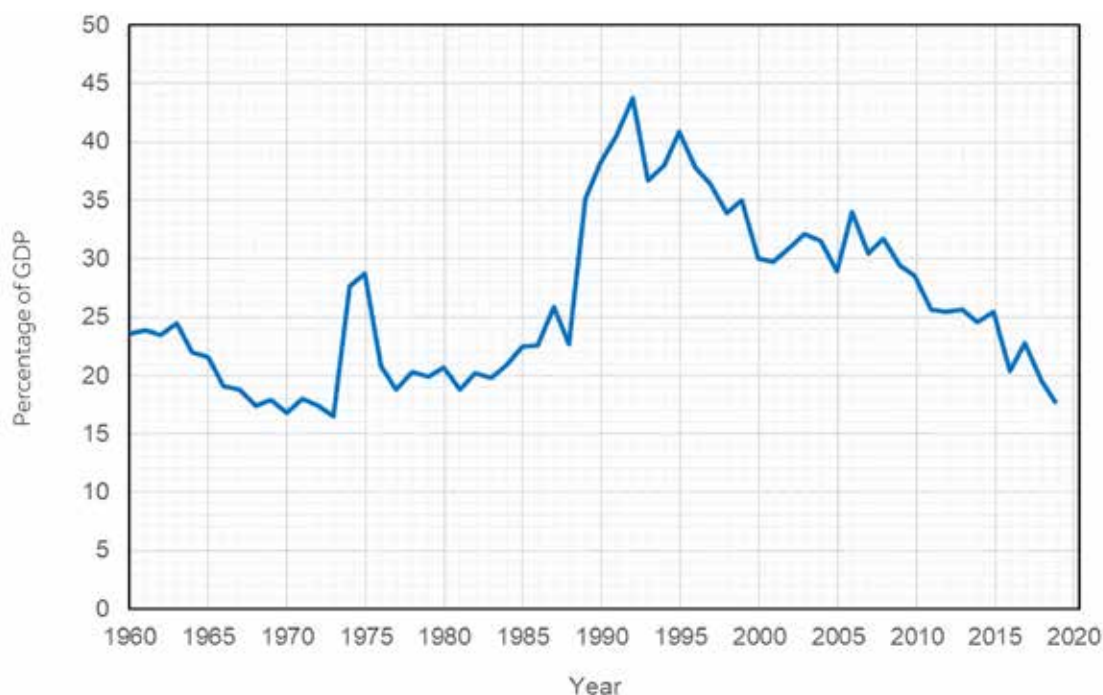
sugarcane land, and the proximity of these development areas to the shoreline concentrates exposure and vulnerability to sea level rise along the coast (McHardy and Donovan 2016).

In the 2005 flood, about 70,000 homes were directly impacted with an estimated damage total of US\$276 million (ECLAC 2005). In subsequent flooding events, including the May 2021 floods, an estimated 25,000 homes were affected due to heavy rainfall along the coast and hinterland. Most analyses of coastal human settlements show sea level rise has the potential to create devastation in Guyana, given the exposed assets and population (Dalrymple 2004; ECLAC 2011; Mycoo 2014).

Agriculture and food security

Guyana is currently a highly agriculture-dependent country with most of its agricultural production concentrated within the coastal zone. Agricultural production averaged 26 per cent of GDP from 1960 to 2019 (Figure 5). Since the 1990s, the sector's contribution has been steadily declining due to a range of challenges, including natural disasters, environmental stress and fluctuating

Figure 5. Agriculture's contribution to GDP in Guyana



Source: World Bank national accounts data; Organisation for Economic Co-operation and Development (OECD) National Accounts data files.

international market prices for traditional crops such as rice and sugar (FAO 2015; Paiva and Bacha 2019). Despite the decline in the traditional sector, export of non-traditional agricultural commodities (agro-processing exports, prepared foods and fresh foods) has increased and the country has continued to produce enough for local consumption and trade.

Sea level rise will affect agriculture mainly through inundation of land, salinisation of soil and fresh groundwater, and land loss due to permanent coastal erosion. Impacts will include damage to farmland and physical infrastructure (including machinery and equipment), production losses, and losses of stock (including livestock, inputs and harvested products). Rice and sugar cultivation are particularly susceptible to saline intrusion and flooding, and higher salinity levels have been shown to affect the germination process of rice. This has prompted research into saline-resistant varieties along the coast, which seems to be providing promising results (NARI 1996; Zorrilla et al. 2012). In the sugar industry, flooding is directly responsible for the rotting of newly planted shoots and underdevelopment of root systems, leading to reduced sugar production (Tomby and Zhang 2019).

In response to the IPCC A2 scenario (IPCC 2000), the Economic Commission for Latin America and the Caribbean (ECLAC) estimated losses of US\$144–300 million for sugar, US\$795–1,577 for rice and US\$15–34 million for fisheries by 2050 (ECLAC 2011). The combined total of estimated losses (direct and indirect) for rice and sugar during the 2005 flood was US\$20 million, while other agricultural losses exceeded US\$30 million (ECLAC 2005). To protect agriculture, Guyana continues to invest annually in flood water control (sea defences, pumps and drainage maintenance) and climate-resilient crops (Lipper et al. 2014; Mcleod et al. 2019).

Fisheries and marine resources

In the nearshore region, several shrimp and crab species are common, while numerous freshwater fish inhabit the canals and drainage ditches that lead into the swamps (Beck et al. 2020). The northwest region of Guyana, specifically Shell Beach in Region 1 (Barima-Waini), provides annual nesting grounds for at least four of the country's seven sea turtle species: the green, hawksbill, leatherback and the olive ridley sea turtles.

