

CLIMATE CHANGE ADAPTATION RESPONSE PLAN for South Africa's Coastal Sector





forestry, fisheries & the environment

Department: Forestry, Fisheries and the Environment REPUBLIC OF SOUTH AFRICA





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Sponsored by

Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection









ACKNOWLEDGEMENTS

The authors gratefully acknowledge contributions to this document by the following stakeholders.

DFFE team: Thandeka Mbambo, Potlako Khati, Tshepiso Monnakgotla, Lebogang Mpedi, Tumelo Ian Mhlomi, Nyanisa Tshaya, Barney Kgope, Tshifhiwa Munyai, Mapula Tshangela, Nenekazi Juduka and Ryan Peter; Oceans and Coasts management team and technical and scientific officials; Climate Change and Air Quality management team and technical and scientific officials; Biodiversity and Conservation management team and technical and scientific officials.

GIZ team: Michelle Hiesterman and Sandile Maseko

Further, we gratefully acknowledge the contributions of the hundreds of coastal stakeholders consulted during the provincial workshops conducted for this project between September–November 2023 and August–November 2024. Without their experience, perspective and passionate contributions to the development of this Adaptation Response Plan, this document would be less meaningful.

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Designed and typeset by: COMPRESS.dsl | www.compressdsl.com

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This report should be cited as:

The Department of Forestry, Fisheries and the Environment (2025): Climate Adaptation Response Plan for South Africa's Coastal Sector.

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Abbreviations

BCE	Blue Carbon Ecosystem
CARP	Coastal Adaptation Response Plan
CC	Climate Change
C-CADS	Australian Coastal Climate Adaptation Decision Support
CML	Coastal Management Line
СМР	Coastal Management Programme
CoCT	City of Cape Town
СОР	Conference of the Parties
CoVu	Coastal Vulnerability
CSIR	Council for Scientific and Industrial Research
CVI	Coastal Vulnerability Index
DAFF	Department for Agriculture, Fisheries and Forestry
DALRRD	Department for Agriculture, Land Reform and Rural Development
DEA	Department for Environmental Affairs (now: DFFE)
DEADP	Western Cape Department of Environmental Affairs and Development Planning
DEDEA	Eastern Cape Department of Economic Development and Environmental Affairs
DEFF	Department of Environment, Fisheries & Forestry (now: DFFE)
DFFE	Department of Forestry, Fisheries & the Environment
DRR	Disaster Risk Reduction
DTIC	Department of Trade, Industry and Commerce
EbA	Ecosystem-based Adaptation
EbM	Ecosystem-based Mitigation
EBUS	Eastern Boundary <mark>Upwelli</mark> ng Systems
EC	Eastern Cape Prov <mark>ince</mark>
ECE	Extreme Climate Event
EEA	European Environment Agency
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
EPA	USA's Environmental Protection Agency
GAP	Geographic Analysis Platform
GCA	Global Climate Action
GCF	Green Climate Fund
GEF	Global Environment Facility

GFCS	Global Framework for Climate Services
GHG	Greenhouse gas
GIZ	Gesellschaft für internationale Zusammenarbeit GmbH
GMSL	Global Mean Sea Level
ICM(A)	Integrated Coastal Management (Act)
IIED	International Institute for Environmental Development
ILK	Indigenous and Local Knowledge
IPCC	Inter-governmental Panel on Climate Change
KZN	KwaZulu-Natal Province
LECZ	Low-Elevation Coastal Zone
LGCCSP	Local Government Climate Change Support Program
LM	Local municipality
LT	long-term
LT-LEDS	Long Term Low GHG Emission Development Strategy
LUS	Land Use Schemes
M&E	Monitoring and Evaluation
MEC	Member of the Executive Council
MISA	Municipal Infrastructure Support Agent
MSL	Mean Sea-level
NAP	National Adaptation Plan
NBA	National Biodiversity Assessment
NC	Northern Cape Province
NCCARA	National Climate Change Adaptation Research Agenda
NCCARF	National Climate Change Adaptation Response Framework
NCCAS	National Climate Change Adaptation Strategy
NCCRP	National Climate Change Response Policy (syn. NCCRWP)
NCCRWP	National Climate Change Response White Paper (syn. NCCRP)
NCMP	National Coastal Management Programme
NCOP	National Council of Provinces
NDC	Nationally Determined Contribution
NEMA	National Environmental Management Act
NFCS	National Framework for Climate Services
NWP	Nairobi Work Programme
RCP	Representative Concentration Pathways
RP	Response Plan
RSA	Republic of South Africa
SA	South Africa

SABS	South African Bureau of Standards
SANBI	South African National Biodiversity Institute
SANTAM	South African National Trust and Assurance Company
SARVA	South African Risk and Vulnerability Atlas
SASDIR	Southern Africa Society for Disaster Reduction
SASP	Sector Adaptation Strategy and Plan
SATS	South African Technical Standard
SDF	Spatial Development Framework
SDGs	Sustainable Development Goals
SH	Stakeholder
SLR	Sea Level Rise
SPLUMA	Spatial Planning and Land Use Management Act
SPP	Sustainable Public Procurement
SROCC	Special Report on the Ocean and Cryosphere in a Changing Climate
ST	short-term
UNEP	United Nations Environmental Program
UNFCCC	United Nations Framework Convention on Climate Change
WC	Western Cape Province



Minister's foreword

Climate change is an indisputable global reality, and its impacts are intensifying—particularly along the world's coasts, where nearly half the global population resides. Migration patterns suggest this concentration will only increase, further amplifying pressure on coastal environments. Rising sea levels, intensifying storms, and widespread ecosystem disruptions are no longer distant threats—they are present realities, especially for the most vulnerable communities.

To safeguard our coastal assets and the livelihoods they support, we must act decisively. Our response must be bold, well-coordinated, and rooted in the principles of resilience, sustainability, and equity. South Africa's White Paper for Sustainable Coastal Development (2000), through Goal C5, mandates that coastal development be managed to reduce exposure to natural hazards and mitigate risks to people, infrastructure, and economic activities.

In this spirit, the Coastal Climate Change Adaptation Response Plan (CARP) provides a strategic framework for enhancing the resilience of coastal communities, ecosystems, and economies. Grounded in the National Climate Change Adaptation Strategy (2019) and supported by the Integrated Coastal Management Act (No. 24 of 2008) and the recently enacted Climate Change Act (No. 22 of 2024), CARP also advances our international obligations under the Paris Agreement and the Kunming-Montreal Global Biodiversity Framework.

CARP builds on the National Coastal Management Programme (NCMP)—the Department's guiding instrument for coastal governance—by prioritising climate-focused interventions that protect natural heritage, support sustainable livelihoods, and foster inclusive economic growth.

With climate change projected to increase the frequency and intensity of coastal storms, accelerate sea-level rise, and compound vulnerabilities due to population growth, the risks to infrastructure and ecosystems are escalating. CARP responds by advancing ecosystem-based management, resilient infrastructure, strong governance, and climate-smart livelihoods to secure a sustainable coastal future. The success of CARP will depend on collective effort. It will require strong partnerships across government, academia, the private sector, civil society, and local communities. Adaptation must be mainstreamed across national, provincial, and local planning frameworks. It is essential that coastal and marine resources remain accessible to all—especially women, youth, and persons with disabilities ensuring that no one is left behind in our resiliencebuilding efforts.

Our coastal future rests on our ability to innovate and to act with unity and urgency. By investing in nature-based solutions, strengthening climate governance, and unlocking sustainable finance, we can shield our people and ecosystems from the harshest impacts of climate change. **CARP stands as our national commitment - to a coastal sector that is not only resilient but thriving in the face of adversity**.



Dr. Dion Travers George *Minister of Forestry, Fisheries, and the Environment*



Executive summary

In South Africa, about 22% (ca 12.9 million) of the total population of 60 million are living within 20 km of the oceans' coasts, with 60% of these people living in densely populated metropolitan areas. Further, 95% of South Africa's imports and exports are ocean-facilitated, making approximately 60% of the South African economy dependent on coastal natural resources and trade infrastructure, such as ports. Most of the socio-economic benefits that we receive from the coast are based on the intactness and functionality of natural coastal environments and ecosystems.

The above highlights the enormous importance of coastal environments and resources but also indicates the potential risk and vulnerability to which coastal populations, environments, and assets in South Africa (and beyond) are exposed.

Climate change is an internationally accepted reality. Effects of climate change are also tangible in South Africa's coastal zone, in the form of rising sea levels, an increase in storm frequency and intensity, and the related increase in damage and loss to coastal infrastructure, private property, livelihoods, and natural resources. This is especially concerning given that approximately 3.7 million people live within 1 km of South Africa's coastline at elevations of up to 30 metres above sea level. Moreover, more than 2 500 people live in coastal areas classified as high or extremely high flood risk areas. Compounding the population growth in coastal regions significantly outpace that of inland areas.

Therefore, developing effective climate response actions is becoming increasingly urgent for South Africa's coastal sector. The inaugural Climate Change Adaptation Response Plan (CARP) for the coastal sector was developed as a strategic framework to address climate change hazards affecting South Africa's coastal sector. The CARP is the response to the Climate Change Act's demand for the development of Sector Adaptation Strategies and Plans (Act 22 of 2024, Section 22), designed to enhance coastal resilience, and safeguard coastal communities, ecosystems, and economies through initiative-taking adaptation measures. It, therefore, aims to ensure climate resilience while safeguarding the ecological, economic, and social functions of coastal environments.

The key objectives of the CARP are to:



Strengthen coastal resilience through integrated, science-based adaptation measures



Align national policies with global frameworks, including the Paris Agreement and the Sendai Framework for Disaster Risk Reduction



Enhance governance structures to improve coordination tross national, rovincial, and unicipal levels



Mobilise public and private sector investment to finance adaptation initiatives



Protect and restore blue and teal carbon ecosystems and enhance climate resilience



Empower local communities through capacitybuilding, gender-sensitive adaptation strategies, and inclusive decision-making processes

The CARP is underpinned by an element-based adaptation framework that prioritises ecosystem-based solutions, resilient infrastructure, and adaptive governance.

The CARP provides a structured roadmap for:



Legislative and policy integration by strengthening the alignment with the Integrated Coastal Management Act, the National Climate Change Adaptation Strategy, and sector-specific policies



Finance and through leveraging mainstreaming adaptation into existing legislation and policies, as well as Green Climate Fund (GCF) opportunities and blended finance models to drive sustainable implementation



Communitycentred adaptation through nhancing local participation, ensuring equitable adaptation benefits, and integrating traditional ecological knowledge



Monitoring and evaluation: Establishing robust mechanisms to track progress, assess effectiveness, and refine adaptation actions over time, to fulfil national and international climate reporting obligations



implementation: Effective adaptation requires strong governance, clear institutional mandates, and cross-sector collaboration, including defined roles for government, private sector, and civil society in adaptation planning and execution



Scalable, context-specific solutions that address regional vulnerabilities and socioeconomic disparities

The adaptation strategy for South Africa's coastal livelihoods and economies must be multifaceted, integrating immediate business-level actions with broader initiatives that support ecosystem health, community resilience, and sustainable infrastructure. This approach not only mitigates the impacts of climate change, but also potentially opens new avenues for economic development aligned with global sustainability goals.

Effective governance and legislation are crucial for climate change adaptation within South Africa's coastal sector, which includes the natural environment, communities, infrastructure, and economic activities. Coastal climate governance requires a coordinated, multi-tiered approach focusing on legislative integration, enforcement, capacity enhancement, resource allocation, and transparent reporting, also relating to international obligations. The success of the CARP depends on tangible and measurable actions that need to be embraced across sectors by the mandated organs of state. Therefore, the CARP was co-developed with more than 700 stakeholders during consultation workshops in 2023 and 2024. As a result, a total of 21 envisaged outcomes and over 150 actionable interventions have been developed; also drawing on examples drawn from various plans, adapted to the coastal context.

Table 1 on page xii provides an overview of the five coastal key aspects (natural environment; people and communities; built environment; livelihoods and economy; and government and legislation), the climate threats they are facing, the co-developed Management Objectives for each, and the envisaged climate response Outcomes, which will be achieved by implementing those adaptation interventions relevant to the respective governance context. The proposed interventions entail both anticipatory (initiative-taking) and reactive measures, thus enabling a flexible response to the uncertainties of climate change. The approach involves:



The CARP emphasises that climate adaptation needs to be cross-sectoral, given the transcending nature of the coastal sector. However, while aiming at climate response for the coastal sector, the cross-sectoral information provided here can also provide valuable insights for climate response planning beyond the coastal zone.

Element-based adaptation needs to align with national policies like the National Climate Change Adaptation

Strategy and the Integrated Coastal Management Act, which aims at ensuring climate-smart planning in land use and economic development. Public and private sector collaboration across government, business and civil society will increase understanding and acceptance of adaptation action, while also promoting opportunities for new economies and civic science and adaptation contributions.

In response to the requirements of the Climate Change Act, the CARP includes a draft Implementation Plan, providing a high-level timeline for key interventions and outcomes, categorised into short-term (1–2 years), medium-term (3–5 years), and long-term (6–10 years) actions. This plan serves as baseline for a national Climate Change Adaptation Action Plan, subject to updates due to the 5–year legal review period for sector-based adaptation plans; these allow for adjustments based on implementation experiences, emerging climate science, and evolving local needs.

Accordingly, the CARP is a landmark policy designed to enable a just transition to a climate-resilient coastal economy. By prioritising proactive adaptation, South Africa can mitigate climate risks, protect its coastal assets, and secure sustainable and just development for future generations.

Description	Sandy beaches & dunes, rocky shores, estuaries, salt marshes, mangroves, reeds, sedges, swamp forests, seagrass beds, kelp forests, coral reefs.	Coastal population and coastal communities.	All built infrastructure, roads, wastewater treatment works, sewer reticulation, railway lines, energy supply lines and pipelines, ports, communication networks, residential, commercial etc. supporting human activities.	All economic activities including subsistence, informal and micro enterprises to nationally relevant and international economy.	Cross-sectoral policies, legislation relevant for climate adaptation and climate mainstreaming and international climate obligations.
Climate threats	 Spatial shift in ecosystem boundaries and animal habitats. Degradation of ecosystems and species composition. Destruction and loss of natural environment, Loss of ecosystem function and productivity. Loss of ecosystem service provision. 	 Injuries and loss of life. Physical and psychological human health impacts. Displacement, loss of property and livelihoods. Health and safety threats due to injuries and fatalities, water contamination and increased risk of waterborne diseases. 	 Structural compromise and damage to buildings and homes. Infrastructure damage to bridges, airports, ports, and railway lines. Damage or destruction of wastewater pipes and treatment plants, powerlines, and stations etc. Damage or destruction of communication infrastructure. 	 Economic losses due to repairs, replacement, and reconstruction of the built environment. Loss of livelihoods, and business and service interruptions. 	 New and increasingly complex demands on government to provide effective management and legislation in a changing environment and rapidly growing population. The need to adapt and proactively enable climate adaptation, while being faced by stagnant budgets and governance structures.

Table 1: Overview of Climate threats, Management Objectives and Adaptation Response Outcomes per coastal element

Natural environment/ assets	People/communities	Built environment/ Infrastructure	Livelihoods/Economy	Governance legislation
	 Social impact due to evacuations or displacement of communities from built-up areas and the associated stress and trauma. 	 Devaluation of properties and / or increased insurance premiums. Long-term impacts of repeated events that increase vulnerability, weaken structures, and reduce coping capacity of the economy, and infrastructure. 		
Safeguard and sustainably manage our rich natural coastal capital for optimal climate resilience and provision of ecosystem goods and services for the benefit of all.	A climate resilient and empowered coastal community, living sustainably in harmony with nature.	By 2050, coastal built infrastructure is climate resilient as foundation for climate-safe livelihoods and economies.	Climate-wise coastal livelihoods and economies conform to sustainable development, sustainable livelihood and just economy which effectively strives in a changing climate.	South Africa's legal and policy baseline effectively promotes climate-wise, sustainable, just, and equitable coastal development and climate resilient livelihoods, economies, and environments, for the benefit of all, by 2035.
 Spatial development and land use management acknowledge the key role that coastal green infrastructure plays in successful climate adaptation and mitigation. Coastal ecosystems are effectively managed and restored to optimally function as ecosystems, carbon sinks, baseline for Ecosystem-based adaptation and key resource for coastal livelihoods and industries. Living resource populations are maintained as baseline for ecosystem functioning and coastal livelihoods and industries. The regulation of the use and extraction of threatened natural resources must ensure that the resources are managed to restore their condition over time, i.e. reverse the decline, not merely to maintain the status quo. Alien and invasive species are controlled to maintain and restore coastal ecosystem functioning and the services and functions they provide, including buffering against climate events. 	 The resilience of vulnerable coastal communities to climate change impacts is strengthened by enhancing their adaptive capacity and reducing their exposure to hazards. The awareness of coastal communities around the potential impacts of climate change (e.g. flooding) and effective adaptation measures that can be implemented is enhanced and increased. Effective measures for disaster risk reduction and response within coastal communities are Implemented, with local and Indigenous knowledge systems are harnessed and enhanced. 	 Infrastructure in high-risk areas is either protected or relocated, and new developments are permitted only if they safeguard ecosystems, avoid endangering lives, and support climate resilience. The coastal built infrastructure can withstand climate hazards such as floods, windstorms, and erosion. Mitigation of the impact of extreme temperatures on buildings and infrastructure has been implemented. 	 The use and extraction of natural resources that support coastal livelihoods and economies are sustainably regulated to not only secure their long-term service provision but also to restore and improve their condition over time, actively reversing degradation rather than simply maintaining the status quo. Coastal industry work environments are designed to ensure safe, fair conditions and protection from climate extremes, supporting the long-term viability of the workforce and sector. Consumer and market demand is guided towards climate-resilient, sustainable products and services, aligned with the full value chain's social, economic, and environmental impact. By 2050, investment in and support for coastal and marine economic activities reflect the full economic and social value of the entire value chain, while accounting for their impact on other, potentially more sustainable, sectors. 	 Climate change adaptation is effectively integrated and mainstreamed into all legislative spheres and sectors relevant for the coastal sector. Legislation relating to coastal climate adaptation is effectively enforced and executed at all levels. Government, the coastal communities, and industries are enabled to make climate-wise decisions in their own respective context. Government provides resources which support climate actions at all levels and for all coastal elements. Government can effectively report on coastal climate change adaptation in their respective sphere of governance. Existing institutional frameworks that facilitate the timely escalation of coastal issues to the appropriate authorities - without bureaucratic delays - are strengthened and leveraged to enable effective government reporting on coastal climate change adaptation across all spheres of governance.

Management objectives

Response Outcomes

Natural environment/ assets	People/communities	Built environment/ Infrastructure	Livelihoods/Economy	Governance legislation
 Water quality is effectively managed to maintain healthy and productive ecosystems that provide key ecosystem services such as nurseries, coastal protection, climate regulation and nutrient cycling. Climate change becomes a priority in the management of estuaries to sustain estuarine benefits and services for coastal communities and coastal climate protection. 				

Response Outcomes

Structure of this document

Part A: Setting the scene

Part A provides the background that led to the development of this Coastal Adaptation Response Plan (CARP). The climate hazards experienced in South Africa's coastal zone are unpacked, as well as current and projected coastal development trends which might aggravate coastal climate risk in the future. Further, the international climate adaptation context is outlined. The section closes with the Vision, Objectives and Scope of this Plan.

Part: A

Part B: Implementation

Part B outlines an implementation framework required for successful actioning of this Plan at a higher level. Overarching topics, i.e. the basic principles and concepts of climate adaptation response, mainstreaming, financing, monitoring and evaluation, the need for monitoring and evaluation as well as communication and capacity building are unpacked.

Part C: Climate response per coastal element

Part C unpacks the "elements" of the coastal sector which are the natural environment, the people and communities living on the coast, the built environment and infrastructure, economies and livelihoods, and the embracing policy context. Climate threats per element are identified, management objectives are formulated together with intended outcomes and proposed required interventions; these take the form of draft Adaptation Programme spreadsheets to guide hands-on implementation on the required

Appendices

The Appendices to this document include a draft high-level Implementation Plan, describe climate impacts on coastal key ecosystems, and provide an overview of international obligations. Part: C

PARTA: Setting the scene

1 South Africa's coastal climate trends

An effective climate response must be informed by a clear understanding of both current and anticipated climate threats in the coastal zone. For the purposes of the CARP, these threats include long-term trends such as sea-level rise, increasing ocean and air temperatures, and shifting rainfall patterns. However, the greatest damage often results from extreme weather and climate events, including intense rainfall, windstorms, and droughts. While the CARP primarily focuses on adapting to a changing climate, the proposed response actions will also address existing climate and weatherrelated threats that frequently have devastating impacts along South Africa's coasts. To inform this, we will briefly map and analyse the recent occurrence of such disasters along the coastline in the recent past (Section 1.1). Before providing an overview of South Africa's expected climate future in Section 1.2, it is also essential to explore climate-related changes in the ocean environment, as the ocean is critical to many economic activities along the coast (Section 1.3).

1.1 Current climate threats

South Africa's coastal climate, spanning a wide range of climate zones, is influenced by tropical, subtropical, and mid-latitude systems (Bopape et al. 2024). Subtropical high-pressure systems transport moisture, and ex-tropical cyclones can make landfall along the east coast. Antarctic cut-off low pressure systems can hit especially southern and southwestern coasts in winter – all these systems can result in severe weather events – which already impact lives, property, and the economy of the country. Figure 1 maps the number of drought-, flood-, storm- and wildfirerelated disasters which affected the country's districts between 1980 and 2022. Floods and storms are by far the most frequently occurring disasters, particularly in KwaZulu-Natal (as far as the coast is concerned), where they originate from extreme rainfall events. Unlike the Northern and Western Cape areas in general, the City of Cape Town experienced a high number of weatherrelated disasters, particularly storms and floods, given the higher exposure of the city and the higher development density in the municipality.

Extreme rainfall events have a high occurrence in the eastern inland areas of South Africa, but also throughout the coastal zone of the Western Cape, Eastern Cape and KwaZulu-Natal (Figure 2c and d). Interestingly, while the Eastern Cape is receiving about the same amount of rainfall as KwaZulu-Natal, flood disasters have been reported here less frequently, likely due to the lower development density and the tendency for settlements to be located in high-lying areas (compare Figure 1 and Figure 2). However, despite the recorded dwindling number of high-rainfall days in the Northern Cape, urban flooding because of extreme rainfall was reported here in 2024 as well (verbal reports during project-related stakeholder workshops). This indicates that despite the statistical probability of an extreme event being low, these unlikely events might still occur, challenging effective disaster response and long-term planning.

Figure 1: Weather-related disasters in South Africa between 1980–2022



Figure 2: Number of days with respective total rainfall amounts between 1980–2022



Source: Bopape et al. 2024

1.2 Future climate threats

The previous section highlighted that the eastern part of South Africa, in particular, is under current climate conditions already exposed to extreme weather events and related hazards and disasters. For the development of the GreenBook (www.greenbook. co.za), global climate models were downscaled to 8 km resolution (Engelbrecht 2019). Figure 3 summarises the expected changes until 2050, under the RCP 8.5 worst-case scenario, on a country level. This map is indicating that the already concerning prevalence of storms and floods is likely to further exacerbate, while the Northern and Western Cape are expected to get hotter and drier, thereby increasing the risk of droughts, extreme temperatures, and potential water shortages. Engelbrecht's model predicts a decrease in wind speed and storm frequency for the western and southern part of the coast, as the cut-off lows systems currently causing storms and flooding in this region are expected to not reach so far north anymore in the future. However, these predictions are in contrast to local observations (City of Cape Town and Western Cape province) of increased storm frequency and intensity and global models.¹

Figure 3: Projected climate changes for South Africa until 2050 under a worst-case RCP 8.5 scenario



Source: CSIR, 2019b

1 At the date of this document, the GreenBook team indicated that an update of the 8 km regional climate model is planned, which might provide more confident insights.

The following figures indicate the degree to which settlements (and surrounding environments) will be exposed by 2050 to an increase in heat stress, droughts, urban flooding, wildfires and changes in water supply. The climate threat of least concern for South Africa's coast is an increase in heat stress, given the moderating effect of the ocean.

It is no surprise that, given the illuminated largescale climate patterns, the intensity of the other climate risks experienced in settlements around the coast vary dramatically. The regional climate context, therefore, needs to be considered for the planning of adaptation response on the ground.

Droughts will increase mostly on the Northern and Western Cape coast and in northern KwaZulu-Natal (Figure 5).

Extreme rainfall-related urban floods will impact the Eastern Cape and KwaZulu-Natal as well as the Western Cape's Overberg and Garden Route. These areas have been affected by flood disasters in the recent past already. Further, worldwide, the number of

Figure 4: Projected increase of heat stress at settlement level until 2050 under a worst-case RCP 8.5 scenario



Source: CSIR, 2019b

Figure 5: Projected increase of drought tendencies at settlement level until 2050 under a worst-case RCP 8.5 scenario



Source: CSIR, 2019b

intense tropical cyclones (Category 4 and 5 hurricanes) is projected to increase as the world continues to warm. Consequently, tropical cyclones and storms, are expected to deliver more rainfall than in the past, as the warmer air can carry more moisture. The cyclones that affect southern Africa originate in the southwest Indian Ocean, where Category 5 events have only been detected over the last two decades. In addition to the extreme precipitation associated with cyclones, elevated sea levels and high wind speeds are likely to contribute to related coastal flooding and erosion during such events. Nevertheless, as mentioned above, these modelled predictions must be seen in correlation to actual weather trends observed over the last decades, for effective climate response.

Wildfires will increase moderately for most of the coastal settlements – in the west related to the decrease of rain and increased heat, and in the east related to more droughts and potentially more fuel due to somewhat higher annual rainfall (Figure 7).

Figure 6: Projected increase of urban floods until 2050 under a worst-case RCP 8.5 scenario



Source: CSIR, 2019b

Part: A

Figure 7: Projected increase of wildfires on the wildland-urban interface (WUI) at settlement level until 2050 under a worst-case RCP 8.5 scenario



Source: CSIR, 2019b

Figure 8: Relative change in water supply vulnerability until 2050 on municipality level



Source: CSIR, 2019b

Figure 8 indicates that the expected relative change in water supply vulnerability is not following the regional climate patterns, as also here, changes in water demand by a growing population are being considered, as well as the general condition of water infrastructure.

These figures show the high variability of regional climate predictions and settlement vulnerability. This will require the tailoring of very context-specific climate response activities and would render a onesize-fits-all adaptation recommendation unsuitable.

1.3 Climate impacts on the oceans

1.3.1 Ocean warming, acidification and oxygen loss

Carbon emissions from human activities are causing ocean warming, acidification and oxygen loss, which are likely to provoke changes in nutrient cycling and primary production.

According to the IPCC Special Report on the Ocean and Cryosphere in a Changing Climate (Bindoff et al. 2019), the ocean continues to warm, particularly in the upper ocean layers, leading to increased stratification and decreased mixing of the water column, continuing the clear multi-decadal ocean warming trends documented in the IPCC Special Report on the Ocean and Cryosphere (Bindoff et al. 2019). By the end of the century, the annual mean stratification of the top 200 m (averaged between 60°S–60°N relative to the 1986–2005 period) is projected to increase in the very likely range of 1–9% for RCP2.6 and 12–30% for RCP8.5 respectively (IPCC SROCC: Bindoff et al. 2019).

Apart from increasing mean temperatures, the ocean is also affected by marine heatwaves, which can, similarly to atmospheric heatwaves, cause severe damage to the natural environment. Figure 9 highlights the occurrence of marine heatwaves and other ocean climate extremes between 1982 and 2011.

Rising atmospheric carbon dioxide concentrations are partially absorbed by the oceans. However, the continued carbon uptake is leading to the acidification of the oceans. The open ocean surface water pH has been declining by 0.017–0.027 pH units per decade since the late 1980s. The intensity of acidification is expected to increase during the next decades (Bindoff et al. 2019).

There is a growing consensus that the open ocean is losing oxygen overall, with a highly likely loss of 0.5–3.3% between 1970–2010 from the ocean surface to 1 000 m. In response to ocean warming and increased stratification, open ocean nutrient cycles are being perturbed (Bindoff et al. 2019).

Most coastal regions will likely experience statistically significant changes in tidal amplitudes during the 21st century.



Source: WMO, Johan Stander, ACCESS conference STB May 2024

Three out of the four major Eastern Boundary Upwelling Systems (EBUS, such as the Benguela on South Africa's west coast) have shown large-scale wind intensification in the past 60 years. However, the interaction of coastal warming and local winds may have affected upwelling strength, with the direction of changes varying between and within EBUS (Bindoff et al. 2019).

1.3.2 Sea level rise

Global sea levels (GMSLs) have been oscillating throughout Earth's history (Fagan 2014). Lower sea levels occurred during glacial periods while rising sea levels occurred during warm periods, including the Last Interglacial (129–116 000 years ago), when the global mean surface temperature was 0.5°C–1.0°C warmer, leading to GMSLs being 6–9 m higher than today, and the mid-Pliocene Warm Period (~3.3 to 3.0 million years ago), having been 2°C–4°C warmer with plausible GMSLs about 25 m higher than today. (IPCC SROCC: Oppenheimer et al. 2019).

The boundaries of natural ecosystems have been oscillating in sync with moving coastlines; even early human communities, supposedly nomadic hunters and gatherers, evaded rising sea levels by migrating further inland (Fagan 2014).

Currently, the GMSL is rising and accelerating (Figure 10). The dominant cause of GMSL rise since 1970 is anthropogenic forcing. Tide gauges and altimetry observations increased from 1.4 mm/yr over the period 1901–1990 to 3.6 mm/yr over the period 2006–2015. Models predict that GMSL will rise between 0.43 and 0.84 m by 2100 relative to 1986– 2005 (Oppenheimer et al. 2019).

Sea level rise is not globally uniform and varies regionally. Differences from the global mean can be greater than ±30% in areas of rapid vertical land movements, including those caused by local anthropogenic factors such as groundwater extraction. These findings on anthropogenic subsidence imply that there is a need for the consideration of local processes to inform projections of sea level impacts at local scales.

As for future sea levels on South Africa's coasts, Mather et al. (2009) observed that sea level rise rates along the southern African coastline vary. Over the last decades, the west coast saw a rise of +1.87 mm/ yr, the south coast of +1.47 mm/yr, and the east coast of +2.74 mm/yr, which – assuming a constant SLR rate – would lead to a total SLR of 7.48 cm, 10.96 cm and 5.88 cm between 2010 and 2050, and 16.83 cm, 24.66 cm and 13.23 cm between 2010 and 2100 on the west, south and east coast respectively.

Due to the projected MSL rise, extreme sea levels that are historically rare (for example, today's hundredyear event) will become common by 2100 under all RCPs. Many low-lying cities and small islands at most latitudes will experience such events annually by 2050 (Oppenheimer et al. 2019). Figure 10: Global Mean Sea Level Rise relative to present day



Source: Oppenheimer et al. (2019, p. 328)

In the absence of adaptation, more intense and frequent extreme sea level events, together with trends in coastal development will increase expected annual flood damages by 2–3 orders of magnitude by 2100 (Oppenheimer et al. 2019). Risk related to SLR (including erosion, flooding and salinisation) is expected to significantly increase by the end of this century along all low-lying coasts in the absence of major additional adaptation efforts (Oppenheimer et al. 2019).

For South Africa, several coastal risk assessments have been conducted, focusing specifically on coastal flooding, erosion, and sea level rise. Results show that the extent of the threat will greatly depend on local shoreline morphology and topography. Geospatial representation of South African coastal areas at risk of flooding and erosion can be accessed on the DFFE Coastal Viewer under the data tab "Coastal Climate Change Vulnerability Assessment" and the OCIMS Coastal Flood Hazard Viewer. KwaZulu-Natal developed coastal risk lines on a provincial level; these can be accessed on the CoastKZN Map Viewer.

Further, in response to the requirements of the Integrated Coastal Management Act (ICM Act, Act 24 of 2008), the provinces are in the process of implementing Coastal Management Lines (CMLs) which regulate development in coastal zones at risk of flooding and erosion (among other management goals). To date, CMLs have been developed for the Western Cape Province (Available on the DFFE Coastal Viewer under the data tab "Integrated Coastal Management Act"), the Northern Cape and KwaZulu-Natal. The Western Cape's coastal risk lines and resulting CMLs can be accessed per District Municipality through the Western Cape Governance GIS portal.

2 South Africa's coastal development trends

Coastal spaces have always been a focal point for human activity. The wealth of resources is believed to have been a major driver of human development throughout human history (Fagan 2014). In 1990, about 1.2 billion people lived within 100 km from the coast at an elevation of up to 100 m, meaning that 23% of the global population lived in 9% of the global land area (Small and Nicholls, 2003). This number increased to 2.15 billion (27.5% of the global population) in 2020 (based on WorldPop). Considering the low-elevation coastal zone (LECZ), defined as land with an elevation of up to 10 m, over 10% (634 million) of the global population lived in this low-lying coastal zone in 2000, covering 2% of the global land area (Reimann et al. 2023).

In South Africa, of the total population of 60 million in 2021 (StatsSA), about 22% (ca 12.9 million) were living within 20 km of the oceans' coasts. Thereof, about 2.33 million resided on the Eastern Cape's coast, 5.17 million on KwaZulu-Natal's coast, 5.4 million on the Western Cape's coast and about 9 500 in the vicinity of the Northern Cape's coast, with 60% of these persons living in densely populated metropolitan areas (Le Roux et al. 2017). In 2019, about 3.7 million people lived within one km of South Africa's coast up to 30 m above mean sea level, and over 2 500 people lived in coastal areas identified to be at either high or very high flood risk (CSIR 2019c).

According to the GreenBook, coastal settlements will remain a magnet for a growing population, leading to extreme population increase, in particular in KwaZulu-Natal's coastal settlements and the coastal metros around the coast (Figure 11).

An example of projected extreme population change is the municipality of uMhlathuze, whose population is expected to double between 2011 and 2050, even under a medium growth scenario (Table 2). This growth will also affect Richards Bay. During the same period, eThekwini's population is expected to grow by about 1.5 million, and Cape Town's population by 1.8 million.

Figure 11: Projected population change in South Africa's settlements (2050 relative to 2011)



Source: CSIR 2019a

Table 2: Population growth pressure across uMhlathuze Local Municipality

Growth scenario	2011	2030	2050
Medium growth scenario	363 327	541 697	727 333
High growth scenario	363 327	554 280	763 172

The above projections do not include the potential additional pull of population into the coastal zones which the planned development of the Boegoebaai deep-sea port on the Northern Cape coast might add and the planned Eastern Seaboard Development across the Eastern Cape-KwaZulu-Natal border (MISA 2023).

The immense population pressure on KwaZulu-Natal's and the eastern Cape coast is of concern when seen in relation to the current and projected climate changes (see Section 1 above), as this region is already prone to disastrous extreme weather-related events, which are likely to get more severe in the future. Pro-active and climate-wise development planning for these areas is imperative to keep the growing population and economy out of harm's way.

3 South Africa's coastal sector

3.1 Importance of the coastal sector

About 95% of South Africa's imports and exports are ocean facilitated, making approximately 60% of the South African economy dependent on coastal natural resources and trade infrastructure, such as ports.

Direct economic benefits that the coast provides include the marine fishing industry, port and harbour development, shipbuilding and maintenance and attractive lifestyles, and recreational and tourism opportunities offered by a coastal location. Furthermore, the coastal natural environment provides indirect economic benefits such as erosion control through coastal features such as foredunes, rocky shores and coastal vegetation. This protects valuable built infrastructure along the coast (including roads, buildings, and service delivery infrastructure) from the damaging effects of waves and wind. Further, the coast allows waste assimilation, detoxification, and recycling through coastal wetlands, forests, and grasslands. Estuarine vegetation such as mangroves and salt marshes also provides important carbon sequestration services.

The above highlights the enormous importance of coastal environments and resources but also indicates the potential risk and vulnerability to which coastal populations, environments, and assets in South Africa (and beyond) are exposed. The socio-economic benefits that we derive from the coast largely depend on the health, intactness and functionality of natural coastal environments and ecosystems. The increasing anthropogenic pressure on these systems, and use of renewable and nonrenewable natural resources requires sensitive and sustainable management to ensure the future health and wealth of the coast.

Apart from immediate human land use requirements and the preservation of a productive natural environment, the perspective of a changing climate (e.g. shifts in rainfall patterns), increased storminess and rising sea levels pose additional threats to natural coastal ecosystems and the human population and infrastructure reliant on them. While coastal communities are considered wealthy (and thus less vulnerable and more resilient to, for example, climate impacts), it must not be forgotten that an estimated 40% of the coastal population is considered to live below the minimum income level of South Africa (CSIR GAP 2013).

Integrating human population and land use requirements with sustainable use and preservation of the natural environment, considering a changing climate, is a core challenge of coastal management (Figure 12).

Figure 12: The three core coastal management challenges



3.2 Elements of the coastal sector

The Climate Change Act (Section 22) calls for the development of Sector Adaptation Strategies and Plans to enhance resilience and ensure a coordinated response to climate risks. The section below will provide a definition of the coastal sector. For the purpose of the CARP, the coastal sector was divided into five 'coastal elements' to better align with key spheres of decision-making, resulting in the structure illustrated in Figure 13.

The "natural environment and natural assets" element provides the foundation for any coastalspecific activity. The natural environment also provides valuable ecosystem services and holds the potential for ecosystem-based Adaptation (EbA). People and coastal communities are dependent on coastal resources and are potentially at risk of climate change impacts. Built environment and built infrastructure include residential infrastructure, as well as service delivery and economically important infrastructure, which are supporting livelihoods and coastal economies. Governance and legislation are embracing the coastal space, its people, and economies at variou levels.

The first four elements of the South African coastal sector are evaluated in Sections 14 to 17. The elements are described, based on the climate and development trends set out in Sections 1 and 2 above, climate threats they are facing are identified, and an adaptation Management Objective is proposed – with relating Adaptation Outcomes and Interventions needed to achieve these Outcomes and Objectives. The description of the Governance/legislation element in Section 18 will follow a slightly different structure. For all five elements, templates with the suggested Interventions are provided as guidance for decision making and prioritising, budgeting, and monitoring and evaluation (M&E) of interventions on the respective governance level.



Figure 13: The elements of South Africa's coastal sector

4 Climate hazards in South Africa's coastal zone

Climate change is an internationally accepted reality. Effects of climate change are also tangible in South Africa's coastal zone, in the form of rising sea levels, an increase in storm frequency and intensity, and the related increase in damage and loss to coastal infrastructure, livelihoods, and natural resources. Storms like the one that hit the South African south coast on 16/17 September 2023, are causing flood damage to buildings, infrastructure, and private property (Figure 14). The observed increase in frequency of these storms is accelerating the economic damage caused and decreasing the resilience, i.e. the ability to recover from these events of natural environments, economies and livelihoods and local government entities.

Coastal municipalities are already under intense pressure, as they are exposed not only to hazards originating from the ocean, such as storm surge and sea level rise-related flooding and erosion, but also to the "universal" climate hazards experienced in South Africa, i.e. drought, rainfall-related flooding, extreme temperatures and veld fires.

Climate risks disrupt economic activities in the coastal zone, damage the built environment and infrastructure and threaten coastal communities and livelihoods. Coastal resources and economies, such as fisheries, tourism, trade, and economies depending on operational ports, are an important driver for the South African economy. Therefore, preventing damage caused by coastal storms and other climate fluctuations by developing effective climate response actions is becoming increasingly urgent for South Africa's coastal sector.

South Africa's legislation landscape is rich in policies on climate adaptation, environmental management, and integrated coastal management. Further, during the last years, various technical risk assessments have been conducted to identify areas susceptible to coastal flooding and erosion, as well as other climate risks that South Africa is facing. **However, there is still a need to provide guidance on tangible options on how to respond to the identified climate threats on the ground, within the legal obligations**.

4.1 Motivation for a Climate Change Adaptation Response Plan for South Africa's coastal sector

In July 2024, the first Climate Change Act (Act 22 of 2024) for South Africa was signed by the President. The objective of the Act is to enable the development of an effective climate change response and a long-term, just transition to a low-carbon and climate-

Figure 14: Flooding and damage caused in Gordons Bay (Cape Town) by the storm on 16 September 2023. Note the floating car in the left picture, being tossed around and into the buildings (right) by up to 6-metre-high waves





Source: Melanie Lück-Vogel

resilient economy and society for South Africa in the context of sustainable development, and to provide for matters connected therewith.

The Act recognises that South Africa is particularly vulnerable to the impacts of climate change, which have the potential to undermine achieving the Republic's developmental goals. Implementing an effective climate response is, therefore, a national sustainable development priority to enable a just transition to a climate-resilient, equitable, and internationally competitive low-carbon economy and society and towards achieving the UN Sustainable Development Goals 2030.

South Africa has, consequently, committed to international agreements such as the Paris Agreement (UNFCCC 2015), to play its role in reducing global greenhouse gas emissions.

Further, the Act raises awareness that climate adaptation is not a mere environmental function, but that it requires an integrated cross-governmental approach in that it acknowledges that **"a robust and sustainable economy and a healthy society depends on the services that well-functioning ecosystems provide, and that enhancing the sustainability of the economic, social and ecological services is an integral component of an effective and efficient climate change response"** (National Climate Change Act, 22 of 2024, Section 3.1).

The Act, therefore, emphasises the need for climate response plans to be implemented across all levels of governance, alongside the development of sector-specific vulnerability assessments, adaptation strategies, and action plans (Act 22 of 2024, Section 22). This Climate Change Adaptation Response Plan is the Department of Forestry, Fisheries and Environment's (DFFE) response to this demand for South Africa's coastal sector, given the very important part the coastal zone and its natural and environmental assets play for the country and its people. This Response Plan is also strongly aligned with the National Climate Change Adaptation Strategy (DEFF 2019).

4.2 International context

Climate response is receiving immense attention internationally, which has resulted in several

international climate mitigation and adaptation obligations (Figure 3). Among others, South Africa ratified the **UN Framework Convention on Climate Change** (UNFCCC), which aims to achieve the "stabilisation of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic [human-induced] interference with the climate system" (UN 1992).

During the Conference of the Parties (COP 16) in Cancun 2010, for the first time, climate change adaptation received the same level of importance as climate change mitigation. The Cancun Adaptation Framework laid the foundation for the Paris Agreement (UNFCCC 2015). As part of this Agreement, member countries are expected to report on their adaptation activities every two years in terms of support received, and every four years on their adaptation activities. The Paris Agreement, so far, the highest pinnacle of international climate change governance, is putting unprecedented emphasis on climate response actions in South Africa. The consequently developed National **Climate Change Adaptation Strategy** (DEFF 2019) fulfils the role of the National Adaptation Plan that the Paris Agreement requires. Strongly related to the Paris Agreement is the Sendai Framework for Disaster Risk Reduction 2015-2030, adopted at the Third UN World Conference in Sendai, Japan in March 2015 (UNDRR, 2015).

The need for (climate) effective coastal management is also highlighted in several international agreements to which South Africa is a party. These include, for example, the outcome document of the Rio +20 Conference (*The Future We Want*), as well as the **Sustainable Development Goals** (SDGs). SDG 13 calls for 'urgent action' to combat climate change and its impacts (UN 2015), which is critical if the effects on coastal environments and communities are to be addressed.

In 2016 the **Climate Change Strategy for the Nairobi Convention** was released (Nairobi Convention, 2016). This document details a comprehensive programme of action for the Nairobi Convention to address its Climate Change Strategy developed in 2015. The strategy will focus on building such resilience and has the following vision: To make coastal communities, economies, and marine ecosystems in the Western Indian Ocean resilient to the effects of a changing climate and climate variability. In awareness that many countries do not have the capacity to effect climate response, a wealth of initiatives and online portals were developed to provide guidance on climate adaptation. The Cancun Conference also established the **National Adaptation Plan (NAP) process for Least Developed Countries** (UNFCCC 2015).

4.3 Climate response in South Africa

Acknowledging that climate hazards affect various sectors differently, sector-specific adaptation guidance has been developed in South Africa, e.g. for Water & Sanitation (DWS 2022), Health (Petrie et al. 2021), Agriculture (DAFF 2015) and Biodiversity (DEA 2015). A Climate Response Plan for South Africa's Ports is currently under development, too (WSP, pers. comm.). Further, Climate Response Plans focusing on settlements are currently being developed on coastal district level, e.g. Overberg (CSIR 2024a), and for selected Priority Human Settlement and Housing Development Area in the coastal zone of coastal local municipalities such as uMhlathuze (CSIR 2024b), Port St Johns (CSIR 2024c) and Ray Nkonyeni (CSIR 2024d). South Africa is also in the process of developing a South African Technical Standard on Climate Adaptation (DTIC 2023).