ECLAC estimated losses of US\$15–34 million for fisheries by 2050 (ECLAC 2011). Coastal fisheries are directly affected by sea level change through mangrove loss, sedimentation changes, species distribution shifts and damage to fishing infrastructure.

Coastal ecosystems (mangroves, coral reefs, wetlands)

Mangrove ecosystems cover about 290km of Guyana's 425-km coast and line its riverine areas. The dominant species are *Rhizophora mangle*, *Avicennia germinans* and *Laguncularia racemosa*. Generally, either an herbaceous swamp or a swamp forest occurs behind the mangroves. These coastal ecosystems provide habitat for fish and wildlife, including commercially valuable fisheries, and provide breeding grounds for many birds, including egrets, herons and the scarlet ibis.

Mangroves take root in sediment that accumulates and gradually rises above the shallow coastal waters. The sediments are transported westward by longshore drift along the coast originating from the Amazon Delta and other rivers along the north coast of South America. High sediment concentration leads to agglomeration into viscous sling mud that settles and forms mudflats on the shoreline and mud shoals in the offshore region (NEDECO 1972). As the tidal flat emerges above the high-water level, mangroves are established, and this serves to stabilise the flats. The coast that lies directly behind the mangrove and accreting mud shoal is protected from wave action as the mud flat dampens out the wave energy. In this way, mangroves serve an important coastal protection function, in addition to their other recognised ecosystem services.

As sea level rises, and coastal cycles of accretion and erosion propagate, mangroves naturally move landward. However, in many developed areas along the Guyana coast, mangroves are unable to naturally migrate inland and therefore slowly die off from coastal squeeze. This exposes the once protected coastline to damage from wave action and eliminates habitats for fisheries and wildlife.

Moreover, mangroves and coastal ecosystems are already impacted by other climate-related ocean changes and adverse effects from human activities, including mangrove clearing for development projects, fuel, housing development, squatting and

the creation of vistas to the sea. According to a national report, Guyana's mangrove cover declined by a staggering 70 per cent from 1992 to 2015 (Government of Guyana, 2018).

Infrastructure and critical services

Water supply for domestic, agricultural and industrial uses is obtained from a combination of ground and surface water sources. Regarding surface waters, higher sea levels will drive saline water further into rivers, resulting in saline contamination in their lower reaches. Narayan (2006) estimated a saline penetration into the Upper Sands, A Sands and B Sands coastal aquifers by 150, 180 and 380 metres, respectively, assuming a 1-metre increase in sea level rise. However, he noted there had been no problem with saline intrusion into any wells at the time of the research (Narayan 2006). Narayan (2006) noted that of more concern is the intrusion of brackish water from rivers into the groundwater aquifers.

The flooding experienced in January 2005 impacted water infrastructure along the large part of the coastal plain of Guyana, including Georgetown, where several water production sites were taken out of service prior to the wells being covered by flood waters. This was done to safeguard control and electrical equipment and to prevent the distribution of contaminated water. In addition, it should be noted that several standpipes in the city became covered, meaning residents were not able to access water.

Road networks also stand to be severely impacted by floods resulting from sea level rise. In many communities, roads are usually constructed prior to housing development. However, in most cases, housing development lands are not built up and managed to improve hydrology. Therefore, as residents construct buildings, they individually raise the elevation of their plot, resulting in uneven elevation in the area. Usually, the elevation is lowest at the road, which is the first to flood during a breach or heavy rainfall. During the 2005 flood, 259km (415 miles) of roadways were affected with almost US\$17 million worth of damage. Other critical infrastructure affected by coastal flooding includes electricity and telecommunications, which saw losses of US\$1.75 million due to the 2005 flood (ECLAC 2005).

Of particular concern are onshore shore base facilities and marine/aviation services for the oil and gas industry, which are vulnerable to sea level rise as they are located within the low-lying coastal plain. Guyana's current shore base is located at the mouth of the Demerara River, just outside Georgetown. There are also the indirect impacts associated with infrastructure disruption and lost time, as workers may be unable to travel to work. Increased vulnerability due to sea level rise will also reduce the capacity for expanding and maintaining onshore and offshore support facilities and transportation networks.

Economic costs and risks

The Low Coastal Plain of Guyana was a former mangrove swamp that was engineered through massive land reclamation work for the cultivation of crops, particularly sugar and rice. Coastal land reclamation mostly took place through impoldering, where a narrow strip of land is separated from the sea and drained by a series of drainage canals. Due to high evapotranspiration rates and intermittent dry weather periods, a supplementary freshwater supply is necessary and is provided from water conservancy reservoirs. The result is productive land squeezed between a saline sea and freshwater reservoirs, which requires constant water management to avoid inundation from both sources.

The cumulative exposure of assets and population to episodic flooding risk can be estimated as a function of the population and GDP per capita within the hazard zone, using an empirical asset-to-GDP multiplier of 2.8 (Hinkel et al. 2014). The relationship $A = 2.8 \times P \times G$ estimates the value of exposed assets (A) by multiplying the population within the hazard zone (P) by GDP per capita (G), and applying a factor of 2.8 to approximate the value of assets relative to annual economic output. Using this relationship, with the 2025 population (assuming 50 per cent live less than 10 metres above sea level) and GDP per capita, asset exposure to episodic coastal flooding is estimated at US\$43.5 billion. This estimate is substantially higher than previous ECLAC studies, which placed the value of exposed assets at approximately US\$5 billion (ECLAC 2011). The difference reflects, in large part, the exceptional growth in Guyana's GDP following the expansion of the oil and gas industry. However, the resulting estimate should

be interpreted with caution, as applying an asset-to-GDP multiplier derived from historical economic relationships to Guyana's rapidly changing, oil-driven economy may overstate the current value of assets exposed to coastal flooding.