The purpose of the CARP is to provide guidance on tangible climate actions to effectively respond to climate hazards in South Africa's coastal sector. In doing so, South Africa is also fulfilling its obligations to the **South African Climate Change Act** (Act 22 of 2024) under which sector-specific Adaptation Response Plans became a legal requirement. It also leans on the **National Climate Change Adaptation Strategy** (DEFF 2019) which gives directives for certain adaptation activities to be developed and implemented. Equally important is the recently revised **Biodiversity and Ecosystems Sector Climate Change Vulnerability Assessment and Adaptation Strategy** (Turpie et al. 2021), which needs to be considered for the natural coastal environment. Further, the CARP must be fully cognisant of the **Integrated Coastal Management Act** (Act 24 of 2008), which already demands climate adaptation action.

The development of the CARP also responds to a long overdue demand stated in the White Paper for Sustainable Coastal Development in South Africa (DEA 2000) under Goal C5: to make provisions for government "To plan and manage coastal development to avoid increasing the impact and severity of natural hazards and to avoid exposure of people, property and economic activities to significant risk from dynamic coastal processes".

Climate adaptation plans are not a single intervention and require foresight, resources, and expertise while being grounded in the local context. This requires the development of actions that align with the objectives and needs of local communities and already existing climate adaptation policies on the provincial and local levels.

5 Vision for South Africa's climate-resilient coastal sector

Guiding the development of the CARP, the following Vision for South Africa's Climate-wise Coastal Sector was developed, based on the inputs received during the 2023 and 2024 stakeholder engagements (DFFE & CSIR 2024)

To create resilient and thriving coastal populations and communities, and livelihoods while maintaining the biological diversity, functioning and service provision of coastal ecosystems under changing climate conditions

6 Objective and scope of the Coastal Adaptation Response Plan

As outlined above, the development of a CARP is a complex undertaking that requires consideration of existing national and international policies and strategies across various government spheres and sectors. The key challenge is distinguishing the CARP from existing response plans while avoiding duplication and ensuring alignment with ongoing efforts.

The primary objective of the Coastal Adaptation Response Plan (CARP) as a national reference is to provide tangible high-level recommendations for South Africa's Coastal Sector on how to respond to climate risks on the ground in line with the requirements of the Integrated Coastal Management (ICM) Act, Climate Change Act (CC) and National Climate Change Adaptation Strategy (NCCAS).

This approach helps to focus this Response Plan, recognising that, due to the high complexity of South Africa's coastline, it cannot address all urgent climate-related issues in the coastal zone. Furthermore, it is important to note that this is South Africa's first Coastal Sector Response Plan, while other sectors, such as Biodiversity, Health, and Water, have already undergone multiple revisions of their response plans. As a result, it is anticipated that the CARP will evolve over time, addressing any aspects that may have been omitted in this version.

PART B: Implementation guideline

Effective coastal climate change adaptation, while actioned largely at local level, can only be successful through coordination of climate responses across scales, sectors and mainstreaming of climate response into the policy domains.

This section outlines core adaptation principles and strategies, ensuring an effective and actionable response, particularly through policy mainstreaming. It also explores how integrating climate considerations into broader policies can unlock funding opportunities for adaptation, including sources not traditionally focused on climate resilience.

Further, capacity at the implementing party needs to be established in terms of an in-depth understanding of the portfolio of adaptation principles, approaches, and actions available, how to implement them and their potential intended and unintended consequences (or co-benefits).

The Climate Change Act emphasises the need to monitor climate actions and report on it at all levels, at prescribed intervals.

Climate response action has shown to be met with resistance from receiving parties, with potentially conflicting interests or the public. Communication, public awareness, education, and training are, accordingly, important elements of successful climate response as well.

PART B of this document then focuses on these overarching implementation factors, needed at a high level to effectively respond to the coastal climate and development challenges set out in PART A.

7 Adaptation principles, approach, actions and pathways

Oppenheimer et al. (2019) point out that adaptation experience to date demonstrates that using a locally appropriate combination of decision analysis, land use planning, public participation and conflict resolution can help to address the governance challenges faced in responding to climate change. Effective climate responses depend primarily on taking a long-term perspective when making shortterm decisions, explicitly accounting for uncertainty of locality-specific risks beyond 2050, and building governance capabilities to tackle the complexity of climate risks.

On a more conceptual basis, climate response is usually focussed on climate change mitigation or climate change adaptation. Climate change mitigation and adaptation refer to the two primary strategies aimed at addressing the adverse effects of climate change, i.e., by either delaying, reducing, redistributing, or avoiding the impacts. **Climate change mitigation** is "a human intervention to reduce emissions, or enhance the sinks, of greenhouse gases (GHGs)" (IPCC 2022 p. 2915). The goal of climate change mitigation is to achieve a reduction of emissions that will limit global warming to between 1.5°C and 2°C above pre-industrial levels (Behsudi 2021).

Climate change adaptation aims to reduce climate-related risks by adjusting a system to the actual or anticipated climate and seeking "to moderate or avoid harm [and] exploit beneficial opportunities" (IPCC 2022 p. 2898) that may derive from unavoidable impacts of climate change such as extreme hazards. The climate change adaptation agenda is concerned with facilitating the adaptation of species, people, places, assets, and systems, to the impacts of actual or anticipated climate-related risks and implements various measures or actions to achieve this (Behsudi 2021, C40 2020).

This Response Plan focuses on adaptation, while recognising the close interconnection between adaptation and mitigation agendas.

The primary aim of climate adaptation is to address both, current and anticipated future risks and vulnerabilities, while also leveraging opportunities for long-term sustainable development. Furthermore, it facilitates the integration and prioritisation of climate change adaptation and resilience measures into various planning mechanisms and processes (CSIR 2023a).

This section of the report proposes adaptation principles (as identified by the South African Bureau of Standards – SABS), an approach for identifying adaptation options, categories of adaptation options (as identified by the GreenBook), and the concept of adaptation pathways.

7.1 Adaptation principles

The Climate Change Act's Section 3 (Act 22 of 2024) stipulates the actions the MECs, and mayors of metropolitans and district municipalities must take to implement Climate Adaptation Response Actions at their respective levels. The requested response actions here might be interpreted and executed differently by the respective authorities. To facilitate and streamline Climate Response, SABS recently published a draft Technical Standard on Climate Adaptation which identifies the following principles that apply to local government when adapting to climate change (SABS 2023). These principles are as follows:

- Accountability: Local governments not only acknowledge but also assume responsibility for their climate change adaptation efforts. They willingly subject themselves to appropriate scrutiny and accept the duty to respond to this scrutiny.
- Continual learning and improvement: Recognising the uncertainties in knowledge and the dynamic nature of drivers of change, available knowledge and evidence, and the contextual factors, continual learning and improvement are essential for effective climate change adaptation.
- Mainstreaming and embedding: The effectiveness of climate change adaptation is maximised when

integrated into local government operations, encompassing policies, plans, procedures, risk management, and implementation strategies.

- Flexibility: Embrace a flexible approach that considers technical, social, administrative, political, legal, environmental, and economic circumstances. This allows for the accommodation of a diverse range of data availabilities and technical and institutional capacities to meet goals and objectives.
- **Practicality:** Set practical and achievable goals and objectives. Impractical targets may hinder the successful realisation of climate change adaptation benefits. Focus on easily measurable indicators/metrics with available underlying data and compare them across scales to avoid imposing additional burdens.
- Prioritisation: During the identification of adaptation plans and measures, prioritise areas based on the relative characteristics of climate change impacts (magnitude, likelihood, and urgency). Consider the capacities of stakeholders and the local government and community's ability to act.
- **Proportionality:** Undertake actions that are most effective under the current circumstances, including economic, social, cultural, and political contexts, capabilities, knowledge, and evidence base. Aspire for continual improvement in identifying and assessing adaptation measures.
- **Relevance:** Facilitate assessments that provide decision-makers and practitioners with meaningful information for adaptation planning, considering appropriate spatial scales and relevant time durations.
- **Transparency:** Ensure that reports and communications on climate change adaptation are openly, comprehensively, and understandably presented, providing accessible information for all interested parties (SABS 2023).

While these principles were set up for climate adaptation at local municipal level, they are also applicable for other government spheres and sectorbased adaptation planning. These principles can guide the formulation of adaptation goals, programs and measures, as outlined in the following approach.
7.2 Adaptation approach

Broadly, adaptation approaches are categorised into anticipatory and reactive measures.

- Anticipatory adaptation involves proactive measures taken in preparation for anticipated climate change impacts, while
- **Reactive adaptation** entails responding to climate change effects as they are experienced.

The inherent uncertainty in future climate trends underscores the necessity for a flexible response and the formulation of adaptable, medium to long-term adaptation strategies. Adaptation, therefore, requires a more nuanced understanding of the local context compared to mitigation strategies, which are usually executed at higher governance levels (CSIR 2023a).

The proposed approach revolves around comprehending climate-related risks and implementing adaptive measures in response to these risks. Climate-related risk encompasses the potential for adverse consequences arising from the interplay of vulnerability, exposure, and the occurrence of climate hazards (IPCC 2022). The components of risk are dynamic with climate hazards influenced by both natural climate variability and anthropogenic climate change. The exposure of individuals, the built environment, and the natural surroundings to climate hazards is driven by both planned and unplanned development and growth. **Vulnerability** incorporates inherent characteristics that render systems sensitive to the effects and impacts of climate hazards.

The approach followed for climate change adaptation implementation involves the following steps:

- 1. Gain an understanding of existing climate risks and vulnerabilities and spatially map these in a specific geographic area
- 2. Identify priority climate hazards based on the risk profile
- 3. Establish adaptation goals to mitigate the risk associated with priority hazards
- 4. Develop adaptation programmes with measures/ actions to achieve these goals
- 5. Integrate adaptation actions into other sector plans/instruments/strategies
- 6. Develop regular review and updating mechanisms to track and report on adaptation success.

As requested by Section 22 of the Climate Change Act, the CARP as the Coastal Sector Response Plan is following this approach with the identification of climate risks to the individual elements of the coastal sector and related goals and adaptation actions, and unpacks overarching implementation factors such as mainstreaming, financing and monitoring and evaluation.

Table 3 provides a more detailed description of the approach. Textbox 1 below gives an example of an adaptation plan developed in the Sarah Baartman District Municipality following this priority-, risk-, goal- and programme-centred approach.

Understand climate risk for a specific sector or geographic area	A climate risk profile assesses risk by determining – for a specific sector or in a specific geographic area and at a specific scale – the likelihood of a hazard to occur, the inherent vulnerability of various systems, and exposure of these systems to specific climate hazards. To be able to develop an appropriate adaptation plan, it is important to understand what contributes to risk and vulnerability.
Identify priority climate- related risks/zones.	Identify the climate hazards and impacts that pose the greatest risk at present and in the future within a geographic area. If possible, also identify climate risk zones that need to be prioritised for intervention.
Establish adaptation goals	Identify adaptation goals to address priority risks/zones that speak to policy goals.
Develop adaptation programmes and actions	 Develop adaptation programmes that speak to the identified adaptation goals and identify appropriate adaptation actions under each of the programmes that are mutually supportive. Adaptation actions should: Be specific to a climate hazard/vulnerability/exposure Suggest a target or an indicator to measure progress Be assignable to a primary implementer Consider co-benefits and other implications Include mitigation as it builds resilience or reduces exposure and vulnerability.

Table 3: An adaptation approach

Mainstream adaptation

Develop regular review and updating mechanisms

Integrate adaptation goals, programmes, and actions into existing instruments and processes. The aim is to ensure that climate change adaptation and resilience are an integral part of all that local government is doing.

To monitor progress of climate adaptation on all governance levels, regular reviews of achievements (and challenges) are needed. Reporting is also needed for international obligations. Further the relevance of the CARP itself needs to be reviewed regularly to accommodate technological developments and implementation priorities on the ground.

Source: adapted from CSIR, 2023a

Illustration of the adaptation approach followed in the Sarah Baartman District Municipality Adaptation Action Plan

Situated in the Eastern Cape Province, Sarah Baartman District Municipality (SBDM), a coastal district, faces significant challenges. Predominantly, the region contends with the dual threats of drought and escalating temperatures, exacerbated by the population growth strain in coastal towns already grappling with service access requirements.

Adaptation goal 1 – Ensuring water security amid climate change: Given the prevailing water scarcity challenges in the country, the Municipality aims to develop comprehensive strategies for water resource management. This involves investing in efficient water infrastructure, prioritising maintenance, promoting water conservation practices, implementing rainwater harvesting systems, and exploring alternative sources like groundwater and wastewater re-use.

Programme 1 – Integrated approach to water augmentation, water use, and water management: This programme is designed to tackle water resource limitations in SBDM comprehensively. Its objective is to create a holistic strategy for efficient resource management, enhance water usage, and ensure long-term sustainability amid changing climatic conditions:

- Water-sensitive urban design (WSUD): The first component integrates the water cycle into urban landscapes, increasing water availability and enhancing its quality.
- Human resources enhancement: Addressing workforce constraints is crucial. This action involves identifying gaps, training existing staff, and recruiting additional personnel as needed.
- Bulk water master plan review: Regularly updating this strategic document is vital due to the dynamic nature of water resources, climate change impacts, and shifts in water demand projections.
- Water safety plan (WSP) Development: Essential for safeguarding public health, implementing a comprehensive WSP ensures safe drinking water from source to tap, meeting regulatory requirements, and enhancing consumer confidence in the water supply. (CSIR 2023a).

In the subsequent phase, specific actions will be identified to effectively address this adaptation goal. The actions should be tangible and concise to enable monitoring of progress.

7.3 Categories of coastal adaptation actions

The coastal sector, vulnerable to the various impacts of climate change, has a spectrum of adaptation actions at its disposal to enhance resilience and mitigate risks posed by rising sea levels, extreme weather events, and changing climatic patterns. Some of the categories of actions include:

- Infrastructure development, encompassing the construction of seawalls, levees, and storm surge barriers to protect against rising sea levels and extreme weather events. These engineered solutions provide immediate protection and enable for longer-term adaptation efforts but are mostly very expensive to build.
- Green infrastructure initiatives offer sustainable and ecosystem-based solutions (EbAs). Cities and settlements can implement urban green spaces, green roofs, and permeable pavements to absorb excess water, reduce flooding, and mitigate the urban heat island effect. Such approaches not only enhance climate resilience but also contribute to improved air quality and overall urban liveability.
- Environmental protection such as restoring coastal ecosystems like mangroves, dunes, and wetlands, not only provides natural buffers but also supports biodiversity and Blue Carbon-based climate mitigation options.
- Integrated urban planning is essential to create climate-resilient cities and settlements. Land-use regulations should be adapted to consider climate risks, prioritising construction practices that enhance resilience. Elevating structures above projected sea levels and using climate-resilient materials in building design can minimise the impacts of flooding and storm damage.

- Early warning systems and emergency preparedness plans are critical tools to ensure swift responses to extreme weather events, minimising the impact on vulnerable communities.
- Innovative water management strategies are essential for coastal settlements and economies facing changing precipitation patterns, increasing water scarcity, and decreasing water quality. Diversifying water sources, implementing water efficiency measures, and investing in advanced stormwater management systems contribute to water security (in terms of quantity and quality) and sustainable resource use.
- Community engagement and education are pivotal components of successful adaptation strategies. Empowering residents to understand and respond to climate risks through awareness campaigns, education programmes, and participatory planning initiatives can enhance local adaptive capacity (CSIR 2019a).
- **Retreat.** In the coastal zone, rising sea levels and increasing threats to infrastructure and livelihoods might render all the above actions unfeasible in the long term. In such cases, giving up areas at risk and moving infrastructure and settlements to higher, safer grounds can be considered.

The coastal sector must embrace a combination of structural, natural, and community-based approaches to build resilience and adaptive capacity, protect vulnerable communities, while ensuring long-term sustainability in the face of evolving climate challenges.

The GreenBook Adaptation Actions Tool provides a wide portfolio of specific actions in the categories listed above as part of the approach to address climate risks which can be used to supplement the adaptation actions provided in the CARP.

8 Adaptation pathways to respond to uncertainty

Flexibility is one of the important adaptation principles needed to enable climate action in light of the high uncertainty of local development trends and future climate. This uncertainty challenges established planning and decision-making practices and introduces the need for more flexible responses (i.e., those that can be adapted over time) and periodically adjusted decisions (i.e., **adaptive decision making**).

One example is adaptation pathway analysis, which has emerged as a low-cost tool to assess long-term coastal responses as sequences of adaptive decisions in the face of dynamic coastal risk characterised by deep uncertainty (Oppenheimer et al. 2019).

Figure 15a below illustrates the adaptation pathways concept. The x-axis of the flow chart represents the timeline, here equivalent to the rate of sea level rise (SLR), as an example of a climate threat. The y-axis represents different potential starting points of responses to SLR (or any other climate threat). While all examples of specific measures provide equal protection in the short-term, in the mid- to long-term certain adaptation measures might become non-feasible. For instance, it might become too

Figure 15: The concept of adaptation pathways. (a) Generic adaptation pathways for coastal cities and settlements to sea level rise, (b) Illustrative pathways for some coastal archetypes



Source: IPCC 2022a (Cross-Chapter Paper 2: Cities and Settlements by the Sea)

expensive to increase the height of seawalls to keep up with rising sea levels. The figure shows that at certain points in time, adaptation measures need to be changed to provide more effective protection.

Figure 15b incorporates the spatial component into the pathway concept. It illustrates that for specific coastal archetypes, i.e. islands, rural deltas, and megacities, some of the potentially possible adaptation options are more suitable than others. For instance, for the protection of rural coasts, seawalls are rarely a suitable option, due to the high cost. Adaptation pathways facilitate long-term adaptation while providing flexibility should other adaptation options prove more suitable in the future. They can also "buy time" to prepare settlements and communities where e.g. Retreat might be the best option in the long-term by implementing other (more cost-effective) adaptation options in the shortterm. Adaptation Pathways, hence, enable planning beyond the horizon of election cycles and facilitate the implementation of 10-Year Adaptation Plans.

9 Governance and institutional arrangements

The Climate Change Act (Section 17.1) requires from the MECs and mayors of metro or district municipalities:

- Assess climate change need and required response for the respective area of jurisdiction
- Assess to what extent its constitutionally mandated functions are affected by climate change and formulate steps on how to address this
- Every five years to review, amend and gazette the identified climate response assessments and needs
- Within two years of the gazetted climate response assessment to review, amend and gazette a climate change response implementation plan.

The Act also strongly emphasises perusing different government structures such as existing ICM coastal committees, DDM district committees, District disaster risk forums, municipal climate change forum etc. for the execution of climate adaptation.

Section 17.2 outlines principles on which the climate assessment and response plans need to be based. The following sections provide a practical guide to assist provinces and municipalities to respond to the requirements of the Climate Change Act (No. 22 of 2024).

9.1 Teamwork and co-development

Climate change adaptation is frequently perceived as an "extra burden" for government officials, especially at the local level, where most of the implementation will take place and where resources are least available. Climate-proofing South Africa's coastal sector will be an incredibly complex process that needs cross-sectoral coordination. The Climate Change Act (No. 22 of 2024) (Sections 8 and 9) acknowledges this complexity and prescribes the establishment of intergovernmental forums at provincial and municipal levels to coordinate the integrated, cross-departmental climate response action and to report to the President's Climate Commission (PCC). These forums will be essential drivers of mainstreaming climate change response into other legislation, as required by the Act (see next section).

Further, there can be collaboration with nongovernment role-players and community representatives. Involvement of parties who will be affected by the outcomes of the planned activities through co-development at an early stage will increase buy-in and acceptance.

9.2 Mainstreaming

The Climate Change Act (Section 7) emphasises the importance of policy alignment, encouraging all organs of state to review and, where necessary, adjust, coordinate, and harmonise their policies, programmes and decisions. This ensures that climate change risks and vulnerabilities are effectively considered, while upholding the principles and objectives of the Act. Mainstreaming is the process of integrating climate change adaptation strategies, programmes, and actions into existing instruments and processes, particularly those related to development and planning. The aim of mainstreaming is to ensure that climate change adaptation and resilience is an integral part of all planning programmes, processes and instruments. Mainstreaming can, thus, be used as an implementation strategy for the Coastal Adaptation Response Plan.

Climate change adaptation requires coordination across government levels and spheres, but implementation and action are positioned locally. Local governments are most sensitive to risks and vulnerabilities and have a distinct role to play in adapting to climate change. The other spheres of government play a significant role in supporting and enabling local government to fulfil their mandate and to drive local adaptation and implementation. To ensure alignment between all actors at various scales of government and society, there needs to be policy and strategy coherence.

To facilitate the mainstreaming of the CARP into provincial and local government planning, the following activities are recommended based on the Guideline on Mainstreaming Climate Responsiveness and Resilience into Urban Planning (National Treasury 2024):

1. Ensure that there is representation of the CARP within an existing formal body, forum, or team that oversees and coordinates the mainstreaming of climate response within provincial and local government. If such a body or team does not exist, it should be established in alignment with Chapter 2 of the Climate Change Act (Act 22 of 2024). The purpose of such a body and its members is to provide policy direction, drive collaboration between stakeholders across sectors, promote

and contribute to common data sources, provide technical and administrative support related to climate response mainstreaming, ensure synergies between activities, and support planning, implementation, and evaluation of mainstreaming efforts. Existing platforms that can be leveraged for this purpose are the National Coastal Committee, Working Group 7, Climate Working Group 9, Climate Change Technical Working Group, Provincial Coastal Committees, Municipal Coastal Committees, Estuary Task Teams and the National Coastal Spatial Planning Working Group. Including the needed activities in the committee members' performance goals will create "space" and acknowledgment of engagement in coastal climate response development.

- 2. Map the unique institutional arrangements within provincial and local government to provide an overview of the regulatory and institutional frameworks, intergovernmental structures, technical structures and to identify the linkages and relationships between them. Having such an overview enables the identification of institutional and organisational gaps and to make recommendations for institutional improvements in support of mainstreaming.
- 3. Establish and renew external (nongovernmental) networks and partnerships that can support the implementation of the CARP. External and internal networks and partnerships offer access to essential resources to support implementation, capacity building, and provide access to expertise, information and funding for climate response. It is imperative to encourage inter-departmental collaboration, incentivise, and enhance capacity to mainstream climate response and adaptation measures. Technical skills and expertise around climate change response should be increased across sectors and departments to facilitate the use and interpretation of relevant climate evidence into programmatic and implementable responses.
- 4. Use available evidence on climate change risks (PART A of this document) and adaptation opportunities (PART C) to inform provincial and local planning instruments and processes. This includes developing a localised climate

change response plan, aligned to the CARP. The purpose of the plan is to identify responses that will address the root causes of vulnerability, reduce exposure to protect investments from climate risks, and increase long-term resilience. The climate change responses set out in this plan, especially for the population and built environment component should be aligned with potentially already existing response plans on settlement or local municipality level. This will allow for easier integration into existing spatial development plans, sector plans, their associated budgets, and into their monitoring and evaluation frameworks.

Municipal Planning By-laws, Land Use Schemes, and Spatial Development Frameworks (SDFs) undergo a review every five years. These review cycles present a critical opportunity to integrate climate risk and adaptation considerations, ensuring that these policies align with the requirements of the Climate Change Act. This process enables the embedding of climate-responsive planning and decision-making at the local level.

10 Financing strategy

One of the key challenges hindering a swift transition to a low-carbon and climate-resilient future is financing. This issue is complex, politically sensitive, and heavily dependent on trust between stakeholders (ODM 2017). In South Africa, the demand for climate investment is substantial, requiring innovative funding mechanisms and stronger public-private collaboration to bridge existing financial gaps.

The Climate Change Act (Section 18) acknowledges this challenge and mandates that government funding for climate action be allocated in consultation with the National Treasury. However, beyond dedicated climate change adaptation funding, several other financing mechanisms exist that can be leveraged. These will be explored in the following sections.

10.1 Mainstreaming as funding source

From a financial perspective, major financial investments – from both public and private sources and guided by climate-appropriate policies – are required to build the resilience of South Africa's coastal sector to the impacts of climate change. Furthermore, substantial integration of climate change into everyday business (i.e. mainstreaming) is required to leverage and capitalise on investments that are being made daily, including at municipal level (ODM 2017). This statement, adopted from the Climate Response Plan of the Overberg District Municipality (ODM 2017) highlights that **one of the most important funding sources is already existing funding from other sources.** For example, undertaking maintenance and repairs on water provision infrastructure to reduce leaks and increase the efficient use of water, adapts to current water scarcity, while also building resilience in a drier climate future.

Successful mainstreaming requires a more integrated, holistic approach that goes beyond the traditional environmental lens of climate change – one that extends past nature conservation, restoration, and ecosystem-based adaptation to include social, economic, and governance dimensions.

In the coastal context, Sections 14 to 18, about unpacking climate threats per coastal element, will highlight connections of climate adaptation to, e.g., Blue and Teal Carbon activities, health, water and sanitation, spatial development and restructuring (e.g. Eastern Seaboard Development), agriculture, water catchment area management and disaster management. Linking up to funding potentially available through these focus areas requires the stipulation of co-benefits of the proposed response actions for the co-sector applied to.

10.2 Sustainable public procurement requirements

In 2013, the Western Cape Government and the Technical Assistance Unit (TAU) of the National Treasury published an analysis on how to increase investment in climate change-related projects at the sub-national level (DEA&DP & TAU 2013). Results reflect that "regulation and legislation in themselves do not prohibit provincial and local government from implementing climate change-related projects," but that various institutional barriers inhibit the implementation of climate change-related projects, including a severely risk-averse municipal culture. Sustainable Public Procurement (SPP) is one avenue that municipalities can use to overcome some of these barriers (WCG 2015).

Sustainable Public Procurement constitutes a key objective of the Sustainable Development Goal (SDG) 12 (African Development Bank 2020) while, again, opening the viewing angle of investments. Sustainable Public Procurement (SPP) is "a process whereby organisations meet their needs for goods, services, works and utilities in a way that achieves value for money on a whole life basis in terms of generating benefits not only to the organisation, but also to society and the economy, whilst minimising damage to the environment". A sustainable procurement choice is one that accounts for the full

value of a service or product over its whole lifecycle, including the costing of social and environmental risk and opportunities, instead of just the capital cost, which is often the only consideration. This again highlights the opportunity of leveraging co-benefits in public investment.

Because SPP supports green innovation, it allows government to procure more resilient 'futureproofed' goods and services that contribute to climate change adaptation and mitigation, and as such could be used to motivate for climate change responses that may require more funds than a "business-as-usual" response. This is also supported by national policies, which recommend that "*Climate risk assessment should be mainstreamed into the decision-making and planning frameworks of government and the financial system to support climate related investment... Government supports the integration and development of climate change considerations into existing financial practices to enable domestic financing institutions to invest in* climate interventions and to promote green growth in South Africa and the region".

10.3 Disaster management funds

It is frequently overlooked that climate adaptation and disaster response to extreme climate or weather events are not two different businesses, but merely the two extreme ends of climate governance: climate adaptation aims at preventing damage from extreme events, disaster management steps up where damage from extreme events could not be prevented. Sourcing on disaster management funds is, therefore, legitimate as climate adaptation can be seen as part of the disaster management spectrum.

To give an example; it might happen that a municipality recognises that existing infrastructure needs to be upgraded for climate resilience, but that the necessary funds are not currently available. However, once infrastructure is damaged during an extreme event the municipality may then be able to motivate for rebuilding or upgrading the infrastructure to accommodate the new appropriate risk levels by partially using disaster funding. Replacing damaged infrastructure with "like-for-like" may not be a financially or socially sustainable option (see the section on Sustainable Public Procurement above), and municipalities need to be prepared to motivate for more climate-resilient infrastructure to allow disaster funds to be used appropriately or supplemented with increased capital budgets to climate-proof affected infrastructure.

10.4 Funding for natural environmentspecific interventions

Climate change adaptation response for biomes and biodiversity is well established in South Africa (e.g. DEA & SANBI 2106), and the DFFE recently published a draft version of the Biome-Level Implementation Plans for The Biodiversity and Ecosystems Sector Climate Change Adaptation Strategy (DFFE 2023a). This document is providing an overview of government and international funding instruments targeting natural environment-specific interventions also applicable in the coastal context (DFFE 2023a, p.114ff).

One specific aspect which can closely be related to climate change adaptation actions involves

Part: B

ecological Infrastructure investment programmes, as ecological infrastructure has the potential to significantly reduce the vulnerability of coastal built infrastructure and communities (see Section 14).

10.5 Private sector funding

The private sector can play an active role in adaptation solutions. Encouraging private sector investment in climate-resilient infrastructure, sustainable livelihoods, and ecosystem-based adaptation through public-private partnerships would enhance the impact of the CARP. Additionally, incentivising climate-positive business practices (e.g., tax benefits for green infrastructure investments) could drive greater private sector participation. Moreover, sustained funding mechanisms such as trust funds or endowments could help secure financial stability for ongoing adaptation projects.

Further funding options include grant funding, venture capital and equity finance, debt and project finance, as well as green bonds. Green bonds are a way of raising capital with low interest rates for new and existing projects with environmental benefits. The issuer of the bond determines which projects qualify and backs the bond with existing assets. The World Bank's Green Bond covers both adaptation and mitigation, and as of 2016, USD9.7bn has been issued across 18 currencies, of which R1.5bn has been issued within South Africa. Two pilot green bonds were also conducted in South Africa, by the City of Cape Town and the City of Johannesburg. However, raising of bonds in small municipalities will prove challenging given the credit ratings required for raising bonds.

When it comes to financing climate change responses, strategic partnerships can contribute to the financial feasibility of implementation, as this presents the opportunity to pool funds, or allow an organisation to access funding that it would not normally be able to. Public-private partnerships have the potential to overcome the limitations that each sector faces on its own when trying to implement responses. Public-private partnerships also hold the potential to enhance the sustainability of funding models, alongside capacity-building efforts to enable local governments to access climate finance more effectively. Examples of projects implemented exist in the Overberg DM such as the Kleinmond Harbour development and the Gansbaai Communal Sports Centre.

10.6 Grant/donor climate change funding and partnerships

Responding to the impacts of climate change, including Sustainable Public Procurement considerations, may exceed the financial sustainability of municipal planning and investment programmes. Projects requiring more finance than currently available, need to access alternative funding and/or financing options to cover the gap between current revenue streams and reserves and the investment needed to design and implement climate-responsive actions. By establishing a climate response project pipeline, opportunities exist in terms of securing funding through a wide variety of international, bi- and multi-lateral and additional domestic public sector climate funding sources. These can make use of innovative financing mechanisms such as carbon credits and green bond. Further opportunities include (adapted from DEA&DP & TAU 2013):

International Climate Funds

- UNFCCC:
 - Green Climate Fund
 - Clean Development Mechanism (Kyoto Protocol)
 - Adaptation Fund (Kyoto Protocol)
- Global Environmental Facility
- Global Climate Change Alliance
- UNEP and Clean Technology Funds
- Africa Climate Change Fund
- NEPAD Climate Change Fund

Bilateral and multilateral ODA

- Bilateral Grants
- EU/Commission
- GIZ, DANIDA, UKAID, etc.

Domestic Public Sector

- Intergovernmental Transfers
- Local Municipal and Provincial Revenue
- Green Fund (National Treasury)
- Energy Efficiency–Demand Side Management Grants
- Climate Response Fund (as of SONA 2024).

The Green Climate Fund (GCF) is currently receiving a lot of attention by DFFE and SANBI. The GCF was established as an operating entity of the Financial Mechanism of the UNFCCC at the 16th Conference of the Parties (COP16) in Cancun. The fund has five current focus areas:

- 1. Transforming energy generation and access
- 2. Creating climate-compatible cities
- 3. Encouraging low-emission and climate-resilient agriculture
- 4. Scaling up finance for forests and climate change
- 5. Enhancing resilience in Small Island Developing States.

DFFE is in the process of developing a national GCF Framework, which will ensure that South Africa's GCF investments are aligned with national climate change response priorities and will inter alia describe South Africa's priority climate change actions and develop a GCF country programme. The national designated authority for this fund is DFFE, and the current national implementing entities (NIEs) are the South African National Biodiversity Institute (SANBI) and the Development Bank of Southern Africa. Municipalities and organisations need to apply to the GCF through an NIE, taking the project parameters set by DEA in the national GCF Framework into account. Besides applying for funding, municipalities should also strengthen their position towards climate change by means of partnerships with other government entities and the private and NGO sector and continuously explore funding opportunities to address climate change mitigation and adaptation.

10.7 Strategic approach to coastal climate response funding

From the above sections, a strategic approach to access funding for coastal climate response funding can be deduced as follows:

- 1. Compose a task team which will be responsible to develop and action the coastal climate response in your specific coastal context.
- 2. Identify the climate adaptation objectives and goals to be achieved for the respective aspect of the coast you are involved with. Sections 14 to 18 of this document provide these on a higher level, but on a local level, objectives and goals could be more specific.
- Identify tangible adaptation actions to achieve the set objectives and goals. Sections 14 to 18 give a general overview of actions to achieve the most widely encountered climate threats. But again, on a local level, the portfolio of feasible activities might be varied, given different priorities and pressing adaptation needs. Also consider the concept of Adaptation Pathways (Section 7) to develop a long-term programme of implementing different adaptation options.
- 4. Determine which actions have high, medium or low priority. Examples are provided in the Draft Implementation Programmes for the respective coastal elements in PART C of this document.
- 5. Identify key responsible departments linking to the proposed adaptation options. Suggestions are made in the Draft Implementation Programmes for the respective coastal elements in PART B of this document. Identification and use of these interlinkages to other departments whose responsibility is not primarily climate adaptation, speaks to Mainstreaming; see above. Linkages, or co-benefits might open the required funding for the proposed activities, especially when highlighting the principles of Sustainable Public Procurement (see above).
- 6. Determine the timeframe over which the actions need to be completed, either specify a date, e.g. "end 2025" or state more broadly as short-term, mediumterm or long-term. Examples are provided in the Draft Implementation Programmes for the respective coastal elements in PART B of this document. This will later allow for effective monitoring of progress and embedding into annual work programmes.
- 7. Establish the cost of the planned activity. This information will support inter-departmental discussions on funding requirements and funding availability and forms the baseline for external funding applications. The draft implementation programmes in PART B of this document provide space for cost estimations.
- Target external funding sources for the proposed activities, should mainstreaming and interdepartmental collaboration not lead to funding for the proposed activities. This might require training on effective grant application writing.

10.8 Training on climate funding sourcing

Successfully applying for climate funding is not a trivial matter. Application requirements and procedures, especially for international funds, can be complicated, and the competition for available funding sources is great. This constitutes a major barrier for many municipalities to accessing these funds, especially those where human capacity is already limited. Current work-around solutions for this problem include larger proposals to international donors being led by provincial or national government or parastatals such as SANBI, with higher experience and capacity in successful proposal writing. However, there is also potential of peer learning between municipalities, especially from the metros.

Another source of successful fund application writing lies within South Africa's academia. Proposal-writing workshops between local government and academia of the relevant field could be explored to tap into this potential.

11 Monitoring and evaluation of climate adaptation actions

Monitoring and evaluation (M&E) of progress and achievements, but also of challenges experienced during the implementation, is a crucial element of transparent and accountable governance.

The Climate Change Act requires that climate response plans be implemented at the provincial and municipal level and must report upon their progress regularly to the Presidential and provincial Forum on Climate Change respectively (Act 22 of 2024, Sections 8 and 9). For tracking the progress and success of any climate adaptation programmes and actions, measures need to be in place that allow for assessing the achievement of set adaptation goals. M&E is also a requirement of the reporting needs to international climate change obligations and other national legislation (see Section 18). Therefore, an important part of the M&E process is the definition of measurable adaptation actions and performance measures. Monitoring and evaluation can be used as a baseline for adaptive management, to refine and adjust interventions for greater impact.

By designing a tracking and evaluation process upfront, the planning team will be in an advantageous position to keep up the momentum gained during previous steps of the planning process. This will require implementing interventions which are specific, measurable, achievable, relevant, and time-bound, to help tracking the plan's progress and facilitate adaptive management.

The **assignment of the action to a responsible entity and a timeframe for completion**, are essential for tracking progress and evaluation of the outcomes against the original objectives.

On a higher level, a draft Implementation Plan for the CARP (e.g. for international reporting obligations) is provided in Appendix 1.

The CARP encourages alignment of reporting formats with the monitoring and evaluation (M&E) requirements outlined in the NCCAS and other relevant climate adaptation reporting obligations and other obligations that demand reporting on climate adaptation.

For transparency of climate adaptation actions, the reports should be made available on relevant portals such as DFFE's National Climate Change Information System NCCIS where geospatially relevant; also on the DFFE's Coastal Viewer and other provincial and municipal systems. The M&E outcomes for the adaptation programme conducted should also feed into the National Climate Change Response Monitoring and Evaluation System (DEA 2015).

12 Review and update of climate adaptation implementation programmes

Climate change adaptation plans, and implementation programmes are living documents that need to be updated to achieve maximum effectiveness. Therefore, in addition to reviewing the status of the plan and the actions on a regular basis (and making revisions as appropriate), a fullscale update should be conducted every few years as determined by policy obligations or as needed (e.g., in the wake of a catastrophe) (NOAA 2010).

The Climate Change Act in Section 2 mandates that sector adaptation plans are being reviewed and updated at least every five years. It is advisable to plan for the update and assign ongoing data monitoring and collection tasks to team members or subgroups. When updating the plan, the following approach can be followed:

- Reconvene the planning team, altering its composition as needed
- Continue involving the public and other stakeholders
- Review the vulnerability assessment (in line with the review requirements of Section 22.b of the Climate Change Act) and make changes to priorities, as necessary, based on:
 - Monitoring and evaluation results of the conducted adaptation actions

- Technological advances
- New climate science findings/projections
- Observed changes
- Recent hazard events
- Changes to exposure
- Changes in adaptive capacity
- Review the goals from the initial plan and make changes, as necessary, based on revised vulnerabilities and priorities, also in the context of the Republic's international commitments and obligations
- Review the actions from the initial plan and reprioritise, change, delete, or add actions based on lessons learned as well as new goals and changes in adaptive capacity
- Review the implementation and evaluation process and adjust as appropriate.

Finally, in the plan update, include a status review of the actions identified in the previous version of the plan. And: document examples of successes, challenges, and lessons learned.

Further, the timing of the review period for the CARP should be aligned to relevant coastal programme/s and as necessary in response to other (international) policy obligations.

13 Capacity building, training and communication

13.1 Uplifting government capacity: "Think nationally – empower locally"

One of the motivations for the development of the CARP is the partly limited capacity, especially at municipal government level, regarding the development of adaptation response actions, mainstreaming, and sourcing of funding. Further, acceptance and buy-in of the planned actions can be facing resistance within government spheres and from stakeholders and affected communities if the plans and benefits of climate change actions are not clearly communicated.

Consequently, capacity building in these areas is essential to the successful implementation of sustainable coastal adaptation. It empowers stakeholders to take on the complex challenges of climate change in coastal areas effectively. Stronger institutions, skilled government personnel, and engaged communities are better equipped to sustain adaptation measures over time.

Capacity building helps government stakeholders develop a deeper understanding of the challenges and opportunities associated with coastal adaptation. This includes understanding climate change trends, the impacts on coastal areas, and the best practices for adaptation and resilience in the short-, mediumand long-term; it identifies potential co-benefits that climate adaptation in the coastal zone harbours. Capacity building also fosters collaboration and coordination among stakeholders and supports the development of strong institutions and policies for coastal adaptation. Capacity building activities aimed at government that need to be considered include:

- Training and workshops on climate change impacts on coastal areas, best practices on climatewise spatial development and coastal adaptation, and on relevant tools and technologies
- Fostering intergovernmental working groups to enable cross sectoral understanding, approaches, and collaboration
- Training on approaches to mainstreaming
- Training on successful fund-raising for climate actions
- Peer learning between government stakeholders facing similar challenges, including international knowledge exchange
- Technical support to enhance the capacity of institutions to undertake coastal adaptation
- Succession planning: Provide fellowship opportunities to cultivate emerging leaders in integrated coastal management and climate adaptation and provide professional development opportunities for the next generation of coastal management practitioners and environmental stewards.

The CARP is one essential element towards increasing government's capacity for successful climate adaptation action. Further support and information is available from the GreenBook online tool on climate adaptation, the LetsRespond online Toolkit and various international sources.

13.2 Empowering the public

Sections 14 to 18 touched on the need for public awareness of the changing climate reality and the potential threats to life, livelihoods, and the environment arising from it. A climateeducated population and communities will be more responsive to adaptation measures and will also be more prepared to respond effectively in disaster situations. They will be aware of the role that individuals and communities can play. One potential goal would be to create community-based (potentially low-tech) early warning systems for extreme events, and an economic coastal element that can adapt to long-term impacts of climate change.

Measures to achieve a climate-educated public and coastal sector include:

- Outreach campaigns at schools and inclusion of climate education into school curricula
- Outreach campaigns to communities, especially to those inherently vulnerable and exposed to the identified climate threats
- Integration of communities, schools, private sector into coastal adaptation actions, e.g. through participation in dune or wetland restoration as an ecosystem-based adaptation measure and stewardship of sensitive coastal environments
- Information boards at sensitive coastal areas explaining e.g. why the destruction of coastal dune vegetation is causing a threat to settlements in the hinterland
- Digital information materials such as YouTube videos, podcasts, and Twitter or Facebook clips, depending on the targeted audience
- Teaming up with established environmental "Influencers," on social media and in established South African institutions (WWF, Two Oceans Aquarium in Cape Town, Ocean World in Durban etc.) can aid in reaching a wider audience.

An informed public will be more supportive to the implementation of coastal climate actions which are affecting their respective "world".

13.3 Communicating climate adaptation success – and challenges experienced

Climate change is usually associated with doom and gloom, apocalypse, inevitable fate, and other negative notions which leave people feeling powerless. However, the CARP has been created to empower decision makers, industry, and the public to act effectively and to also show potential opportunities arising from the changing environment.

South Africa has regular climate action reporting duties in the context of international obligations, such as the Paris Agreement, and on provincial and municipal level, as demanded by the Climate Change Act. National and international reporting duties are usually coupled to obligatory two- or five-year reporting cycles and might need to answer specific questions (which should be considered in the objectives in the implementation programme from the start). This information should be considered for feeding back to coastal municipalities, as the nationally compiled information holds potential for peer-learning at local level, especially in the light of the vastly different climate action capacity among coastal municipalities.

Further, repackaging climate reports to inform the public about how progress and successes in reducing climate risk in their environment has many benefits, might compensate for disadvantages the implementation of climate action caused (i.e. loss of sea view after constructed seawall) and might relieve anxiety felt over the imposing climate threat. Also, shared success stories might empower communities elsewhere. The following questions can guide the topics to communicate:

- Is the action complete?
- If the action is ongoing, what was accomplished during the reporting period?
- Were there any unexpected problems, obstacles, or delays associated with the action? If so, how were they overcome?
- Have there been any indicators of success or failure of implemented actions in meeting the intended goals? Any losses avoided?

- Were there any unintended consequences (positive or negative) due to implementation of an action?
- Are there any new stressors or challenges that may hinder action-specific or overall success? If so, can anything be done to overcome them?

Information channels could be social media podcasts, printed or digital one-pagers, TV news reports and targeted outreach actions to schools and communities. The CARP and related digital and printed information materials are contributing to these efforts.

Part: B



PART C: Climate response per coastal element

While PART B of the CARP aimed at providing high-level guidance on general government aspects that need to be in place, PART C focuses deeper on the five coastal elements – the natural environment, people and communities, the built environment and infrastructure, economies and livelihoods and governance and legislation (Figure 16). It will illuminate how climate and coastal development trends, laid out in Sections 1 and 2, are impacting each element. Based on the resulting threats, management objectives will be set, and the envisaged climate response outcomes will be defined.

Great emphasis will be placed on the description of suitable (although not mandatory or comprehensive) interventions to reach these outcomes.

The provided actions have been sourced from a wide range of international literature and existing national reports and tools at various government levels, and the decision makers are encouraged to add further actions suitable in their respective context or adapt the suggestions made in the CARP.