The total assets exposed will increase as a factor of GDP growth, assuming no investment in adaptation infrastructure, primarily coastal defence, to reduce current flood risks. Given the estimate described above, maintenance of current flood risks would be unsustainable for Guyana as GDP continues to increase. Instead, the situation calls for an adaptation policy that reduces flood probability over time. The projected cost estimates for adaptation exceed US\$2 billion (Guyana Times 2023). This figure includes the costs of building and reinforcing sea defences, upgrading conservancies and drainage, developing and deploying flood resistant crops, and innovative financial risk management and insurance measures to strengthen resiliency.

Coastal flooding disasters result from the interaction of hazard magnitude, exposure and vulnerability, which are influenced by underlying development processes. The combination of flood severity and frequency, the population and assets exposed, and their vulnerability to damage is key to determining the risk associated with coastal flooding. Even if the probability of coastal flooding is unchanged in the future, assuming that coastal defence infrastructure is increased and upgraded, the fact that a larger share of existing assets is protected by these defences means that annual losses will increase relative to local GDP. In other words, even if Guyana experiences the same or fewer occurrences of flooding, each flood event will be more destructive owing to sea level rise and subsidence, even with better defences. This means that policy-makers need to ensure the development of defences outpaces rising sea-levels.

Policy and Governance Framework

National policies and strategies (NAPs, NAPAs, NDCs)

Guyana has demonstrated its commitment to addressing vulnerability through the ratification of key international climate change agreements and its partnership in the Declaration of Turkeyen. Following the 2005 flood, which resulted in significant economic losses, the country embarked on a series of policy and strategy initiatives aimed at reducing vulnerability and advancing its development priorities. These priorities are reflected in key national policy and planning frameworks, including the National Development Strategy (NDS), Poverty Reduction Strategy Paper (PRSP), National Competitiveness Strategy (NCS) and Low Carbon Development Strategy (LCDS).

Through several policies and strategy documents, and within the broader context of an evolving international legal framework for climate adaptation – including state obligations under the UN Framework Convention on Climate Change (UNFCCC), the Paris Agreement and related human rights instruments (Lancaster 2023) – Guyana has indicated its intention to address adaptation measures in response to multiple hazards. In its adaptation planning, the country has given priority to key infrastructure development to protect against the risks of extreme events and the slow onset of climate-induced sea level rise. This includes drainage and irrigation infrastructure and the development of early warning systems for climate events.

The NDS (1996) acknowledges Guyana's vulnerability to flooding and identifies the need for infrastructural development, funding and mangrove protection as flood abatement strategies. The PRSP (2002) recognises the importance of drainage and irrigation infrastructure for flood management and overall poverty reduction through flood prevention to protect homes and agricultural productivity. The NCS (2006) identifies flood reduction as a strategy to improve economic competitiveness and identifies the Drainage & Irrigation (D&I) Board as the implementing agency.

Guyana's LCDS (2009) recognises that investments in priority climate adaptation infrastructure can reduce the 10 per cent of current GDP that is estimated to be lost each year because of flooding. It identifies, as a priority, the rehabilitation of drainage and irrigation systems to improve the country's ability to manage water in the East Demerara Water Conservancy. The strategy commits US\$100 million as a once-in-a-generation effort to upgrade Guyana's ability to cope with climate change.

The Disaster Risk Management (DRM) Policy (2013) is built on the 2005–2015 global Hyogo Framework for Action (HFA) and pulls on the Caribbean Disaster Emergency Management Agency's (CDEMA's) Comprehensive Disaster Management (CDM) Framework 2014–2024. The policy seeks to mainstream DRM and climate change adaptation into development planning, enacts the national DRM platform, establishes co-ordination mechanisms, roles and responsibilities, provides for a disaster emergency management system and a multi-hazard alert system, and establishes a national DRM Fund to assist DRM activities.

The Climate Resilience Strategy and Action Plan (CRSAP) (2015) is intended to provide an overarching framework for planning and implementing climate resilience actions. It includes a five-year development road map, training needs and capacity development plans, the updating of climate information, associated risks, adaptation actions and eventually updating the CRSAP to the National Adaptation Plan (NAP).

Guyana has committed to the NAP process. While an initial draft was developed under the earlier UN Development Programme Japan-Caribbean Climate Change Partnership (UNDP J-CCCP), it was not formally adopted by Cabinet, and subsequent changes in government leadership shifted national priorities. A renewed NAP preparation process was launched in 2024, building on Guyana's CRSAP and aligned with the LCDS 2030, the country's updated Nationally Determined Contributions (NDCs), and the UNFCCC technical guidelines for NAPs.

Legal and institutional framework

National legislation linked to sea level rise is currently fragmented and addresses specific resources and aspects of coastal management separately. The legal framework includes legislation for sea and river defence (Sea and River Defence Act, 2024), mangroves and forest (Forests Act, 2009) and environmental protection (Environmental Protection Act, 1996). The Civil Defence Commission is, as of 2025, advocating for the development of dedicated DRM legislation.

A co-ordinated and planned development strategy remains missing and sea defence maintenance work is still often carried out in an ad hoc fashion. However, there has been increased focus on the need to be proactive with sea defence management by following an established, but flexible, programme that guides interventions. A Sea and River Defence Sector Policy has been developed and was last updated in 2015. While the policy provides guidance for sea defence management, achieving the full objectives is often hindered by availability of resources.

In 2019, the Coastal and Marine Management Committee (CMMC) was established through the Environment Protection Agency (EPA) to assist with co-ordinated management of the coastal and marine environment through inter-agency collaboration. Nonetheless, there is no comprehensive coastal-zone management legislation that governs and guides inter-agency co-ordination.