To facilitate the decision makers who will have to implement these interventions, for each element a draft adaptation programme will be provided, which can be used as a template for realising the climate actions at the respective governance level. The programmes consider the anticipated outcomes, key risks or vulnerability addresses, key role-players, cobenefits, the envisaged timeframe of the action, its priority in the municipal context, estimated cost of the action and related performance measures. **Given** the cross-sectional nature of many interventions, some of them feature in more than one Element. To support decision-makers responsible for implementing the proposed interventions, each element is designed to be adaptable, allowing departments to omit sections that fall outside their specific mandates.

The draft programmes are designed and recommended to serve as the foundation for climate action planning at the respective levels of governance, as they identify key actors and sectors for mainstreaming and offer a starting point for effectively identifying funding opportunities to support implementation.

Figure 16: Information flow of PART C per coastal element



14 Natural coastal environment

The natural coastal environment is the basis for all activities and economies in the coastal zone. It provides living space, food, recreation space, natural economic resources (e.g. fish and energy), social opportunities and a sense of being and well-being for the people on the coast. It is undisputed that South Africa's coastal environment is a rich and diverse national asset – but what is the "natural coastal environment" or the "coastal zone" to be included in this Coastal Response Plan?

According to the Integrated Coastal Management Act (Act 24 of 2008), the coastal zone includes the Exclusive Economic Zone (EEZ) on the seaward side and extends 1 000 m inland from the highwater mark in rural areas and 100 m inland in urban areas. In the National Biodiversity Assessment 2018, the coastal zone was determined ecologically, by identifying terrestrial and marine ecosystem types with strong coastal affinities. In addition, all estuarine ecosystem types were considered coastal. According to the NBA 2018, the coast extends from the seaward edge of the surf zone to the inland boundary of the foredune, including estuaries (SANBI 2019). A more holistic definition could be "the coast is the interface between the Ocean, the Land and the Atmosphere". It becomes clear that the definition of "the coast" depends primarily on the person asking this question.

In our context, the description provided in the IPCC's Special Report on Oceans, Coasts and Cryosphere is the most meaningful in the context of the CARP: "The world's shelf seas and coastal waters encompass diverse ecosystems, including estuaries, sandy beaches, kelp forests, mangroves and coral reefs. Coastal seas include several frontal and upwelling areas that support high fisheries yields and productive coastal ecosystems, such as wetlands" (IPCC SROCC Bindoff et al. 2019, page 493).

Coastal ecosystems form important habitats supporting high biodiversity. Further, the "natural coastal environment" provides the natural assets and services that form the physical and resource baseline for the coastal built environment and coastal communities and economies.

Describing coastal ecosystems in the CARP, also through the lens of Blue and Teal Carbon, is important because this has not been done in other climate response plans focussing on natural infrastructure, such as the Climate Change Adaptation Plans for South African Biomes (DEA 2015) and the Draft Biome-Level Implementation Plans for the Biodiversity and Ecosystems Sector Climate Change Adaptation Strategy (Anchor & DFFE 2023). As this is the first time that climate impact on coastal ecosystems is described in a national programme, this section, together with Appendix 2 will provide a more comprehensive description of this coastal element than provided in the subsequent sections on the other coastal elements.

14.1 Climate threats to the natural coastal environment

Coastal ecosystems, in South Africa and world-wide, are already under pressure arising from human activities, both on the terrestrial and marine side. Pressures include:

- coastal development
- recreational use of estuaries and coastal beaches
- fishing (recreational, commercial and subsistence)
- agriculture on coastal plains and estuaries
- mining
- harbours
- aquaculture
- freshwater flow reduction
- pollution, including the discharges of wastewater
- illegal harvesting and trade
- indirectly: invasive and alien species.

which can lead to:

- loss and fragmentation of habitats
- loss of coastal connectivity (e.g. estuaries close)
- degradation of ecosystems
- loss of species diversity
- reduced ecosystem functioning and service provision (NBA 2018).

While most of the above pressures occur on a local scale, climate change is adding additional stressors on a much larger scale, related to:

- regionally increasing average, minimum, and maximum temperatures
- changing average rainfall (in South Africa both, increase and decrease)
- increase in extreme rainfall events

- increase in droughts
- potentially an increase in windstorms on the atmospheric side
- sea level rise
- shifts in ocean currents and upwelling systems
- change in ocean and estuary water temperatures (both warming and cooling being observed) and increased ocean stratification
- increased ocean acidity
- decreased ocean oxygen concentrations and changes in nutrient cycles and primary production
- increased wave action
- increased storm frequency and intensity.

However, coastal ecosystems display regional complexity and varying levels to compensate for environmental changes that can render the conclusive detection and attribution of climate effects uncertain (Bindoff et al. 2019). Projections of the ecological impacts of climate change in coastal ecosystems must, therefore, deal with many emerging complexities such as the differentiation between the long-term climate trends (e.g., SLR, progressive temperature increase and ocean acidification) and the short-term natural fluctuations, ranging from seasonal dynamics to interannual climate oscillations like El Niño.

Coral, seagrass and kelp ecosystems are highly sensitive to extreme climate events and have been extensively studied over the past decades; hence, the attribution of changes in biodiversity, structure and functioning is more robust for these ecosystems than for most other coastal ecosystems (Bindoff et al. 2019). It needs to be understood that estuaries and sandy beaches are naturally highly dynamic in terms of hydrological and geomorphological processes, giving them more adaptive capacity to climate impacts. In these systems, sediment relocation, soil accretion and landward expansion of vegetation may mitigate against flooding and habitat loss in the context of SLR and extreme climate-driven erosion, provided natural processes are allowed to prevail.

It is expected that by the end of the 21st century, all coastal ecosystems will face high to very high risk under RCP8.5, with coral reefs, seagrasses, kelp forests, and rocky shores anticipated to be at very high risk. These ecosystems have low to moderate adaptive capacity, as they are highly sensitive to ocean warming, marine heat waves and acidification. The transition to new ecosystem states driven by unpredictable pulses of disturbance and progressive climate hazards will have negative impacts on ecosystem services.

The ecosystems at moderate to high risk under future emission scenarios are estuaries (including mangroves and salt marshes) and sandy beaches. Mangrove and salt marshes can often initially cope with SLR by plant biomass accumulation, soil accretion and sediment relocation, but the evidence shows they are unlikely to withstand the SLR projected under RCP8.5. The risk of losing habitats for flora and fauna is expected to rise to high levels under the high emission scenario by the end of the 21st century. By contrast, the risk of impacts is expected to be only slightly higher than present for a low emission scenario than today (Bindoff et al. 2019).

To summarise, the main climate impacts to be expected on coastal ecosystems are as follows:

• Spatial shift in ecosystem boundaries and animal habitats:

With a warmer climate and warmer ocean temperatures, a spatial shift in ecosystem boundaries and animal habitat ranges is expected (e.g. SanParks 2011, Van Niekerk et al. 2022). This shift is not to be expected as a continuous shift of an entire ecosystem, as the mobility and resilience to changing climate conditions vary between species.

• Degradation of ecosystems and species composition:

While some species can tolerate a wide range of ecosystem conditions (e.g. temperature and salinity), species with a narrow ecological niche might be unable to thrive under changing climate conditions, leading to loss of species. This includes the impact of ocean acidification especially on calcareous invertebrate and the breeding success of some fish. The resulting spatial and functional gaps in the ecosystem may lead to the invasion of undesirable species causing accelerated ecosystem degradation.

Destruction and loss of natural coastal environments:

The natural coast, being an ecotone between the terrestrial and marine realm, is well adapted to the event-driven destructive impact of storm surges and erosive wave action. However, sea level rise and the predicted increase in storm frequency and intensity will locally lead to permanent destruction and loss of coastal and estuarine habitats, such as dunes and salt marshes, if no space is available for a landward migration of species and habitats. Ocean acidification can lead to increased erosion of coral reefs, which form the basis of highly diverse ecosystems.

14.2 Management objective for the natural coastal environment

In the light of the described climate impacts and the threat that they impose on coastal ecosystems, the services they provide and the significant consequences these will have on coastal communities, livelihoods and economies, the following management objective for the natural coastal environment was co-developed with coastal stakeholders during the 2023 and 2024 consultations for this project.

> Safeguard, restore and sustainably manage our rich natural coastal capital to strengthen climate resilience and ensure the continued provision of ecosystem goods and services for the benefit of all.

14.3 Climate response outcomes

To achieve the management objective, pro-active land use and spatial planning, environmental protection, restoration, maintaining living resource populations, alien invasives control, water quality management, and estuarine freshwater and estuary mouth control interventions will be needed. Therefore, the following Outcomes relating to these categories have been set:

Outcome 1: Spatial development and land use management acknowledge the significant role

that coastal green infrastructure plays in successful climate adaptation and mitigation.

Outcome 2: Coastal ecosystems are effectively managed, restored, and rehabilitated to function optimally as healthy ecosystems, carbon sinks, a foundation for ecosystem-based adaptation, and a vital resource for coastal livelihoods and industries.

Outcome 3: Living resource populations are conserved and sustainably managed to support ecosystem functioning and serve as a foundation for coastal livelihoods and industries.

Outcome 4: Alien and invasive species are controlled to maintain and restore coastal ecosystem functioning and the services and functions they provide, including buffering against climate events.

Outcome 5: Coastal water quality is effectively managed to maintain healthy and productive ecosystems that provide key ecosystem services such as nurseries, coastal protection, climate regulation and nutrient cycling.

Outcome 6: Climate change is prioritized in the management of estuaries and associated water resources to support ecosystem functioning and sustain the benefits and services they provide for coastal communities and climate resilience.

For more Response Options for the natural environment, refer to the Climate Adaptation Plans for South African Biomes (DEA 2015) and the Biodiversity and Ecosystems Sector Climate Change Vulnerability Assessment and Adaptation Strategy (Turpie et al. 2021).

14.4 Required interventions

To achieve the proposed outcomes, the following response interventions are required:

Key response interventions for Outcome 1: Spatial development and land use management acknowledge the significant role that coastal green infrastructure plays in successful climate adaptation and mitigation.

• Actively prevent 'coastal squeeze' through the development of conservative setback lines (as

per NEMA) and coastal management lines (as per ICMA), to protect coastal ecosystems from land-use change and development to ensure their ecosystem functioning and service delivery. Promote land-use planning practices that allow upslope and upstream migration of critical estuarine and coastal habitats with sea-level rise.

- Develop overarching policies/strategies and reporting mechanisms that will ensure the persistence of blue and teal carbon ecosystems and avoid future losses and maintain their climate mitigation function as important CO₂ sinks, focussing on land use practices as well as other anthropogenic activities that cause degradation.
- Highlight the importance of carbon ecosystems in the development of Coastal and Estuary Management Plans under National Estuarine Management Protocol (2021) and formally include them in future updates of the respective DFFE Guidelines.
- Elevate all land use change and soil disturbance within the Estuary Functional Zone in the NEMA EIA Regulations (2014) to Listing Notice 1, i.e., Regulations currently list the clearing/infilling of estuarine habitat within EFZ in Listing Notice 3.
- Actively incorporate coastal habitat protection into the approval processes and planning of infrastructure (e.g., transportation planning, sewer utilities). Include protection requirements in the municipal Integrated Development Plans and the location of important coastal green infrastructure in municipal Spatial Development Frameworks.
- Develop strategies to manage the impact of boating (e.g. zonation and limiting engine size) on nearshore ecosystems and channel stability to prevent coastal and estuarine habitat erosion (and oil pollution). Strategies should also be considered for the development and construction of instream infrastructure, such as jetties and slipways that impact ecosystem function, coastal protection and associated blue and teal carbon ecosystems.
- Avoid all mining-related activities (sand mining, diamond mining, mineral mining, salt works) on sandy shores and within a one km buffer of the Estuary Functional Zone given the irreversible, long-term impacts on blue and teal carbon systems. In addition to disturbance to soils and

the water table, mining also poses a significant risk of smothering habitats by dust. Further, sand abstraction impacts coastal sediment flows and reduces the beaches and dunes buffer function against coastal storm-related flooding and erosion. Conduct a "Mining SEA" for South Africa's estuaries to determine the impact on estuarine processes (including sediment budgets).

Many of the interventions proposed above will need to be actioned co-operatively by various line functions, not just a jurisdiction's environmental body. This highlights the importance of integrated, cross-departmental approaches for successful climate response. It further highlights the role of effective governance structures and enabling policy frameworks for protecting the natural coastal element on which many coastal (economic) activities rely. Further, many of the proposed actions need to be executed not "on the ground" since they relate to adaption of climaterelated environmental aspects into other policies and legislation, thus making very direct demands where mainstreaming (see Section 9.2) needs to take place.

Key response interventions for Outcome 2: Coastal ecosystems are effectively managed, restored, and rehabilitated to function optimally as healthy ecosystems, carbon sinks, a foundation for ecosystem-based adaptation, and a vital resource for coastal livelihoods and industries.

The interventions suggested here include highlevel strategic environmental assessment and management programmes as well as location-based, hands-on interventions on the ground:

• Increase the monitoring and protection of critical blue carbon (mangroves, salt marsh, seagrass and kelp forest) and teal carbon (e.g. swamp forest, reeds and sedges) habitats, including those in the Estuary Functional Zone of estuarine lake systems, to meet Global Biodiversity Framework Target 3 through a combination of enhanced formal protection (e.g. parks) and initiating less formal approaches such as implementing of stewardship/Other Effective Conservation Measures (OECMs) at lower priority/smaller sites (in agreement with the United Nations Framework Convention on Climate Change (UNFCCC) [Reduced Emissions from Deforestation and Degradation (REDD+) and Paris Agreement).

- Identify and prioritise critical ecological infrastructure/assets in need of protection and restoration using systematic planning approaches to ensure climate resilience and ecological service delivery under a changing climate, including areas such as nursery grounds, feeding grounds, and areas of high species diversity and abundance to ensure that supporting biotic processes and feedback loops in coastal ecosystems are retained. This includes the development of a national/provincial action plan on how to implement this.
- Identify and prioritise areas for Ecosystembased Adaptation options: Identify and monitor critical ecological infrastructure/assets in need of protection and restoration using systematic planning approaches to ensure their function for water provision and purification and as protection against coastal storm impact and flooding.
- Regularly re-evaluate and adapt boundaries of protection areas/zones to make sure that critical processes are included as the spatial distribution of these areas change under future climate conditions.
- Reduce ecological fragmentation and connect lands and seascapes with corridors to conserve key biophysical processes and enable landsea connectivity. Consider implementation of incentives that encourage and support mitigation actions. Also consider third-party or donor funding for creating of incentives.
- Develop a national monitoring and restoration programme for estuaries and coastal ecosystems with clear restoration targets (requirement of Global Biodiversity Framework 2030– Target
 2) that are integrated into provincial and local coastal management programmes; blue and teal carbon habitats and water quality should be a key focus of such a restoration programme.
- Maintain sediment transport processes as they are critical to the management of sea level rise impacts. Assess regional-scale sediment process and develop a regional sediment management (RSM) plan. Such a plan should include the management of impacts by dam development, mining, dune stabilisation and harbour development.

- Identify and leverage ecological infrastructure investment programmes to fund protection and restoration of ecological infrastructure.
- Also consider public/private partnerships or stewardships to achieve protection and restoration goals.
- Consider and promote active retreat from lowlying areas that are regularly inundated (e.g. <2.5 m MSL) to allow natural processes to re-establish critical habitats under future climate conditions. Discourage all developments and future land-use change below the five m MSL contour in estuaries. Return disturbed land to natural process to allow for wetland accretion (accommodation space).

Key response interventions for Outcome 3: Living resource populations are conserved and sustainably managed to support ecosystem functioning and serve as a foundation for coastal livelihoods and industries.

Protection and sustainable use of coastal and marine living resources ensure self-maintaining populations which are more resilient to future climate conditions. Actions to support living resource populations include:

- Increase formal monitoring and protection of living resources, e.g., through the establishment of Marine Protected Areas, closed area zonation, IUCN Red Listing of Threatened Species
- Institute/enforce catch/gear control measures to ensure sustainable fishing levels, e.g. catch limits, size/slot limits, closed periods (spawning seasons, night ban on fishing in estuaries)
- Invest in effective regulatory and compliance measures, such as quotas, no-take zones, legitimate stock assessments, and remote tracking systems, and human resources respectively
- **Invest in strategic restoration programmes** to restore severely depleted stock and/or estuary nursery function (where applicable)
- Create public awareness of the risk overexploitation and habitat destruction poses to coastal ecosystems functionality and societal

benefits, including the value of natural resources for livelihoods and climate adaptation.

- Key response interventions for Outcome 4: Alien and invasive species are controlled to maintain and restore coastal ecosystem functioning and the services and functions they provide, including buffering against climate events.
- Biological invasions pose a risk to indigenous ecosystem functionality and populations and in many cases respond faster and more effectively to climate change stressors. Climate-relevant actions to combat alien invasions include:
- Develop protocols/procedures for early detection, risk assessment, monitoring, and management of invasive alien species (e.g. in vessels' ballast water)
- Develop long-term catchment clearing programmes (e.g. in collaboration with Working for Water/Wetlands in South Africa), including the development of control programmes using a range of methods (biocontrol agents, manual, mechanical or herbicide control). NOTE: Chemical control most often NOT the solution, especially for waterbodies and wetlands, where they lead to unintended consequences associated with organic load, developing anoxia and fish kills, persistent organic pollutants (POPs) accumulation.
- Aquarium trade and aquaculture introduction pathways need to be controlled through permitting system(s) and detailed EIA studies as they pose a significant risk for biological invasions that will further increase the pressure on existing biodiversity
- Create public awareness among civil society and researchers of the risk invasive species pose to the coastal and estuarine ecosystems and the need to clean gear and boats
- Invest in alien invasive research programmes that 1) identify and evaluate the full suite of invasive species occurring in coastal waters

 marine, estuarine, and freshwater, and 2)
 develop an understanding of the spread of alien invasive plants along the coast and estuaries.

Key response interventions for Outcome 5: Coastal water quality is effectively managed to maintain healthy and productive ecosystems that provide key ecosystem services such as nurseries, coastal protection, climate regulation and nutrient cycling.

Pollution increases aquatic ecosystems vulnerability to increasing water temperatures and reduces estuarine and coastal productivity. Water quality management, specifically targeting wastewater and storm water, is therefore relevant to increase coastal ecosystems' resilience to climate change. This is another example where intergovernmental collaboration is needed for effective climate protection of natural coastal resources, with the benefit of protecting coastal urban spaces from flooding and preserving essential freshwater sources. The proposed interventions include:

- Control/reduction of the impact of wastewater discharges on estuaries and the coast by reducing and/or improving the water quality of effluent from existing wastewater treatment works, with the intent of recycling or reusing effluent in the long term, especially in regions where climate change will reduce water availability for human use in the future (in line with current national policies).
- Prohibit the development of new wastewater treatment works that would discharge into estuarine lakes/estuaries (in line with current national policies). Specifically estuarine lakes are nutrient sinks; it is thus critical that all wastewater discharges be removed from these systems.
- **Prevent development of wastewater treatment works in** areas which are at risk of flooding, coastal erosion and other climate and weatherrelated threats and relocate treatment works already existing in vulnerable areas.
- Control/reduce the impact of agricultural runoff on estuaries and coastal ecosystems through the development of agriculture best practice guidelines and generate awareness of the impact of over-fertilisation on wetlands and estuaries.
 Develop industry standards that will support this.
- No direct agriculture drainage of coastal and estuarine floodplains should be allowed. This practice both increases nutrient input and dries out remaining blue and teal carbon ecosystems and soils.

- Develop stormwater model legislation/ ordinance/by-laws that require the use of green infrastructure. These can help local municipalities/ metros incorporate climate change projections or green infrastructure incentives into local practices.
- Include the adoption of more stringent stormwater policies and requirements for developers to manage water onsite to the maximum extent feasible. Stormwater should be captured and treated onsite where possible using soft engineering approaches (e.g. in new residential developments). The use of Sustainable Urban Drainage Systems (SUDS), bio-retention, stormwater tree trenches, blue roofs and underground storage systems should be encouraged to reduce the amount of (polluted) urban stormwater into natural coastal waterbodies.
- Develop adaptive stormwater management practices that attenuate stormwater peak inflows (e.g. remove the impervious surface, replace undersized culverts, promote natural buffers, and detention wetlands to reduce flood risk and provide water quality and ecological benefits).
- Provide training for municipal staff on the benefits, creation and protection of green infrastructure and offer incentives for developers/engineers to use green infrastructure designs, rather than relying on pipe-based systems.
- **Permitting systems** should constrain locations for landfills, hazardous waste dumps, mine tailings, and toxic chemical facilities in or near estuaries.

Estuaries and nearshore coastal ecosystem types and functioning depend on specific freshwater inflow regimes. Projected changes in rainfall regimes, specifically extreme events increase the pressure coastal ecosystems are already experiencing from water abstractions in the catchments and impaired water quality. The following interventions are aiming to support and ensure their future resilience to shifts in rainfall/runoff cycles and extreme droughts:

• Determine the freshwater flow allocations ('Reserves') that ensure the maintenance of critical estuarine and coastal processes (e.g. landsea connectivity, nearshore fan, and plumes) and habitats (e.g. blue and teal carbon habitats) through medium to high confidence environmental flow assessments (not only desktop assessments).

- Explicitly incorporate the requirements of blue and teal carbon habitats in the Resource Quality Objectives (RQOs) developed as part of the DWS Water Resource Classification process to ensure contribution to climate mitigation strategies. Investigate opportunities to retrospectively adjust flow RQOs to protect critical blue and teal carbon habitats.
- Effectively manage water demand (through water reuse, recycling, rainwater harvesting, desalination, etc.) to take pressure off natural freshwater resources.
- The clearing of invasive alien plants in the catchments of estuaries should be encouraged to restore critical baseflows to estuarine and nearshore ecosystems.
- Invest in effective compliance monitoring and regular auditing of water resource use.
 Strengthen compliance efforts (e.g. compulsory licensing) to reduce the impact of illegal freshwater abstraction in or above estuaries.
- Invest in long-term monitoring programmes that can inform streamflow management strategies and country-level indicators.
- Protect/restore natural groundwater flows to estuarine and coastal (e.g. stromatolites) ecosystems.

Key response interventions for Outcome 6: Climate change is prioritized in the management of estuaries and associated water resources to support ecosystem functioning and sustain the benefits and services they provide for coastal communities and climate resilience.

Estuarine areas are frequently subject to land use conflict, given their ecological importance, scenic landscape, making them preferred locations for holiday and permanent residences, and agriculture. The naturally highly dynamic water levels pose a flood risk to residential property and agricultural crops and fields. For manoeuvring this conflict, the following measures are suggested:

- Nationally, develop a plan for a "managed retreat" under rising sea levels, focusing on all land use in estuaries below the 2.5 m MSL level as a priority.
- Ensure that a conservative flood line assessment is in place that highlights the impact of 1:100-year flood events under future climate conditions (e.g. sea-level rise, increased wave energy and increased flooding) and incorporate in the municipal Integrated Development Plan and local estuary management plans. Prohibit the development of new infrastructure within the estuary functional zone that would require artificial breaching, mouth stabilisation, or inlet diversion in the future.
- Develop a land acquisition programme purchase coastal land that is damaged or prone to regular flooding and use it for the protection of estuarine habitats (e.g. blue and teal carbon) and processes. Opportunities may exist under the Global Biodiversity Framework 2030 umbrella.
- Develop a National Artificial Breaching Protocol for estuaries (informed by approaches already developed for the Western Cape and KwaZulu-Natal provinces).
- Develop a comprehensive Estuary Management Plan (under the ICM Act) for all estuaries subjected to artificial breaching; this should include a detailed 'Mouth Management Plan' that stipulates the motivation for breaching and a pre-approved 'Maintenance Management Plan' (under the Environmental Impact Assessment (EIA) regulations) that details the criteria for and approaches to a breaching.
- Engage with National and Provincial Disaster Risk agencies to highlight the risk poor breaching practices pose to estuarine/carbon ecosystems and develop a strategy to mitigate the impact of premature breaching.

15 People and communities on the coast

Since the beginning of humankind, coasts have been focal areas for human settlement, given the wealth of natural resources they provide, economic opportunities and the beauty and recreational opportunities of the coastal zone. Nowadays, approximately 40% of the South African population lives within 60 km of the coast (DEA 2014b), and coastal settlements are projected to see their populations grow into the future (Section 2). In particular, the Eastern Cape and KwaZulu-Natal coastal zones are experiencing increasing densification in nodes, which is expected to continue (DALRRD 2023).

In South Africa, of the total population of 60 million in 2021 (StatsSA), about 22% (ca 12.9 million) were living within 20 km of the oceans' coasts. Thereof about 2.33 million resided on the Eastern Cape's coast, 5.17 million on KwaZulu-Natal's coast, 5.4 million on the Western Cape's coast and about 9 500 in the vicinity of the Northern Cape's coast (CSIR 2025 unpublished).

In 2019, a study estimated that 3.7 million people lived within 30 m above mean sea level or within 1 km of South Africa's coast, while over 2 500 people live in coastal areas at either high or very high flood risk (CSIR 2019c). Weather and climate-related disasters such as storms, floods, droughts, and wildfires occur at higher frequencies in the Eastern Cape and KwaZulu Natal, together with coastal flooding and erosion (see Section 1). Projections indicate that coastal settlements in the Western Cape and Eastern Cape will be increasingly exposed to drought and wildfire, while coastal settlements in KwaZulu-Natal and the northern parts of the Eastern Cape are projected to see increases in exposure to flooding (see Section 1). Projected increases in average annual temperatures are lower along the coast than for inland settlements, which could drive further migration and population growth in coastal areas due to the more favourable climate conditions (DALRRD 2023).

Exposure of coastal communities to the impacts of climate change is driven by numerous contextual factors, particularly their location, which could make them susceptible to certain climate hazards or disasters such as storm-related flooding, SLR and coastal erosion. Different communities will also experience the impact of climate change to varying degrees, depending on socio-economic factors such as income levels, availability of adequate shelter, effectiveness of disaster management, among many other aspects (Davis-Reddy & Vincent 2017). Poor and marginalised communities are more likely to experience severe setbacks from the impacts of climate change, and even more so when they are living in informal settlements. Therefore, prioritising consideration of social vulnerability and equity in climate adaptation planning underpins efforts to promote fair and just climate resilience and sustainable development.

15.1 Climate threats to the coastal population

Coastal communities could experience numerous negative impacts associated with climate change and climate-related disasters including the following:

Injuries and loss of life

Climate and weather-related disasters can cause direct and indirect injuries and loss of life (Davis-Reddy & Vincent 2017). During storm events strong winds can cause buildings, trees, and powerlines to fall and flying debris, causing injuries and increasing the risk of fatalities. Extreme rainfall events can cause watercourses to rise quickly, flooding nearby areas; this is particularly where there is poor drainage due to vegetative overgrowth and land pollution, due to inadequate drainage maintenance (Dube et al. 2022). Such flooding, as well as coastal storm surges can increase the risk of drowning. Risks of injuries and loss of life are also exacerbated by the fact that coastal and inland flooding can damage roads, infrastructure, and communication networks (Davis-Reddy & Vincent 2017), delaying and disrupting emergency response efforts to provide critical life-saving services to affected communities. Flood waters can also contaminate drinking water sources, which can lead to diseases

such as malaria, diarrhoea, and cholera (Davis-Reddy & Vincent 2017). Loss of life and injuries, such as severe burns, can also be caused by wildfires, which similarly to floods and storm surges, can disrupt emergency evacuation routes and response efforts to provide medical care. Extreme heat events have been shown to negatively impact especially the physically challenged, the elderly and people living with disabilities, potentially leading to death

Physical and psychological human health impacts

as well.

The gradual and acute impacts of climate change can affect the physical and psychological health of people (World Economic Forum 2024). Climaterelated disaster events could have short-term and long-term effects on physical health. Some of the health impacts include respiratory, cardiovascular, infectious and heat-related diseases, as well as malnutrition (World Economic Forum 2024). Floods and extreme rainfall events could lead to the outbreak of waterborne diseases due to increases in microbial agents' density and stagnant water that creates favourable conditions for vectorborne diseases (World Economic Forum 2024). Prolonged periods of drought could drive food insecurity and malnutrition, with droughts also impacting water availability and quality, leaving communities vulnerable to the possible spread of diseases such as cholera, typhoid, and dysentery (World Economic Forum 2024). Prolonged exposure to extreme heat could cause a range of ailments from dizziness and heat exhaustion to heat stroke (World Economic Forum 2024). Heat wave events affect occupational health, particularly in exposed sectors such as agriculture and construction (David-Reddy & Vincent 2017, World Economic Forum 2024).

In addition to the physical health effects of climaterelated disasters, first-hand experience of floods, storm surges, or wildfires and prolonged exposure to climate change events such as droughts could lead to mental health conditions such as post-traumatic stress disorder, depression, and anxiety (Ma et al. 2022). Mental health can also be affected by the

flow-on effects of climate change and disasters, which include impacts on physical health, physical losses, economic insecurity, disruption of family life, displacement, uncertainty, and food shortages (Ma et al. 2022).

Displacement, loss of property and livelihoods

Climate change and related extreme events and disasters can force people to leave their homes temporarily or permanently and can cause extensive damage to personal and public property. Of all climate change impacts (i.e. wildfires, storms, flooding, extreme temperatures, and droughts), storms and flooding were the greatest cause of displacement in Southern Africa between 1980 and 2016 (Davis-Reddy & Vincent 2017). The destruction of property and displacement directly impacts a household and community's ability to earn a living.

Farmers can lose their crops, livestock, and arable land, while fisheries are affected by rising sea temperatures, storm-related water pollution, ocean acidification, disruption of marine ecosystems, and reduced fish stocks (Davis-Reddy & Vincent 2017; Willima & Naidoo 2024). Local tourism and small businesses are impacted by damage to infrastructure and the natural environment, and disruption to supply chains (Davis-Reddy & Vincent 2017). Such impacts lead to a decline in tourist arrivals and income, and a decreased customer base. Local livelihoods are affected through loss of income and disruption of access to resources and services, including ecosystem services which can increase risk of food insecurity.

As populations are projected to become more concentrated in our coastal settlements, and communities' exposure to extreme events, disasters, and climate impacts increase; it is important to acknowledge human dependence on nature and to implement appropriate adaptation measures to support the capacity of both human and natural systems, also necessitating enhanced disaster preparedness and response strategies, including early warning systems.

15.2 Management objective for coastal population and communities

The management objective for coastal population and communities:

Build a climate-resilient and empowered coastal community, living sustainably in harmony with nature, by protecting communities and economic activities from the impacts of hazards and disasters.

15.3 Climate response outcomes

The following three Outcomes are envisaged to guide climate interventions for climate resilient coastal communities.

Outcome 1: Increase the resilience of vulnerable coastal communities to the impacts of climate change, through enhancing their adaptive capacity.

Outcome 2: Increase awareness of coastal communities around the potential impacts of climate change (e.g. flooding) and effective adaptation measures that can be implemented.

Outcome 3: Implement effective measures for disaster risk reduction and response within coastal communities.

15.4 Required interventions

To achieve these outcomes, the following response interventions are needed:

Key responses for Outcome 1: Increase the resilience of vulnerable coastal communities to the impacts of climate change, through enhancing their adaptive capacity.

Response interventions include the following (NCCARF 2016, Davis-Reddy & Vincent 2017, Department of Environment, Forestry and Fisheries 2019, Department of Environmental Affairs et al. n.d., CSIR, 2019d):

- Identify coastal communities that are 1) exposed to climate threats and 2) vulnerable to the impacts of climate change and develop targeted adaptation programmes that prioritise the most vulnerable, including low-income groups, women, the elderly, children, the sick and people with disabilities. Ensure that such adaptation programmes are informed by traditional and local knowledge and address the underlying causes of social vulnerability such as low employment levels, a lack of shelter, a lack of disaster management, among other factors.
- Participatory approaches will increase acceptance of co-developed adaptation programmes. Engage with community networks in developing adaptation programmes (as described above), identifying climate change 'community champions' that can assist with the development and implementation of such programmes.
- Consider incorporating Indigenous and Local Knowledge (ILK) as a potential source for intervention, i.e. information on areas which were exposed to flooding in the past. Local communities, especially when having inhabited the coast in question for generations, will have developed coping strategies to climateextreme events. ILK could offer valuable insights and tailored solutions that may enhance the acceptance and effectiveness of the proposed measures.
- Ensure the equitable and inclusive provision of basic services (e.g. water supply and waste collection) and infrastructure to coastal communities. Provide access to such services in informal settlements, enabling them to become part of integrated urban developments.
- Monitor critical services and facilities (e.g. health care facilities, communication, fire and security services) to ensure that they are properly resourced and have the capacity to manage climate change-related health effects. Establish whether these facilities are in areas exposed to climate hazards, i.e. fires, flooding and erosion and are accessible during extreme events. If not, prioritise relocation.
- Increase awareness of the potential health impacts of climate change among communities,

developing action plans to adapt to – and mitigate – impacts such as heat stress and potential increases in diseases.

- **Promote storage (or generation) of potable water at households** to prevent waterborne diseases should water infrastructure fail during extreme events, or droughts.
- Maintain and enhance ecosystems and ecological infrastructure (e.g. dunes) that protect coastal communities from the impacts of climate change, as well as ecosystem services (e.g. fertile land, fisheries, and water sources) that support community livelihoods.
- Promote urban agriculture/local food production to increase food security, reducing reliance on food supply chains that may be vulnerable to the impacts of climate change.
- Adopt sustainable land use practices (e.g. in local farming) to increase resilience to climate change (e.g. water reuse etc).
- Invest in research and modelling of the impacts of climate change on coastal communities and the most effective adaptation measures within a variety of socio-economic contexts.

Key responses for Outcome 2: Increase awareness of coastal communities around the potential impacts of climate change (e.g. flooding) and effective adaptation measures that can be implemented.

Response interventions include the following (DEFF 2019, CSIR 2019d, World Meteorological Organisation 2022):

- Empower communities through awarenessraising to adapt – and respond – to climate change and extreme events, ensuring that this is informed by traditional and local knowledge.
 Participatory approaches are crucial to empower local communities as active agents in climate adaptation efforts.
- Ensure access to accurate, real-time, locally relevant climate data and information (climate services), particularly by vulnerable and marginalised communities.
- Develop a comprehensive public awareness campaign, adapted to the needs of coastal

communities, partnering with local organisations and community groups where possible. Ensure that vulnerable and marginalised groups are specifically provided for.

- **Build local capacity** to design, implement, and monitor adaptation and mitigation measures, involving the community as far as possible.
- Use online and social media tools to disseminate information around climate change and its impacts among coastal communities.
- Support knowledge and capacity building for rural livelihoods, particularly for women from vulnerable households (e.g. water saving practices)
- Provide education and training around the use of resources, particularly for vulnerable groups, providing them with the knowledge of how to gain support from government and other social organisations.
- Develop and implement training programmes within municipalities on climate change and its impacts on coastal communities, as well as potential mitigation and adaptation measures.
- Develop and implement training and awareness programmes among businesses (including formal and informal) within the coastal zone on the potential impacts of climate change and how to adapt to and/or mitigate these.
- Ensure the inclusion of climate change information into the formal education system.

Key responses for Outcome 3: Implement effective structural and financial measures for disaster risk reduction and response within coastal communities.

Response interventions include (NCCARF 2016, CSIR 2019d):

• Develop (or adapt) multi-use community centres that can act as heat refuge or warming centre and as a point of safety and mass care centre during extreme events, as well as a communication point (e.g. disaster warnings) and place for capacitybuilding and training around climate change impacts. Ensure coordinated communication between such centres and disaster risk departments.

- Consider multi-use conditions for other public facilities, which allow for their multi-purpose use (as described above) in support of disaster risk reduction and response.
- **Providing climate resilience grants or incentives** for community-led adaptation initiatives could also drive bottom-up engagement.
- Identify communities that are particularly vulnerable and located in high-risk areas. If no other adaptation actions are viable, such communities may need to be relocated. The identification of suitable land for relocation requires intense consultation with the community and relevant stakeholders, with a clear long-term vision and understanding. Work through existing community networks to identify and involve climate change adaptation champions within community groups throughout the process. Participatory planning approaches should be prioritised, where local communities are involved, not just as beneficiaries but as co-developers of adaptation actions. An adaptation pathway approach might be useful in this regard.
- Identify, with the participation of coastal communities, the disaster response infrastructure and services that are critical during or immediately after a disaster to protect human life and property and reduce impacts on

health and safety. Such infrastructure and services include communication services, escape routes, social facilities, and emergency services (e.g. hospitals and fire stations).

- Ensure uninterrupted access to critical services related to health and security which are required to mitigate the impacts of disasters on communities, including health care, fire and police services.
- Assist communities in preparing for and responding to – climate-related disasters; develop and implement effective early warning systems (EWS). This will increase the ability of communities to respond timeously (e.g. taking preventative measures or evacuating). Participatory planning approaches should be prioritised, where local communities are involved, not just as beneficiaries but as co-developers of adaptation actions. Ensure that the systems of communication adopted respond to the level of access to technology among the various affected communities.
- Strengthen community networks and organisations (e.g. community policing forums) that can support effective communication and evacuation during extreme events and ensure that safe evaluation spaces are identified and prepared.

16 Coastal built environment and infrastructure

The coastal built environment refers to humanmade structures and developments located along coastlines. This environment encompasses a wide range of infrastructure, residential, commercial, and recreational facilities designed to support human activities in coastal areas (Nissanka et al. 2023).

The coastal built environment should be adapted to the impacts of climate change in a way that balances the need and desirability for development with the protection and preservation of the natural coastal ecosystem. This balance will ultimately be more costeffective and is crucial for sustainable development and minimising the impact of human activities on the coastal and marine environment.

16.1 Climate threats to the coastal built environment

Sea levels are expected to rise by about 0.35-1.0 metres by 2100. Apart from the level of the sea rising, increased storm frequency and intensity will lead to

permanent or episodic flooding of low-lying coastal areas (CSIR 2019c). The Western Cape and KwaZulu-Natal coasts are already frequently battered by severe storms that inflict significant damage on coastal infrastructure and the built environment.

While damages by coastal storms and wildfires normally affect only small fractions of the coast, other climate events affect large areas, such as droughts, heatwaves and SLR. The total amount of built infrastructure located on South Africa's coast and subjected to climate events is immense. Using the number of buildings as of 2022 as indicator for built and service infrastructure, Table 4 shows the distribution of buildings across five specific coastal flood risk areas developed for the National Coastal Climate Change Vulnerability Assessment (DEFF 2020). Table 4 indicates that the highest number of buildings at risk of coastal flooding can be found in the Western Cape, while the largely steep coastal topography in the Eastern Cape and KwaZulu-Natal currently prevents development in areas prone to coastal flooding (Table 4).

Storm scenario	Occurrence	Number of buildings exposed				
		NC	WC	EC	KZN	total
0.3m SLR, 1:10 yrs	very high	23	4 443	118	367	4 951
0.3m SLR, 1:30 yrs	high	22	1 926	89	305	2 342
1m SLR, 1:30 yrs	moderate	27	6 459	192	442	7 120
1m SLR, 1:50 yrs	low	62	7 196	93	113	7 464
1m SLR, 1:100 yrs	very low	84	24 334	214	226	24 858
Total		218	44 358	706	1 453	46 735

Table 4: Number of buildings exposed to coastal flood risk in 2022 per province

Apart from flooding caused by high sea surges and large waves, the already noticeable increase in more extreme rainfall events is increasing the volumes of storm water runoff in river catchments and subsequently increasing the flood risk in settlements (CSIR 2019a). The figure below provides an indication of the future flood risk severity for settlements in South Africa by 2050. Figure 17 indicates the percentage of South African settlements which will be affected by an increase of coastal flooding and rainfall related flooding by 2050. According to this assessment, by 2050 more than half of all South African settlements will be at medium to extreme risk of flood impacts.



Figure 17: The percentage of South African settlements at risk of an increase in surface water flooding by 2050

Source: CSIR 2019e

Surface water flooding, droughts, severe wind, and coastal flooding and erosion as well as the increasing number of wildfires can cause extensive damage and losses to the built environment, affecting infrastructure, residential areas, commercial properties, and natural resources. The impacts are often severe and can have long-term consequences for the built environment and infrastructure and potential economic activities associated with this infrastructure. It can also result in the displacement of coastal communities.

Some of the potential loss and damage to the built environment and coastal infrastructure due to extreme climate events can include:

- Structural compromise and damage to buildings and homes. Informal and lightweight structures and older buildings are particularly vulnerable.
- Infrastructure damage to bridges, airports, ports, and railway lines that can lead to transportation

operational disruptions. Damage or destruction of utilities such as wastewater pipes and treatment plants and power lines and stations. Communication infrastructure can be damaged, disrupting phone and internet services which is particularly detrimental during or just after a disaster event.

- Economic losses due to repairs, replacement and reconstruction of the built environment, devaluation of properties and/or increased insurance premiums, loss of livelihoods, and business interruptions.
- Health and safety threats due to injuries and fatalities, toxic smoke, water contamination and increased risk of waterborne diseases.
- **Social impact** due to evacuations or displacement of communities from built-up areas and the associated stress and trauma.
- Long-term impacts of repeated events that increase vulnerability, weaken structures and reduce coping capacity of the economy, and infrastructure, making the built environment more susceptible to future events (Van Niekerk & Le Roux 2017, DEA 2018, IPCC 2022).

16.2 Management objective for the built coastal environment and infrastructure

The management objective for South Africa's coastal built environment and infrastructure is therefore:

By 2050 coastal built infrastructure is climate- resilient as foundation for climate-safe livelihoods and economies.

16.3 Climate response outcomes

To achieve this vision the following climate response goals are suggested:

Outcome 1: The coastal built infrastructure can withstand climate hazards such as floods, windstorms, and erosion.

Outcome 2: Mitigation of the impact of extreme temperatures on buildings and infrastructure has been implemented.

16.4 Required response interventions

"The most effective adaptation and disaster risk reduction interventions are those that offer development benefits in the relative near term, as well as reductions in vulnerability over the longer term" (IPCC 2022 p. 439). Adapting the coastal built environment to the impacts of climate change is crucial to protect coastal infrastructure and properties at risk. It also ensures the safety, health, and prosperity of communities in the face of a rapidly changing climate. Otherwise, these severe events will cause considerable damage to coastal areas, placing a huge financial burden on communities, industries, and the government.

Key response interventions for Outcome 1: Buildings and Infrastructure to withstand climate hazards such as floods, windstorms, and erosion:

- Buildings and infrastructure risk assessment: Conduct spatially explicit assessment of infrastructure in coastal hazard zones (i.e. flooding from rainfall and sea storms, erosion, wind).
- Hard engineering solutions: Conduct sediment studies to inform construction of seawalls, levees, and storm surge barriers to protect the buildings and infrastructure against rising sea levels and storm impacts. Designing and building resilient infrastructure ensures long-term sustainability and reduces the need for costly repairs and replacements. Hard interventions must only be considered in exceptional circumstances where it is in the interest of the whole community as defined in ICMA.
- **Soft engineering solutions**: Ecosystem based adaptation (EbA) options such as restoring natural barriers like dunes, wetlands, and mangroves

to enhance natural resilience against storm surges and support biodiversity. Planting trees or constructing windbreaks to reduce wind speed and protect structures.

- Infrastructure retrofit: Retrofitting existing infrastructure to withstand floods and windstorms, such as raising roads, improving drainage systems, and reinforcing buildings. Ensuring critical infrastructure, such as transportation, utilities, and communication networks, can withstand climate impacts is vital for maintaining essential services.
- Land use management: Implementing land-use policies and climate-wise Spatial Development Plans that restrict development in high-risk flooding and erosion areas and promote resilient building practices. In the coastal zone specifically implement and enforce Coastal Management Lines. Where necessary and appropriate, relocate vulnerable infrastructure, including schools, hospitals and power stations from locations at risk.
- Building codes and standards: Incorporation of green building designs in the National Building Regulations. Providing building guidelines for new developments in potentially hazardous areas. Enforcing building codes that require wind- and flood-resistant construction techniques and materials.
- Explore innovative ways to develop climateresilient settlements: In the light of rising sea levels which will enforce the "coastal squeeze" effect by reducing safe urban development areas, concepts of "floating buildings" or even "floating cities" are emerging which can expand into flooded areas and accommodate rising sea levels.
- Develop adaptive stormwater management practices that attenuate stormwater peak inflows (e.g. remove the impervious surface, replace undersized culverts, promote natural buffers, and detention wetlands to reduce flood risk and provide water quality and ecological benefits).
- Include the adoption of more stringent stormwater policies and requirements for developers to manage water onsite to the maximum extent feasible. Stormwater should be captured and treated onsite where possible using soft engineering approaches (e.g. in

new residential developments). The use of Sustainable Urban Drainage Systems (SUDS), bio-retention, stormwater tree trenches, blue roofs and underground storage systems should be encouraged to reduce the amount of (polluted) urban stormwater into natural coastal waterbodies.