The Guyana National Bureau of Standards has developed national building codes for the country. However, there is no legal framework to implement the codes, which are completely voluntary and provided as guidelines. No agency has been given the legal mandate to monitor and enforce the provisions of the codes.

Sub-national and local governance

Resource allocation is critical for the success of disaster co-ordination provided by the Civil Defence Commission (CDC), Guyana's national agency responsible for disaster risk management and emergency preparedness and response. Providing the legal framework for disaster risk management can promote strong accountability for reducing disaster risk at the community level. However, even with implementation of a legal framework, local

government agencies and community groups will require strengthening if they are to make DRM a priority.

Community engagement examples exist at the local level to foster collaborative and co-ordinated responses on the ground, including several with an explicit environmental and coastal resilience focus. Notably, Village Mangrove Action Committees (VMACs) have been established in at least eight coastal communities – including Victoria, Annandale/Friendship and communities along the Essequibo Coast – through the Guyana Mangrove Restoration Project and National Agricultural Research and Extension Institute's (NAREI's) ongoing programme. These committees train community members in mangrove ecology, restoration, seedling propagation and monitoring, while also supporting alternative livelihoods such as beekeeping and eco-tourism (UNEP CEP 2019; NAREI 2016).

At present, programme and policy success, in general, is still highly dependent on consistency in implementation and sufficient resource and budgetary allocation to empower the participating agencies to meet the desired objectives. The significance of projected sea level rise impacts and experience with coastal flooding incidents in the last two decades should encourage or foster commitment across different government administrations to champion and maintain consistency in the mainstreaming of sea level rise (and more generally, climate change) into sea defence policy, including resource and budget allocation.

Adaptation Measures

Coastal protection (hard infrastructure)

For more than a century, coastal protection measures have been put in place at various locations along the Guyana coast as part of sea defence efforts. These include hard, soft and flexible engineered structures. Hard structures include concrete seawalls and revetments, while flexible structures include rock armour (rip rap), which is constructed using large blocks of natural rock arranged in a slope at the base of the earthen embankment. Concrete seawalls make up the larger share of coastal protection (70 per cent). These structures are usually effective in deflecting wave energy, but often suffer from erosion at the base and may require regular repair. They can also be expensive to construct: estimated cost per kilometre is between US\$4.4 and US\$6.4 million.

For existing and new sea defence structures to effectively reduce coastal risk and impacts from mean or extreme sea levels, they must be designed for projected sea level rise and account for at least a 1-metre and 2-metre rise in 50 and 100 years, respectively.

The construction of sea defences has long been a response to seawater inundation in Guyana. This is necessitated by the low-lying reality of the coastal plain and the fact that both 90 per cent of its population and 75 per cent of economic activity have been confined to the area. Hence, throughout its pre- and post-independence history, the country has always placed a high priority on the construction, rehabilitation and maintenance of sea defences. Seawalls, in particular, will continue to be a widespread response to coastal inundation, especially in highly populated areas along the coast. A well-designed and maintained seawall can be highly effective in reducing flood risk, but the cost of construction is a concern.

There are also drawbacks to engineered coastal protection, including modification of hydrodynamic and morphodynamic patterns, which may affect erosion and accretion patterns in the nearshore with consequences in adjacent areas (NEDECO 1972). Seawalls also create coastal squeeze for mangroves by restricting their onshore migration as

sea level increases – leading to both a loss of habitat and of the protection function of ecosystems (Pontee 2013; Gittman et al. 2016).

Guyana's Second National Communication to the UNFCCC identified 360km of sea defence requiring upgrade and maintenance (GoG 2012). Over the last decade, public spending on sea defence has been approximately G\$3 billion per year, while estimates put future expenditure at G\$5 billion per year. Even with significant past investments, the expected annual damage from flooding in the wider Georgetown is estimated at G\$1.3 billion per year (approximately US\$6 million), with a further G\$0.625 billion (approximately US\$3 million) in disruption and repair costs to critical infrastructure (IDB 2019). Desmet et al. (2021) project an almost 2 per cent loss per year in real GDP by the end of the century because of coastal flooding.

Ecosystem-based adaptation

Mangrove forests occupy more than 50 per cent of the Guyana coastline, spanning an area of approximately 226 square kilometres (km²). Significant reduction in the standing stock of mangrove forests occurred from 1992 to 2015, with as much of the 70 per cent of mangroves disappearing (Government of Guyana, 2018).

However, given their susceptibility to erosion, particularly on loose mud flats, mangroves may require complementary risk reduction measures to achieve a desired level of protection. In Guyana, co-location of mangroves with breakwaters, geotextiles and groynes can assist in creating accretionary and stabilised mud banks that support mangrove growth (Spalding et al. 2014; Toorman et al. 2018). If integrated appropriately, mangroves can contribute to risk reduction in almost every coastal setting, ranging from rural to urban and from natural to heavily degraded landscapes.

Mangroves offer a sustainable alternative to rigid sea defences, particularly with respect to maintenance cost. However, for these ecosystems to optimally contribute to risk reduction, they need to be managed within an Integrated Coastal Zone Management framework. Following restoration, ongoing planning and monitoring are necessary to

Figure 6. Government leaders tour the city of Georgetown and urge citizens to refrain from dumping in the drainage system at Charity, Essequibo



Photo credit: Ministry of Agriculture

ensure that restored areas continue to thrive. In Guyana, NAREI has developed a comprehensive mangrove monitoring system that integrates GIS (Geographic Information System), remote sensing, field surveys and community engagement, drawing on partnerships with SERVIR-Amaozonia, a regional Earth-observation and geospatial information initiative formerly supported by the US National Aeronautics and Space Administration (NASA) and the US Agency for International Development (USAID) (Hyman et al. 2020; SERVIR-Amaozonia 2022). EU funding has further contributed to mangrove restoration and sea defence works, including a 7.5 million euro (€) programme for coastal protection ((Ragobeer 2023).