• **Provide training for municipal staff** on green infrastructure and offer incentives for developers/ engineers to use green infrastructure designs, rather than relying on pipe-based systems.

These measures can help reduce the vulnerability of the coastal built environment to severe wind, flooding, and erosion, though they require significant investment and ongoing maintenance. The importance of maintaining infrastructure in South African settlements cannot be overemphasised.

Key response interventions for Outcome 2: Mitigation of the impact of extreme temperatures on buildings and infrastructure:

- Hard infrastructure: Design roads, sidewalks, bridges, and railways to withstand temperature extremes, using materials that can tolerate thermal expansion and contraction. Ensure the power grid can handle increased demand during extreme temperature events and reduce the risk of loadshedding.
- Ecosystem-based adaptation using urban green infrastructure: Integrate parks, green roofs, and open spaces to provide shade, reduce urban heat island effects, and enhance cooling. Create shaded areas in public spaces using trees and other natural vegetation to provide relief from the heat.
- Ecosystem-based adaptation: Protect and restore coastal wetlands and mangroves, which can moderate local temperatures and provide cooling effects. Use indigenous and drought-resistant plants for landscaping to reduce water use and provide shade.
- Climate-considerate site development: Orient buildings to maximise the direction of sea winds, natural ventilation and minimise heat gain during hot periods and heat loss during cold periods.
 Promote the development of green spaces and limit heat-absorbing surfaces.

- Building codes: Implement stricter building design codes to accommodate temperature extremes, especially to take advantage of natural heating from the sun in winter and shading in summer. These codes can include using reflective materials for roofs and pavements to reduce heat absorption and lower temperatures, enforcing building insulation to keep interiors cool in summer and warm in winter, reducing energy demand for heating and cooling. This can also be an effective way of climate mitigation.
- **Renewable sources of energy**: Promote the use of solar energy to power cooling and heating systems.
- **Rainwater harvesting**: Collect and store rainwater for irrigation and cooling purposes, reducing the demand on potable water supplies.
- Heat shelters and warming centres: Establish cooling centres or heat shelters where people can seek refuge during extreme temperatures. These could, for example, be existing community halls or libraries.

By implementing a combination of these adaptation interventions, coastal settlements can effectively reduce the impact of extreme hot and cold temperatures on the built-environment and infrastructure, enhancing the resilience and quality of life for their inhabitants, while also actively contributing to reduction of fossil fuel use and climate mitigation. For more Response Options for built environment and infrastructure, refer to the GreenBook (https://adaptationactions.greenbook. co.za/) and the Let's Respond Toolkit (https:// letsrespondtoolkit.org/).

The decision of which adaptation action to choose will depend on the feasibility and affordability of options, largely on a local level or by private infrastructure owners. For official adaptation planning, the concept of Adaptation Pathways (see Section 8) should be considered, as it allows decision makers to set up a long-term adaptation plan, accommodating current and future financial constraints and a potentially uncertain climate future.

17 Coastal livelihoods and economies

Approximately 60% of the South African economy depends on coastal natural resources and trade infrastructure such as ports, given that more than 95% of South Africa's imports and exports are ocean facilitated. During the stakeholder engagements informing the CARP development (DFFE & CSIR 2024), participants helped to define the "coastal economic sector" to be considered in the CARP (Table 5).

Table 5: The coastal economic sector and activities as per DFFE & CSIR 2024

Fisheries and maritime economy	Food production	Energy	Conservation	Mining
Commercial shipping	Aquaculture	Renewable energy IPPs	Restoration economy	Mining companies
Commercial fishing		Wind farms (rangelands and ex- mining)		Dune mining
Harbour entities		Innovative projects –	Conservation economy	Sand mining
Maritime agencies		hydrogen, SEZs, blogas	(rangers, scientists, others)	Minerals processing
Bunkering		Power ships		
Ship building and repair industry		Blue carbon trading/ economy	MPAS	
Navigation systems and lighthouses				
Commercial port infrastructure				
Coastal protection				
Ocean economy				
Slipway/jetty leases				
Wild fishing				
Arts, education, culture, and wellbeing	Trade and transport	Service provision, manufacturing, business, and finance	Development	Tourism, recreation entertainment and hospitality
Oceanography	Aviation Green transport Import and export .g. Robben	Insurance and reinsurance Retail Informal traders	Property development / real estate	Ecotourism
Education and research				Whale watching
Medicine				Shark cage diving
Heritage resource management (e.g. Robben Island)				Ecotour operators
		ITC		Tourism cruises
Traditional uses of marine		Waste management		Cultural tourism
nd coastal resources		National and international donors		Boating
Crafts and jewellery industry		Desalination		Film production
		Water treatment		Diving industry
		SMMEs		Sporting events, including cycling

Further, stakeholders also identified the livelihoods typically found in South Africa's coastal context (Table 6).

Fishing	Farming and food production	Wild harvesting	Forestry and conservation	Mining
Fishermen Fishing sector Commercial fishing Small scale fishing communities Fishing boat owners Fishing exporters Boat crews MLRA seaweed farming/ harvesting Boat charters	Crop farming and farmers (small- and large-scale commercial) Livestock farming and farmers (small- and large- scale commercial) Subsistence farming Farm workers Agroprocessing Aquaponics Abalone farming Aquaculture mariculture	Subsistence fishing community Shell collection Medicinal plant harvesting Harvesting of firewood Harvesting of reeds Harvesting of sour figs Harvesting of flowers Poaching	Afforestation Management of nature reserves, marine protected areas, estuarine nursery grounds	Small scale mining (diamond digging) Sand mining Salt mining Marine mining
Arts, education, culture and wellbeing	Housing	Service provision, industry, and business	Entertainment	Tourism and recreation
Craft making Research and innovation Indigenous knowledge and culture Maritime education Services related to aesthetics and spirituality	Building/retrofitting of homes for climate change	Divers Lifeguards & safety officers Cleaners SMMEs and vendors Regulatory services Law enforcement Boat building Recycling ITC Energy generation Tradesmen	Film making Event management	Scuba diving operators Boat charters Professional water sportsmen Swimmers/bathers Hotel and restaurant employees Sporting event management Operation of accommodation facilities Tour guides and operators Drivers

Table 6: Livelihoods in South Africa's coastal sector and who engages in them, as per DFFE & CSIR 2024

Both tables show that economic activities and livelihoods depending on them in South Africa's coastal zone are incredibly diverse, as these do not just include coast-specific activities, but also non-coastal-related and marine-related activities. Further, activities are multi-dimensional stretching from very small businesses, e.g. craft-making and informal vendors related to tourism to international enterprise level, such as tourism and the fishing industry.
17.1 Climate threats to coastal livelihoods and economies

Climate change and climate-related disasters and long-term impacts have direct implications on crucial sectors of the ocean's economy such as fisheries, aquaculture, and tourism that depend on the health and productivity of marine ecosystems (Global Centre on Adaptation, 2022).

Some of the potential loss and damage to coastal livelihoods and economies due to extreme climate events can include:

- **Permanent loss of resources**, e.g. due to ecosystem degradation, shift and species migration
- Temporary damage of economic and livelihood resources
- Temporary disruption of economic activities
- · Loss of workforce and markets.

Coastal livelihoods and economy cannot successfully exist without the other coastal "elements" which are described in PART C being functional, namely the natural environment, people and communities, the built environment and infrastructure, on which they are heavily dependent, and effective governance and legislation (Figure 18).

Figure 18: The four pillars of coastal livelihoods and economies



The natural environment provides the resources on which many coastal industries rely, such as fishing (large-scale and small-scale) and tourism. Coastal communities play a double role, namely as workforce for coastal industries and as consumers. Intersectional factors such as age, gender and socioeconomic status exacerbate climate risk and impacts for marginalised youth. Young women in the ocean's economy often encounter additional obstacles in accessing education or employment, compounding their vulnerability to the impacts of climate change and their ability to adapt (William & Naidoo 2024).

The built infrastructure encompasses factories, harbours and tourism structures, but also traffic routes for transportation of goods and services as well as crucial electricity, water and communication infrastructure, which are key for economic activities. Therefore, climate change adaptation of coastal livelihoods and economies needs to consider actions to maintain these three essential pillars of their success and long-term sustainability as well as direct climate adaptation and mitigation actions executable at the immediate enterprise level. Governance and legislation have both an enabling function for successful coastal economies and a regulating and enforcing function (more detail on this in Section 18). The latter might include prescriptions for climate adaptation action at enterprise level.

Climate change adaptation for coastal livelihoods and economies, when implemented considering all the four pillars on which it relies, has therefore the large potential to also uplift and adapt those Elements. It further bears the potential to address much wider societal challenges such as poverty, gender-biased social vulnerability and sustainable development, while also providing potentially exciting new industrial opportunities.

17.2 Management objective for coastal economy and livelihoods

The management objective for South Africa's coastal economy and livelihoods is correspondingly stated as follows:

Coastal livelihoods and economies embrace sustainable development and just economic principles, ensuring resilience in a changing climate. Part: C

17.3 Climate response outcomes

Recognising the interdependence of the five coastal pillars, climate response must secure robust, cross-elemental outcomes across every sector. By integrating adaptation measures across the natural environment, coastal communities, infrastructure, economic livelihoods, and governance, we can deliver direct adaptation at the national level, while also implementing targeted actions that fortify the broader framework supporting our coastal sector.

This provides the opportunity to connect the ocean's economy to climate action, nature and poverty reduction agendas and local economic development initiatives, as well as power imbalances and inequalities linked to gender, labour conditions, tenure rights, and market access (IIED 2022).

Consequently, the following, cross-Elemental climate adaptation outcomes have been set:

Outcome 1: Natural resources on which coastal livelihoods and economies depend **are used sustainably**, with the aim to improve the status of the resource, and to secure their service provision for coastal industries in the future.

Outcome 2: The work environment for work force in coastal industries enables climate-considerate work condition and provides protection from climate-extreme events.

Outcome 3: Consumers and markets are educated and shaped towards products and services which are sustainable under a changing climate.

Outcome 4: Production and service delivery infrastructure can withstand climate impacts and contribute to climate mitigation.

Outcome 5: Coastal livelihoods and economies are cognisant of the dynamic nature of climate change and can respond timeously.

17.4 Required response interventions

To reach the proposed outcomes, the following response interventions are needed:

Key responses for Outcome 1: Natural resources on which coastal livelihoods and economies depend are used sustainably to secure their service provision for coastal industries in the future. "Sustainably" should also be understood in the sense that competition between economic activities – e.g. Fishing vs ecotourism - should be resolved in favour of the longer-term social and ecological good:

- Adhere to laws and policies that regulate the sustainable use of natural coastal and marine resources.
- **Respect marine protected areas** and other effective area-based conservation measures that serve as nurseries for economically important fish and crustaceans and conserve biodiversity as baseline for other socioeconomic activities.
- Create own or contribute to existing resourcemonitoring schemes for coastal and marine resources to enable tracking of resourceabundance dynamics and long-term trends. This will provide early-on information on sustainability of current resource and its use.
- Explore and invest into alternative and additional livelihood sources (livelihood diversification) and economic endeavours to prevent the crash of livelihoods/economies, should the use of current resources become unfeasible. Examples are contribution to ecotourism, shift to different target species in fishing, and creation of subsistence vegetable gardens. Collaboration with NGOs and science will support and guide these activities, which should be conducted in a participatory community approach when targeting small-scale industries.
- Avoid pollution and other detrimental effects on the environment from economic activities to maintain stable populations, even under increased

climate stress: adhere to wastewater and pollution regulations, keep industrial infrastructure wellmaintained, avoid fishing methods which are harmful to non-target species.

Key responses for Outcome 2: The work environment for work force in coastal industries enables climate-considerate work condition and provides protection from climate extreme events:

- Ensure that industrial labour environments adhere to health and safety regulations. Specifically ensure that labour environments provide protection from climate events such as extreme heat or cold spells, flooding and exposure to excessive sun and wind.
- Should changes to buildings be necessary to create climate-wise working conditions, prioritise options for ecosystem-based solutions and the use of green nfrastructure over conventional options (such as aircons) which might be heavily reliant on fossil energies. EbA options could include roof gardens for building insulation, greening of facades, and planting of indigenous, water-wise trees, parks, and gardens between buildings for natural cooling. Harvest and use rainwater for irrigation thereof. Natural ventilation (for cooling) and sunroofs (for heating) can be an effective alternative to aircons. Greener work environment will also contribute climate mitigation, reduction of air pollution and to general wellbeing of staff.
- Especially for outdoor work, **provide workers with clothing and protective gear** to prevent them from climate impacts such as excessive heat, cold or sun exposure. Consider interruption of outdoor work when climate conditions prevent protection of workers.
- Develop support schemes for workforce to compensate for climate impacts. Extreme climate events may disrupt economic activities for a period. Be aware that especially low-income labourers rely heavily on continuous income streams as they lack the capacity to compensate for temporary income losses in their private capacity. Create climate-impact insurance or compensation funds. (This might also be an opportunity for a new insurance scheme).

Key responses for Outcome 3: Consumers and markets are educated and shaped towards products and services which are sustainable under a changing climate:

- **Promote sustainable tourism** that regenerates the ecosystems on which it depends, builds the resilience of coastal communities, reduces inequality through promoting equal opportunity and equitable distribution of benefits (Ocean Panel 2022).
- Develop, and promote your products as "climatewise". Change of brand image might attract customers.
- Use environmental responsibility as an explanation for decommissioning products and services which become unsustainable or nonlucrative due to climate impacts.

Key responses for Outcome 4: Production and service delivery infrastructure can withstand climate impacts and contribute to climate mitigation:

- Ensure that production and service delivery facilities are protected from climate impacts such as floods and climate disaster-related disruptions. Prioritise relocation of facilities (and land swap) – should they be in the risk zone – over protection of facilities, as retreat will be the more viable option in the long-term.
- Where retreat is not an option, consider construction of flood walls and fire breaks around critical infrastructure, elevating critical infrastructure from ground level to higher floors, use solar energy for electricity and hot water, to be independent from (potentially failing) public grids during disasters. This will also contribute to climate mitigation.
- Prioritise ecosystem-based protection options to protect economic infrastructure from climate impacts, such as renaturation of wetlands (to absorb excessive rainfall and prevent flooding), restoration of coastal vegetation (dunes, beaches, estuarine vegetation) as buffer against coastal storm-related wind and wave impact.

 Create storage for rainwater (and treatment technology thereof, if needed), to reduce usage of public water sources (permanently, not only during periods of climate related water shortage).

Key responses for Outcome 5: Coastal livelihoods and economies are cognisant of the dynamic nature of climate change and can respond timeously:

- Record climate data and other data relevant to your business (e.g. catch numbers, numbers of days suitable for fishing, occurrence of red tides etc.) in your own capacity or collectively in your cooperative etc. Some companies and NGOs have ongoing programmes in this regard which you might be able to join.
- Keep yourself informed of new research and science relating to new climate scenarios. Follow relevant institutions on social media, such as

South African Universities, CSIR, SAWS, Disaster Management, SANBI and NGOs.

- Participate and contribute to coastal climate events, such as the proposed DFFE-led Coastal Climate Action Science Fair and events organised by ACCESS.
- Stay abreast of new technological and societal developments to effectively respond and adapt.
- Share relevant information and experiences, e.g. with modern technologies, with your network to enable peer learning, either during meetings of relevant professional bodies or as flyers or social media contributions.
- **Create or join climate change response forums** for your industry to share industry-relevant climate impact or technology information among peers.

18 Governance and legislation

The preceding sections highlighted the impacts of climate change on the various coastal Elements within the coastal sector, namely, the natural coastal environment, people and communities, the coastal built infrastructure, and coastal livelihoods and economies. The management objective for each Element articulates an ideal scenario, if the associated climate response goals and the required adaptation actions are achieved. For each Element to achieve the respective management objectives and for South Africa to realise the Vision of the CARP, governance and legislation have a significant role to play.

This section outlines the challenges governance faces and articulates main responsibilities and activities the various spheres of governance should embrace to enable a successful climate response of South Africa's coastal sector. In doing so, South Africa will make a substantial contribution towards its international climate obligations, such as the Paris Agreement, the Nairobi Convention, the UN Framework Convention on Climate Change, the UN Sustainable Development Goals and other national development goals.

18.1 Governance challenges relating to coastal climate change

Governance and regulation of South Africa's coastal activities is an incredibly complex endeavour, given that the legal responsibility for the various aspects is distributed across local, and national government spheres. Additionally, international obligations need to be adhered to as well for some aspects. Further, apart from this horizontal stratification of responsibilities, also "vertical" clustering of responsibilities exists between the departments responsible for the various economic sectors (e.g. Water Affairs, Environment, Mining, etc.). See Figure 19. This segregation of responsibilities and enormous diversity of coastal activities has led to an overwhelming landscape of policies and regulations relating to integrated coastal management. (Taljaard et al. 2019) packaged the legal landscape governing various aspects related to integrated coastal management in South Africa into a "horrendogram" (Figure 20, zoom in for details). More detail on the legislation compiled in this Figure is provided in Appendix 3. The "horrendogram" also highlights the cross-sectoral nature of the legal landscape to be considered. **This emphasises the need for horizontal, vertical, and cross-sectoral integration and collaboration of effective management of the coastal sector**.

Figure 19: Governance and legislation spheres relevant to South Africa's Coastal Sector





Figure 20: Overview of legal landscape governing various aspects related to integrated coastal management in South Afrifa

Source: adapted from Taljaard et al. 2019

Climate change is adding another dimension of challenge to coastal governance: the anticipated varying degree of expected local impact and severity thereof make it impossible to provide a one-size-fitsall "hard-wired" climate adaptation recommendation – especially at national level and cross-cutting across government sectors – while also emphasising the need for governance to stay abreast of scientific climate research and technological developments relevant to climate adaptation.

Further obstacles in effective coastal management

and coastal climate adaptation are conflicting interests between stakeholders, complicated legislation to implement adaptation on the ground (the textbox below illustrates some of these governance challenges) and the difficulty in finding funding for climate response actions.

Despite these significant challenges, the Climate Change Act mandates provincial and municipal governments, as well as industrial sectors, to implement climate action effectively and fulfil related reporting obligations. Section 18 below directly addresses this requirement by providing specific guidance to support government entities in

taking meaningful action.

Coastal climate governance – lost between conflicting interests

According to IPCC (2014), governance challenges are amongst the most common hindrances to implementing coastal adaptation measures. One main issue to resolve is conflicting stakeholder interests. This includes conflicts between those favouring protection and those being negatively affected by adaptation measures. In many parts of the world, coastal adaptation governance is further complicated by existing conflicts over resources. For example, illegal coastal sand mining is currently a major driver of coastal erosion in many parts of the developing world, including South Africa.

There is also conflict related to the distribution of public money between communities receiving public support for adaptation and non-coastal communities who pay for this support through taxes. Access to financial resources for adaptation, including from public sources, development and climate finance or capital markets, frequently constrain adaptation.

An associated governance challenge is ensuring the effective maintenance of coastal protection. Ineffective maintenance has contributed to many coastal disasters in the past, such as in New Orleans (USA), illuminating that ineffective governance is frequently the result of lack of capacity at the point of decision making.

The coastal protection benefits of natural ecosystems (Ecosystem-based Adaptation, EbA) are increasingly being recognised within international discourse and national coastal adaptation, resilience and sustainable development plans and strategies (IPCC SROCC 2019, Bindoff et al. 2019). In general, obtaining permits for EbA remains as difficult as established hard protection measures, given South Africa's EIA regulations. However, globally there are examples of instruments specifically tailored to retain the protective function of EbA. The Living Shorelines Regulations of the state government of Maryland in the USA, for instance, requires that private properties must include marsh creation or other non-structural measures when stabilising their shorelines, unless a waiver is obtained.

18.2 Governance objective for effective climate adaptation of the coastal sector

The following management objective for South African governance embracing the coastal sector in its entirety is set:

> South Africa's legal and policy baseline effectively promotes climate-wise, sustainable, just and equitable coastal development and climate resilient livelihoods, economies and environments, for the benefit of all by 2035.

18.3 Governance-related outcomes

To achieve the above objective, government's responsibility towards effective climate adaptation can be unpacked in the following areas:

- Creating an enabling legislative environment
- Enforcing this legislation
- **Capacitating** government officials, coastal communities and industry to make climate-wise decisions
- **Providing support** to government spheres, communities and industries beyond legislation and regulation, e.g. through finance mechanisms and other resources
- **Reporting** of climate action to national and international obligations.

Based on these main responsibilities, the following outcomes for coastal climate adaptation governance have been formulated:

Outcome 1: Climate change adaptation is effectively integrated and mainstreamed into all legislative spheres and sectors relevant to the coastal sector.

Outcome 2: Legislation relating to coastal climate adaptation is effectively enforced and executed at all levels.

Outcome 3: Coastal communities and industries take ownership of climate-wise decision-making, applying context-specific knowledge and solutions to build resilience.

Outcome 4: Strategic support and resources are provided to enable climate action at various levels of governance.

Outcome 5: Coastal climate adaptation efforts are systematically reported within respective spheres of governance, ensuring transparency and accountability.

18.4 Required interventions

To achieve these Outcomes, several interventions are proposed in this section for government to act. The proposed interventions should be considered at all levels of government and across sectors. For the successful execution of most of these interventions, cross-sectoral and inter-governmental collaboration is essential.

The Climate Change Act (sections 8 and 9) calls for the establishment of Provincial and municipal Forums of Climate Change which must coordinate climate change response action in their relevant context and which must report on climate change considerations to the President's Coordinating Council or Provincial Forum on Climate Change respectively: The interventions proposed below are directly answering to the requirements of the Climate Change Act.

Given that governance naturally transcends all the coastal Elements described in the sections above, many of the interventions proposed below might have been covered in the previous sections. However, it appears essential to list these actions here again, as it is anticipated that the reader of this section might engage with the CARP from a different angle.

Key responses for Outcome 1: Climate change adaptation is effectively integrated and mainstreamed into all legislative spheres and sectors relevant to the coastal sector.