Predicting the nearshore dynamics of the coast, especially modelling of accretion and erosion cycles, can help sector agencies better understand site selection for successful mangrove restoration. A foreseeable challenge is the increase in coastal development pressure on mangroves as coastal real estate value increases, especially due to oil and gas development.

Accommodation and resilience building

The historic conversion of Guyana's low-lying coastal plain into a productive economic and human settlement zone has meant that numerous forms of accommodation were necessary to sustain continued livelihoods and productivity. Accommodation responses include impoldering of the coast with a vast system of drainage and irrigation canals, house construction on stilts to elevate living quarters above flood levels, the building up or infilling of domestic residences above road level, sustainable use of coastal ecosystems, and the diverse institutional responses that make living on the coast possible. Among institutional responses are building codes, coastal setbacks, disaster planning, insurance and land-use planning.

The coast is defined by a dense system of drainage and irrigation to support agriculture and remove surface runoff. Drainage takes place by gravity but is augmented by pumps. Pumped drainage will become more relevant with higher sea levels, especially during co-occurrence of high tides and heavy rainfall. Apart from the investment in large

drainage pumps, maintenance of drainage canals has been a challenge, especially in areas where illegal dumping is prevalent (Figure 6).

Climate smart agriculture is an integrated approach to managing crops to maintain food security in the face of climate change-related challenges, through sustainable and equitable transitions for agricultural systems and livelihoods across scales (Lipper et al. 2014). Owing in large measure to flooding with saline water, Guyana has invested in the development of crop varieties, specifically rice, to survive flooding conditions (including saline exposure). The Guyana Rice Development Board has developed rice varieties that are more compatible with flooding and saline waters. They have developed varieties that have tolerance to saline conditions and can emerge from standing water of 23 centimetres (NARI 1996; Zorrilla et al. 2012).

In 2013, Guyana developed an Integrated Disaster Risk Management Plan with support from the Inter-American Development Bank (IDB). The plan addresses flood risk evaluation, strengthening of national and local capacity for integrated disaster risk management, and design of an investment programme in flood prevention and mitigation (Green 2013). In addition, the Civil Defence Commission (CDC) is tasked with disaster response and has been advancing a Disaster Risk Management (DRM) Bill, which – as of early 2025 – remained under development.

Planned relocation and retreat

Just south of the Low Coastal Plain is the Hilly Sand and Clay Belt of Guyana, a region that extends across the country and covers 14 per cent of the land mass. This region is an undulating expanse of white and brown silica sands rising nearly 120m. Debate on inland expansion for Guyana has continued for decades. In the years following independence, inland towns such as Linden were established. However, 90 per cent of the population remains on the narrow coastal plain. Historically, there has been limited investment in redirecting development and economic activity from the coast towards inland areas. However, this has begun to change, with development progressing in areas such as Soesdyke and Yarrowkabra along the Linden–Soesdyke Highway. The Silica City initiative is a notable example of this emerging focus on inland development.

The Government of Guyana is actively developing a new inland city, 'Silica City', located along the Soesdyke–Linden Highway. As of 2025, approximately 3,800 acres had been allocated, with initial housing construction underway. The site is situated in the Hilly Sand and Clay Belt, with Phase 2 of development targeting the Guyanese diaspora. While construction is advancing, a comprehensive assessment of the full implications of large-scale inland relocation has not yet been completed.

Inland expansion would reduce coastal risk by repositioning people and activity away from flood-prone areas. A large part of this process will require public education, because public buy-in will be necessary to achieve the political will for proactive policy development around a sustainable inland expansion effort.

Climate finance and funding mechanisms

The projected economic improvement in Guyana provides a real opportunity to engage in serious long-term planning for sea level rise and implementation of adaptation measures. Revenue and taxes from oil and gas production activity could provide resources to address long-term adaptation. The Natural Resource Fund (NRF), established under the Natural Resource Fund Act 2021 (No. 19 of 2021) and operational since January 2022, provides the legislative framework for managing petroleum revenues, including for national development priorities and infrastructure investment. Under the Act, withdrawals from the Fund must be deposited into the Consolidated Fund (the government's central account through which public revenues are managed and authorised expenditure is made) and may only be used for national development priorities or essential projects directly related to ameliorating the effects of a major natural disaster. Withdrawals must also be approved by the National Assembly (Sections 16 and 19, NRF Act 2021). As of September 2025, the NRF balance stood at approximately US\$3.6 billion. The extent to which these resources will be directed toward long-term climate adaptation and coastal resilience, however, will depend on the prioritisation of such measures within broader national development planning and budgetary processes. Over the last decade, public spending on sea defence has been approximately G\$3 billion

(approximately US\$ 14 million) per year. Estimates put future expenditure at G\$5 billion (approximately US\$23 million) per year.

Guyana's LCDS (2009) committed US\$100 million as a once-in-a-generation effort to upgrade Guyana's ability to cope with climate change. The allocation includes the development of a Climate Resilience Strategy that includes infrastructural upgrades, hinterland adaptation and an adaptation readiness programme.

Assessment of Adaptation Effectiveness

Comprehensiveness and inclusiveness

The IPCC defines adaptation as adjustments in ecological, social or economic systems in response to actual or expected climatic stimuli and their effects or impacts. It is recognised that the successful implementation of adaptation strategies requires all sectors across society to be engaged and work collaboratively. If individuals and communities do not perceive their own vulnerability, then they are less likely to implement measures to reduce vulnerability and adapt to future projections (Pulwarty and Hutchinson 2009). Further, access to resources by individuals is necessary if they are to take actions to reduce vulnerability.

Adaptation has very strong human elements. Pelling (1999) points out that attitudes to the environment, hazards and responses to hazards for such societal institutions as the family, and public and private sector organisations, are driven by information and cultural norms, and are shaped by expectations, historical experience and political context. This is true because it is well known that there are competing views by different actors over natural resource utilisation and approaches to achieve adaptation to climate change. These differences in perception, related power asymmetries, politics and the prevailing political economy often manifest as inter-group conflicts and are important drivers of exposure and vulnerability. The understanding and resolution of these conflicts are essential to create societal buy-in to improve adaptation prospects.

Coastal adaptation to sea level rise in Guyana can be classified into four main approaches: (i) coastal protection; (ii) accommodation; (iii) ecosystem-based adaptation; and (iv) inland expansion. These approaches broadly align with the adaptation options identified in Guyana's National Communications to the UNFCCC, which have recognised the need for strengthened sea defences, structures designed to accommodate rising sea levels, mangrove ecosystem restoration, and the potential for gradual population

redistribution to higher ground in the interior (GoG 2002; GoG 2012; GoG 2024). These approaches are not mutually exclusive and can therefore be combined to establish the most appropriate level of adaptation.

Implementability and integration

While national policy and strategies are moving towards more integrated approaches that mainstream climate adaptation into development priorities, there are still key gaps which require attention if adaptation is to reduce the long-term risk associated with coastal flooding exacerbated by sea level rise. First, shifts in perception are necessary to address how citizens see the coast and the role each citizen plays in shaping group vulnerability. Coastal flooding risk is often externalised, and flooding is seen as an aberration instead of a natural occurrence. Further, there is a need to link personal action to vulnerability and adaptive efforts.

Second, national policies and strategies tend to provide significant focus on infrastructure development and upgrades as a primary mitigation measure to address flooding. Adaptive response is often focused on getting back to the state of things prior to the flood or rebuilding better for the next. However, for adaptation to work, the coast needs to be seen for the dynamic zone that it is; that is, as a natural area subject to environmental change. Therefore, it is human settlement and activity that must be designed with these changes in mind to drive compatibility with coastal processes.

In the absence of comprehensive ICZM legislation, Guyana's coastal-zone challenges continue to be managed in a fragmented manner, with responsibilities dispersed across multiple agencies operating under separate mandates and without a binding co-ordinating framework. This fragmentation has persisted despite more than two decades of recognition – dating back to the ICZM Action Plan conceived in 2000 – that an integrated approach is needed. A priority should be to develop an integrated legislative and institutional

framework that brings together coastal-zone management, land-use planning, sea and river defence management, disaster risk management, and resource conflict resolution under a single co-ordinating mechanism.

Monitoring and evaluation

Research and data collection are critical to support ongoing accommodation responses. Quantitative information on the effects and impacts of flooding is useful when formulating long-term development plans with proper budgetary allocations to prevent future impacts and build resilience. Data collection should focus on collecting the most pertinent information to support adaptation responses.

Data collection should also be structured to prioritise quality, continuity of measurement and practical relevance over analytical complexity. To this end, tide gauge and rainfall monitors will remain indispensable, and monitoring efforts should incorporate hydro-meteorological surveys along the coastline. There is also a need to develop and distribute flood risk maps and evacuation routes.

In Guyana, NAREI has developed a comprehensive mangrove monitoring system that integrates GIS, remote sensing, field surveys and community engagement, supported by partnerships with SERVIR-Amaonia/NASA and formerly USAID (Hyman et al. 2020; SERVIR-Amaonia 2022). This system uses combined optical and synthetic aperture radar (SAR) satellite datasets to produce annual data on mangrove extent, gains, losses and restoration impact, with outputs made freely accessible to partner agencies.

Lessons Learned and Exemplars of Good Practice

Guyana constitutes an interesting case study in natural resource management, as it stands at a pivotal stage of economic development where strategic decisions made today will have long-term implications for community vulnerability and sustainable development in the years ahead. As planning for the new economy accelerates, there is a timely opportunity for incorporation of practical adaptation strategies to help safeguard future socio-economic gain. It is within this context that the following policy options and good practice initiatives are proposed.

It is important to invest in the development of population centres away from flood prone areas to reduce the number of people exposed to coastal hazards. Key options include the following:

- Control population density in flood-prone areas by providing alternative settlement options.
- Formalise the residential construction industry to improve housing quality and enforce building codes.
- Enforce development setbacks in vulnerable areas.
- Reimagine local architecture to work with local circumstances.
- Provide transportation network infrastructure that connects population centres.
- Provide access to secure housing to keep up with coastal housing demand.
- Discourage the habitation of 'bottom houses' in flood-prone areas.

Sustained investment in sea defences is essential, both to extend protection to new areas and to maintain existing infrastructure. It is important that all future sea defence designs consider local sea level rise rates and projections. Maintaining drainage infrastructure throughout the coast, especially in urban areas such as Georgetown, and collaboration among government institutions and the private sector, are necessary to curb the solid waste disposal challenge.

It is critical to protect mangrove forests, both as a natural sea defence and flood mitigation strategy, but also for the preservation of ecosystem services. Mangrove forests are structurally diverse ecosystems, sustaining high biodiversity as well as rich seafood supplies, which have direct impacts on the local fisheries industry.

Strategies to increase the fraction of insured properties along the coast should be developed by making insurance more affordable and accessible. Creating a contingency/disaster fund to provide funding during flood events is essential, as a quick disaster response can dramatically reduce impacts and recovery.

Research and data collection should be strengthened. Robust quantitative information on the effects and impacts of flooding is essential for informing long-term development planning, supporting appropriate budgetary allocations, and identifying measures to reduce future impacts and build resilience. Continued investment in climate data collection will help ensure that future responses to climate change are informed by robust evidence.

The illegal dumping of waste into canals, along roadsides and the continued use of latrines in flood-prone areas poses significant public health risks. Strategies to reduce the use of pit latrines and improve solid waste management are key to reduce flood impacts.

Increasing disaster response resources, strengthening local government agencies and community groups, developing strategies to get disaster and adaptation information into communities, and creating evacuation routes, particularly for major storm surge, are all priorities.

Recommendations

Reducing the number of people exposed to coastal hazards requires deliberate investment in developing population centres away from flood-prone areas. The following measures are recommended:

- Control population density in flood-prone areas by directing alternative settlement to population centres outside high-risk zones.
- Formalise the residential construction industry with strengthened housing quality standards and stricter enforcement of building codes.
- Enforce development setbacks in vulnerable areas to keep development away from critical ecosystems and key infrastructure.
- Reimagine local architecture to suit local conditions, with a particular focus on flood-proof home designs.
- Develop transportation network infrastructure linking population centres to facilitate the movement of goods and labour.
- Expand access to secure housing to meet growing coastal housing demand.
- Actively discourage the habitation of 'bottom houses' in flood-prone areas through public awareness and alternative housing programmes.

Sustained investment in sea defences is essential, both to extend protection to new areas and to maintain existing infrastructure. All future sea defence designs should account for local sea level rise rates and projections. Adequate resources and budget allocations must be provided to help agencies meet their obligations under existing action plans and policies. Drainage infrastructure along the coast requires ongoing maintenance, especially in urban areas such as Georgetown, while collaboration among government institutions and the private sector is necessary to address the solid waste disposal challenge. Investment in flood alleviation technology, including large-scale coastal pumps to improve drainage during high tides, is also recommended.

Mangrove forests should be protected, both as a natural sea defence and flood mitigation strategy, but also for the preservation of ecosystem services. Funding for research on mangrove restoration and coastal erosion/accretion patterns should be provided to identify areas viable for mangrove restoration.

Strategies to increase the proportion of insured properties along the coast should be developed by making insurance more affordable and accessible. A contingency/disaster fund should be created to provide funding during flood events. Investments away from oil should lead to better economic opportunities for an ever-increasing share of the Guyanese population, allowing household wealth to increase and giving families the resources to recover from flood events.

Critical infrastructure should be protected and adapted to withstand flood events through the following measures:

- Protect potable water supplies and design systems to provide adequate and safe emergency supplies during flood events.
- Consider constructing electricity generation facilities outside of flood-prone areas.
- Protect telecommunications systems located in flood-prone areas.
- Develop health centres and facilities that are accessible and operable during flood events.
- Invest further in virtual education to mitigate education disruption during disasters

Strategies to reduce the use of pit latrines and improve solid waste management are key to reduce flood impacts. Investment in a sewage treatment plant for urban areas is recommended.

Disaster response resources should be increased to allow agencies such as the CDC to execute co-ordinated emergency operations. Local government agencies and community groups should be strengthened and provided with training in disaster response. Strategies to get disaster and adaptation information into communities should be developed. Evacuation routes, particularly for major storm surge, should be created.

Conclusions

Guyana's coastal zone is vulnerable to sea level rise and is likely to experience catastrophic flooding without the implementation of proper adaptation strategies. There has been a tendency toward maladaptation, including incompatible development in areas designed as reserves, destruction of mangrove ecosystems, poor solid waste management and habitation of 'bottom houses' in highly vulnerable zones.

Human settlement, agriculture (which represents 20–30 per cent of GDP), oil and gas support services, critical infrastructure, and commercial activity are all at risk within the coastal zone. Oil and gas development will concentrate people and onshore assets in the coastal zone, which will serve to increase the exposure of assets to flood risk.

Guyana must take steps to reduce its vulnerability through a series of targeted measures, including inland expansion. National leadership and public education are necessary to obtain buy-in to allow residents to consider inland expansion. Resource investment in areas outside vulnerable areas is important to drive the paradigm shift. Shifting perceptions on risk and coastal vulnerability are also critical to drive individual action at the community level so that people can adopt adaptation measures.

Meaningful proactive action to adapt to coastal hazards can only be achieved through an integrated and co-ordinated strategy founded on the principles of integrated coastal-zone management and sustainable development.

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Annexes

Annex A. Country dashboard

COMMONWEALTH SEA LEVEL RISE CASE STUDY GUYANA	MODEL DASHBOARD
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Country snapshot

Coastline 425km	Coastal population ~90% of total	Coastal elevation 0.5–1.0m below mean seal level (MSL)
GDP from coastal sectors >50%	Coastal zone (% land) ~7%	Major flood impact (2005) >70,000 households

Sea level rise indicators

Observed local SLR 4.7–10.2mm/yr vs. global ~3.5mm/yr	Projected rise by 2100 Up to +1.2m above 2000 levels	Land subsidence Up to 10mm/yr groundwater extraction
Asset exposure US\$43.5 billion 2025 estimate (oil era)	Adaptation cost needed >US\$2 billion ~17% of 2020 GDP	Tide gauge record 1951–2010 Georgetown station

Adaptation at a glance

Type	Key measures	Status
Coastal protection	Sea walls (180km), embankments (140km), rock armour (large stones or boulders placed along the coast to absorb wave energy and protect the shoreline)	~40% fair or below
Ecosystem based	Mangrove restoration, coastal ecosystem protection	Active; squeeze threat
Accommodation	Drainage, climate-smart agriculture, building codes	Infrastructure ageing
Planned retreat	Inland expansion programme	Policy; limited action
Climate finance	Natural Resource Fund (oil revenue)	New fiscal space

Key milestones

1989	2001	2005	2009	2012	2019	2021
Holdgate Report	LCDS initiated	Major flood (>50% GDP)	CRSAP adopted	NAP developed	Offshore oil production	Kwakwani flood

Apia Commonwealth Ocean Declaration relevance

How does sea level rise in this country intersect with the **priorities set out in the Apia Commonwealth Ocean Declaration?**

	Ocean–Climate Nexus Primary Action Group for this series. Local SLR rates 2–3x global average, compounded by land subsidence. Climate change intensifies rainfall, increasing compound flood risk. Local SLR: 4.7–10.2mm/yr (global: ~3.5)		Marine Pollution Coastal flooding mobilises solid waste into waterways and the ocean. Illegal dumping into drainage canals exacerbates flood vulnerability and contaminates coastal waters. Waste infrastructure coverage: [TBC]
	Sustainable Fisheries Coastal fisheries directly affected through mangrove loss, sedimentation changes, species distribution shifts and damage to fishing infrastructure. Fisheries % GDP/employment: [TBC]		Blue Economy Offshore oil & gas has transformed Guyana's economy, but supporting onshore infrastructure sits in the vulnerable coastal zone. Asset exposure: US\$7.8 billion Oil: 2019+
	Marine Protection and Restoration Mangrove cover declined 70% from 1992–2015, but active restoration and community-led monitoring now protect over 50% of the coastline. Coastal squeeze from sea walls and development pressure remain key threats. Mangrove coastline: ~290km of 425km 8+ VMACs active		

Annex B. Legislative and policy framework summary

Category	Instrument / Framework	Year	Description	Relevance to SLR
International agreements	UNFCCC	1992	Ratified; Guyana is a non-Annex I party.	Provides framework for adaptation obligations and reporting.
International agreements	Paris Agreement	2016	Ratified; basis for NDC commitments.	Commits Guyana to adaptation planning and climate-resilient development.
International agreements	Declaration of Turkey	2007	Partnership commitment to addressing climate vulnerability.	Signals regional co-operation on climate adaptation.
National strategy	National Development Strategy (NDS)	1996	Acknowledges flood vulnerability; identifies need for infrastructure, funding and mangrove protection.	Foundational strategy linking SLR-related flood risk to development.
National strategy	Poverty Reduction Strategy Paper (PRSP)	2002	Recognises drainage and irrigation infrastructure for flood management and poverty reduction.	Links flood prevention to protection of homes and agricultural productivity.
National strategy	National Competitiveness Strategy (NCS)	2006	Identifies flood reduction as economic competitiveness strategy; designates D&I Board as implementing agency.	Connects flood risk management to economic performance.
National strategy	Low Carbon Development Strategy (LCDS)	2009	Commits US\$100 million for climate adaptation infrastructure including D&I rehabilitation.	Directly targets flooding losses, estimated at 10% of GDP annually.
National strategy	LCDS 2030 (updated)	2022	Updated strategy aligning with oil-era economy and NDCs.	Provides framework for channelling petroleum revenues toward adaptation.
National policy	DRM Policy	2013	Built on Hyogo Framework; mainstreams DRM and climate change adaptation (CCA) into development planning; establishes DRM Fund.	Creates co-ordination mechanisms for disaster and flood response.
National policy	Climate Resilience Strategy and Action Plan (CRSAP)	2015	Overarching framework for climate resilience; five-year roadmap.	Intended to evolve into the National Adaptation Plan (NAP).
National policy	Sea and River Defence Sector Policy	2015	Guidance for sea defence management and interventions.	Directly governs coastal protection infrastructure against SLR.
National policy	National Adaptation Plan (NAP)	2024 (in preparation)	Renewed preparation building on CRSAP, aligned with LCDS 2030 and NDC.	Will provide comprehensive adaptation framework addressing SLR.
National policy	Nationally Determined Contributions (NDCs)	Updated	Commits to adaptation measures for multiple hazards including SLR.	Prioritises infrastructure development and early warning systems.
Legislation	Sea and River Defence Act	2024	Governs construction and maintenance of sea and river defences.	Primary legal instrument for coastal protection against SLR.
Legislation	Forests Act	2009	Provides for management and protection of forests including mangroves.	Relevant to mangrove-based coastal protection.
Legislation	Environmental Protection Act	1996	Overarching environmental legislation; establishes EPA.	Framework for environmental governance and coastal management.
Legislation	Natural Resource Fund Act	2021	Establishes framework for managing petroleum revenues; operational since January 2022.	Potential source of long-term climate adaptation financing; NRF balance approx. US\$3.6 billion as of September 2025.

Category	Instrument / Framework	Year	Description	Relevance to SLR
Legislation	DRM Bill	Under development (2025)	Being advanced by the Civil Defence Commission.	Will provide legal framework for disaster risk management.
Institutional	Civil Defence Commission (CDC)	1982	Tasked with disaster response and advancing DRM legislation.	Co-ordinates disaster response including coastal flooding events.
Institutional	Coastal and Marine Management Committee (CMMC)	2019	Established through EPA for inter-agency coastal and marine management.	Aims to co-ordinate coastal-zone management; no binding legislation.
Gap	Integrated Coastal Zone Management legislation	Absent	No comprehensive ICZM legislation despite 2000 action plan.	Critical gap; coastal challenges managed in fragmented manner across agencies.
Gap	Building codes enforcement	Voluntary only	National building codes exist but no legal framework for enforcement.	No agency mandated to monitor or enforce provisions.

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