Integrating climate change aspects in the context of the CARP means that a legislative and policy

environment needs to be created so that climate adaptation can be implemented as effortlessly as possible. Mainstreaming has already been highlighted as a key intervention for successful climate adaptation in all spheres in Section 9 above. The interventions listed below iterate the required actions stated and unpacked in that section. For more detail on the motivation for these interventions, refer to the section above.

- Ensure that there is representation of coastal climate adaptation and mitigation matters within an existing formal body, forum, or team that oversees and coordinates the mainstreaming of climate response within provincial, metropolitan and local government (as per Sections 8 and 9 of the Climate Change Act).
- Map the unique institutional arrangements within the respective provincial and local government context, including the national and provincial coastal committees, to provide an overview of the regulatory and institutional frameworks, intergovernmental structures, technical structures and to identify the linkages and relationships between them. Appendix 3 to the CARP provides a comprehensive overview of coastal-relevant policies and legislation which can serve as a starting point for this activity.
- Establish and renew external (non-governmental, including traditional leadership) networks and partnerships that can support the implementation of the CARP to support implementation, capacity building, provide access to expertise, information, and funding for climate response.
- Use available evidence on climate change risks (PART A of this document) and adaptation opportunities for the respective coastal Elements provided in the previous sections to inform provincial and local planning instruments and processes.
- Apply/implement risk zone delineations and CMLs in designs and decisions.
- Across legislation for all sectors, pay specific attention to the following aspects, which will not only benefit climate change adaptation, but can also contribute to climate mitigation, poverty alleviation, equity and other societal development goals:

- Ensure alignment of spatial and development planning with the need to restore and protect coastal ecosystems, and the need to avoid placing development in harm's way
- Establish whether Ecosystem-based adaptation options and the use of Green Infrastructure has been emphasised
- Does the legal framework facilitate implementation of Ecosystem-based adaptation options and the use of Green Infrastructure, or do legal frameworks need to be simplified to enable implementation thereof?
- Establish whether climate action can be used as an opportunity for carbon trading
- Establish options to be prioritised which provide equitable opportunities at implementation level
- Ensure better alignment with disaster management strategies at municipal level. Preexisting municipal plans should be enhanced with more robust early warning systems, contingency planning, and risk reduction measures for coastal hazards, to ensure quicker and more effective responses.

Key responses for Outcome 2: Legislation relating to coastal climate adaptation should be effectively enforced and implemented at all levels.

Across sectors, identify policies and legislation which are supporting coastal climate adaptation and prioritise their enforcement. This will include, among others:

- Coastal management lines (in relation to the ICM Act): to keep communities, infrastructure, and economy out of coastal risk zones and to prevent risk and damage.
- Coastal setback lines, protected areas and MPAs etc. (sensu NEMA): to preserve and protect coastal natural environments as natural resource basis to continue providing sustainable ecosystem services for coastal communities, livelihoods, and economies.
- **SAMSA and DFFE**: monitoring and enforcement of fishing rights.
- Fishing quotas and other regulations, to protect marine resources.

- **Coastal access and offroad driving**, to protect dunes and preserve their coastal protection function.
- Any type of pollution legislation.
- **Building regulations** for climate-wise construction and retrofitting.

Key responses for Outcome 3: Government, the coastal communities and industries are enabled to make climate-wise decisions within their own respective context.

This outcome relates to capacity building and climate education of government officials, coastal communities, and industries. This outcome is essential, as only entities which are aware of the risk a changing climate might pose, will be willing to act.

- For government officials, provide regular training courses on the CARP in their respective relevant context, to enable effective action. This should include long-term capacity-building programs, targeting technical, administrative, and community levels, ensuring that the knowledge gained is retained within the system. Introduce Adaptation Pathways and Retreat as potential long-term response strategies.
- For government officials, provide training on the development of climate response implementation plans for Provinces/ municipalities.
- For government officials, provide training courses on successful proposal writing. Especially local municipalities (LMs) struggle to find funding for Climate Action (and funding for local governance execution in general). They state lack of experience in successful proposal writing and business strategy development which will be tackled in this intervention.
- For communities and the wider public: organise climate awareness campaigns on climate change risks and which actions they can take in their own capacity to protect their lives, livelihoods, and property. Encourage citizen science for monitoring and recording of climate data and extreme events (e.g. flood lines, or impact on biota). The CARP can act as a starting point for identifying these actions. Introduce Adaptation Pathways and Retreat as potential long-term response strategies. Information

about long-term strategies can ease anxiety and allow for personal planning. Social media, printed leaflets, information boards on the coast and community meeting can be employed as relevant as a platform for these engagements.

- For communities in identified risk zones: in collaboration with the community: propose disaster and emergency evacuation plans and develop safe evacuation points. Develop community-based, low-tech early warning systems.
- Embed climate change in school curricula at all levels: to enable a climate-wise next generation.
- Targeting coastal industry: Raise awareness of local climate adaptation plans among industry stakeholders, including micro-enterprises such as small-scale fishers. Social media, industryspecific fairs and industry associations and boards could be used for sharing digital and printed info-material as well as presentations.
- For all coastal stakeholders: Organise a biannual Coastal Climate Action Science Fair to bring together all coastal climate stakeholders and academia to overcome the disconnect between academia and coastal role-players. This will fast-track the awareness and absorption of relevant scientific and technological developments into climate action on the ground. This includes the uptake of emerging technologies like artificial intelligence, satellite monitoring, and Internet of Things (IoT) for real-time tracking of coastal climate changes. These technologies could be used in M&E frameworks to provide more accurate, real-time data that can drive timely interventions, and respond to the government's priority on the 4th Industrial Revolution.

Key responses for Outcome 4: Provide resources to support climate actions at all levels and for all coastal Elements.

Providing the legislative framework for effective climate action in all spheres of government, resources in the form of staff, climate monitoring equipment, and materials, e.g. for Ecosystem-based coastal protection or communication materials and workshop venues, etc. are necessary to implement climate adaptation on the ground. In many cases, the key challenge can be defining projects or needs and then to source funding.

The activities 1–8 listed in the following are related to Section 10 of the CARP and are repeating the essence of the funding strategy made there (page 34). That section must, therefore, be read in conjunction with the interventions made in the following sections, Interventions 1–8 should not be actioned in isolation, but as a logical sequence of a fund-sourcing strategy to provide the necessary context.

Interventions 1–8 are kept general, to allow this framework to be applied to sourcing funding for a wide range of targeted interventions. Interventions 9–11 are going beyond the specific intervention context, as they are aimed at the development of new funding programmes.

- **Compose a task team** which will be responsible to develop and action the coastal climate response in your specific coastal context.
- Identify the climate adaptation objectives and goals to be achieved for the respective aspect of the coast you are involved with. Sections 14 to 17.5 of this document provide these on a higher level, but on a local level, objectives and goals could be more specific.
- Identify tangible adaptation actions to achieve the set objectives and goals. Sections 14 to 17.5 give a general overview of actions to achieve the most widely encountered climate threats. But again, on a local level, the portfolio of feasible activities might be different, given different priorities and pressing adaptation needs. Also, consider the concept of Adaptation Pathways (Section 7) to develop a long-term programme of implementing different adaptation options.
- Determine which actions have high, medium, or low priority. Examples are provided in the Draft Implementation Programmes for the respective coastal elements in PART C of this document.
- Identify key responsible departments linking to the proposed adaptation options. Suggestions are made in the Draft Implementation Programmes for the respective coastal Elements in Sections 14 to 17 above.

- Determine the timeframe over which the actions need to be completed – either specify a date or timeframe. This will later allow for effective monitoring of progress and embedding into annual work programmes.
- Establish the cost of the planned activity. This information will support inter-departmental discussions on funding requirements and availability and forms the baseline for external funding applications. The draft implementation programmes in PART B of this document provide space for cost estimations.
- **Target external funding sources** for the proposed activities, should mainstreaming and interdepartmental collaboration not lead to funding for the proposed activities. NB: This might require training on effective grant application writing (enforcing the need for Outcome 3 above).

Interventions 1–8 will more likely be actioned at a provincial or local level, where most tangible adaptation interventions will be realised. It is quite likely that application of Steps 1–8 will be aimed at individual actions that have been identified and prioritised by a specific office. In addition to this "reactive" fund-raising, the different organs of state should strive to embrace "pro-active" measures. The following interventions should be implemented:

- Creation of tax or other incentives for climate adaptation and mitigation actions, specifically Ecosystem-based adaptation, and mitigation actions. The existing VAT reduction for photovoltaic solar installation is one example.
- Creation of dedicated budget for climate actions at national and/or provincial levels. Since funding availability at government level is not bottomless, it could be considered to apply a rigorous application and approval mechanism. Aspects that could be included here are the project's contribution to poverty alleviation, equity and, merit for climate adaptation and mitigation.
- Establishment of a National Climate Action Funding Office for international donor funding liaison. In the light of the generally low capacity – especially at local level – to approach

 Consider establishment of a "Working for Adaptation" programme which trains and dispatches early & mid-career staff and training as inter-disciplinary CC adaptation implementor at local and district municipality level. This will respond to the challenge indicated by LMs of being under-capacitated in terms of shortage of staff and work in siloes. First year of Working for Adaptation employment to be financed by national, for consideration of permanent employment at the deployment place afterwards, to strengthen CC adaptation and interdepartmental collaboration in the long-term.

Key responses for Outcome 5: Effectively report on coastal climate change adaptation in their respective sphere of governance.

The Climate Change Act (No. 22 of 2024) emphasises the need for climate action in all spheres of government. Related to this is the demand to report regularly on climate adaptation progress made at the respective government level and line function and to review their respective adaptation plans and programmes. Receiving upstream entities are the Presidential Climate Commission (Section 10 of the Climate Change Act) and the Provincial Climate Change Forums. Further, South Africa's international obligations, such as the Paris Agreement, also demand climate reporting at regular intervals. For all levels of government, the following interventions can aid in reporting and updating climate programmes and strategies in a meaningful way and within the required timeframes on climate action progress made.

- Establish the general reporting intervals and reporting deadlines of upstream reporting recipients. Refer to the Climate Change Act for guidance at the different government levels.
- Where possible, align both the reporting and review cycles of climate action plans and programmes with those of other key legislation, such as Spatial Development Frameworks. This approach not only streamlines reporting but also promotes the integration of climate goals across governance frameworks. Additionally, the content of reporting should be harmonised, thus ensuring that national government requests are relevant, impact-focused, and responsive to provincial realities. Reporting requirements should reflect meaningful progress on the ground and make use of existing data and reporting systems.
- Establish the requirements of upstream reports and whether a reporting template is available. If not, reports delivered in previous cycles might provide guidance.
- Highlight success stories and challenges. Optimally provide constructive suggestions on how to overcome challenges and obstacles. Where no suggestions can be made, reporting on challenges can invite peer- or upstream support.
- Re-use the information compiled for official reporting to inform the public, industry, and other stakeholders. Official reporting can be a complex endeavour but can also provide the opportunity to reflect on climate adaptation successes – and challenges encountered. This information can be re-packaged to inform coastal communities, industries (in the form of flyers and social media podcasts etc.) and academia (i.e. in the form of scientific journal publications). This feedback generates transparency, can facilitate peer-learning and other constructive interactions with the public.

19 Draft Implementation Plan

Sections 14 to 18 provided a wealth of information about climate threats to and management objectives for each coastal element, as well as envisaged climate response outcomes and required interventions. For providing tangible implementation guidance, the CARP also needs to provide an Implementation Plan which stipulates a timeline to the proposed interventions. Table 7 below highlights that across the five coastal Elements, the CARP developed a total of 21 envisaged Outcomes and more than 150 Interventions. The development of a detailed timeline for each of 150 Interventions is beyond the scope of this first-ever CARP, more so as most of the interventions need to be assessed in the specific local context where they will be actioned.

Table 7: Overview of the number of Outcomes and Interventions per coastal Element compiled in the CARP

			Coastal element			
	Natural environment	People and communities	Built environment and infrastructure	Livelihoods and economies	Governance and legislation	Total
No. of Outcomes	6	3	2	5	5	21
No. of Interventions	>50	27	19	24	30	150

Consequently, this version of the CARP can only provide a draft Implementation Plan as baseline for a national climate Change Adaptation Action Plan (Appendix 1). This Implementation Plan provides a timeline for the short-term (1–2 years from CARP launch), medium term (3–5 years) and long term (6–10 years). It should be considered, though, that the legal review period for sector-based adaptation plans such as the CARP is 5 years. Consequently, long-term goals could be adapted during the review to meet the emerging needs in each context. The draft Implementation Plan provides timelines to address specific Objectives. Related interventions will need to be actioned by different organs of state to effectively aid the CARP implementation. It is, therefore, located as an Appendix to the CARP, to allow an update independent from the 5-yearly review and update of the CARP in its entirety.

20 Conclusion and Way Forward

This document constitutes the first Climate Change Adaptation Response Plan (CARP) for South Africa's Coastal Sector. It outlines the climate and development future projected for South Africa's coastal zone and describes the elements of the coastal sector, the climate threats experienced and the vision/objective, the goals, and the suggested adaptation actions. The coastal elements as referred to in the context of this Response Plan are the natural environment; people and communities; built environment and infrastructure; coastal livelihoods and economies; and the all-embracing element of governance and legislation. This document also provides a draft Implementation Plan as baseline for a national climate Change Adaptation Action Plan. One of the crucial factors of success is that the actions suggested are tangible and measurable to control the success of the response.

The Adaptation Programmes provided in this document for each coastal element are suggestions,

based on examples from other, including non-coastal, adaptation plans, and expert knowledge. The CARP was co-developed with about 700 coastal stakeholders during provincial workshops in 2023 and 2024 and, of course, with inputs by the Project Steering Committee. Nevertheless, there might still be gaps which eluded the project team and the stakeholders in this round. The team is also aware that the proposed actions might not be applicable in every context on the South African coast. Endorsement of the CARP, as well as identifying gaps and refining priorities and interventions will only be possible once the CARP in its current version has been put to the test and executed by the relevant actors.

It is expected that the resulting experiences will further shape and refine the CARP, which will have an anticipated review cycle of five years. In the long-term, the CARP will constitute a valuable contribution towards South Africa's sector based climate-wise future.

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APPENDICES

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lline	2030								
Time	2029	E "							
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tended outcome Need/challenge addressed			atcome 1: Climate Perceived lack of mandate, funding, ange adaptation is iectively integrated, ainstreamed into, gislative spheres of vernance. Perceived lack of mandate, funding, legal support at sphere to action.	Atcome 2: All coastalClimate science and adaptationakeholders are enabledtechnology advances quickly.make climate-wiseLegislation should provide acisions in their ownmeaningful framework in responsespective context.to recent developments	Ineffective climate relevant legislation	Shortage of skills for CC action	LMs struggle to find funding for Climate Action (and funding for local governance execution in general). They state lack of experience in successful proposal writing and business strategy development	LMs struggle to take (coastal) climate action as there are still substantial gaps in climate change, and how it impacts different government and economic sectors.	Science-to-policy disparity needs to be addressed for improved management outcomes. Governance could benefit from ongoing or recent academic activities, and academia could better direct research for local impact.
Required I actors			all relevant c c c c c c c c c c c c c c c c c c c	DFFE	all relevant sectors	DFFE	DFFE	DFFE	DFFE and DST
Sphere			All government spheres	National	All government spheres	National	National	National	National
Intervention category			Legal framework and mainstreaming	Legal framework and mainstreaming	Legal framework and mainstreaming	Capacity building	Capacity building	Capacity building	Capacity building
Coastal Element			бочеглапсе						

Appendix 1: DRAFT Implementation Plan

Appendices

Timeline						
Need/challenge addressed	shortage of staff, finance, and other resources for CC action	LMs indicated that they are under- capacitated in terms of shortage of staff and work in siloes. This constantly hampers effective CC and/or environmental action	Coastal squeeze, disturbed sediment dynamics, ecosystem fragmentation and degradation, all decreasing climate resilience	Reduced climate resilience through threatened species populations	Healthy species populations needed as sustainable service and resource baseline	Threat to indigenous ecosystems and water sources, often also fire risk
Intended outcome	Outcome 3: CARP Resource Mobilisation Plan implemented to support all coastal sector elements.	Outcome 4: CARP M&E Plan implemented, and priority indicators identified for reporting purposes.	Outcome 1: Spatial development and land use management acknowledge the important role that coastal green infrastructure plays in successful climate adaptation and mitigation.	Outcome 2: Coastal ecosystems are effectively managed and restored to optimally function as ecosystems, carbon sinks, based adaptation and key resource for coastal livelihoods and industries.		Outcome 4: Alien and invasive species are controlled to maintain and restore coastal ecosystem functioning and the services and functions they provide, including buffering against climate events.
Required actors	DFFE, treasury, Dep. Economy, DWS	DFFE or Provinces				
Sphere	National and provincial	National and / or provincial	Largely local	Largely local	Largely local	All spheres
Intervention category	Finance and resources	Finance and resources	Spatial planning, Legal framework and mainstreaming	Nature conservation, finance and resources, spatial planning	Legal framework, finance and resources, capacity building	Legal framework, finance and resources, capacity building
Coastal Element	อวนยน	Gover		tnəmnorivn3 lini	Uatu	

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Timelin						
challenge addressed	on threatens species & tem health, reduces their nce and service provision	ılarly high flood risk in es	f resilience of communities s thereof to climate impacts	sponse capacity on unity level.	f safe and evacuation spaces tal communities	
Need/(Polluti ecosys resilier	Particu estuari	Lack of or part	Low re commu	Lack of in coas	
Intended outcome	Outcome S: Coastal water quality is effectively managed to maintain healthy and productive ecosystem services key ecosystem services such as nurseries, coastal protection, climate regulation and nutrient cycling.		Outcome 1: The resilience of vulnerable coastal communities to the impacts of climate change is increased through enhancing their adaptive capacity.	Outcome 2: The education and awareness of coastal communities around the potential impacts of climate change (e.g. flooding) and early warning systems	Outcome 3: Empowering coastal communities on effective measures for disaster risk reduction.	Outcome 4: Indigenous knowledge is effectively integrated into climate change adaptation strategies, enhancing the resilience of coastal communities by combining traditional ecological knowledge with local adaptive capacity.
Required actors	DWS, Agriculture, LM, CMAs					
Sphere	Mainly LM and DM	All spheres	Mainly local	Mainly local	Mainly local	Local
Intervention category	Legal, spatial planning, capacity building, technical	Legal, spatial planning	Legal, capacity building, service provision, nature conservation	Capacity building	Service provision, spatial planning, capacity building	Service provision, spatial planning, capacity building
Coastal Element	Natural Environment A			səitinummoʻ) bns slqosq	

Appendices

Timeline						
llenge addressed	frastructure vulnerable to ents	do not provide protection the temperatures and to carbon emissions				
Need/cha	Coastal ini climate ev	Buildings of from extre contribute				
Intended outcome	Outcome 1: The coastal built infrastructure can withstand climate hazards such as floods, windstorms and erosion.	Outcome 2: Mitigation of the impact of extreme events on buildings and infrastructure has been implemented.	Outcome 3: Ensuring that coastal management lines are effective and implemented to deal with properties and infrastructure that is exposed to disasters.	Outcome 4: Built Environment Curriculum/ Standards/ Codes/ Engineering Guidelines/ solutions reviewed and updated to incorporate climate change considerations.		
Required actors						
Sphere	Mainly local	Mainly local	Local	Local		
Intervention category	Legal, technical, spatial planning, nature conservation	Technical, nature conservation, legal	Technical, nature conservation, legal	Technical, nature conservation, legal		
Coastal Element	Built infrastructure					

Timeline					
Need/challenge addressed	Lack of responsibility by industry regarding exploitation and degradation of natural economic resources	Exposure of workforce as industry assets to climate stressors reduces health and productivity	Uneducated consume behaviour leads to climate-unwise economies	Economic losses due to economic infrastructure vulnerability to climate impacts	Economies and enterprises cannot pro-actively prepare for dynamic climate situation
Intended outcome	Outcome 1: Natural resources on which coastal livelihoods and economies depend are used sustainably to secure their service provision.	Outcome 2: The work environment for work force in coastal industries enables effective work condition and provides protection from climate extreme events.	Outcome 3: Consumers and markets are educated and shaped towards products and services which are sustainable under a changing climate.	Outcome 4: Production and service delivery infrastructure can withstand climate impacts and contribute to climate mitigation.	Outcome 5: Coastal livelihoods and economies are cognisant of the dynamic nature of climate change and can respond timely.
Required actors	Enterprises	Enterprises	Economy and sectors	Enterprises	Enterprises, government academia
Sphere	Economy and sectors	Economy and sectors	Economy and sectors	Economy and sectors	Economy, national government
Intervention category	Legal compliance, technical	Technical and resources, EbA	Capacity building	Technical and resources, EbA	Capacity building
Coastal Element	γmonoɔs bnɕ sboońilsviJ				



Appendix 2: Detailed description of climate impacts on coastal environments in South Africa

The following sections provide deeper insights into the respective coastal ecosystem constraints in South Africa.

A2.1 Sandy beaches

Beach ecosystems support dune vegetation, animals, and sea birds, and provide nesting areas for marine turtles, and several key ecosystem services. In South Africa, rocky, mixed, and sandy shores are represented in equal proportions but vary regionally (Harris et al. 2011). Most of South Africa's shoreline is exposed and subject to strong wave action, except inside large log-spiral bays and for headlands that provide isolated areas of relative calm. Sandy beaches range between reflective and dissipative conditions. Reflective beaches comprise coarse sand, with steep and narrow intertidal zones, and narrow surf zones while dissipative beaches have fine sand, flat and wide intertidal zones, wide surf zones, and wave energy that dissipates on the beach face.

Sandy Beach ecosystems are physically dynamic, with sediment movement being a key driver of flora and fauna zonation (Harris et al. 2019). **However, under a changing climate, increased SLR, storminess, and wave energy will continue to erode coastal shorelines**, especially where sediment availability is low, and affect the soil accretion and land-based ecosystems. Built-up infrastructure and geological constraints reduce shoreline movement, causing coastal squeeze and morphological changes in sandy beaches.

Along with SLR and climate-driven intensification of waves and offshore winds, increased erosion rates suggest a reduced resilience due to insufficient sediment supply and accretion capacity (IPCC 2019). Consequently, narrow sandy beaches are particularly vulnerable to climate hazards when combined with human disturbances and where the landward retreat of beach profile and benthic organisms is constrained due to increasing urbanisation (Harris et al. 2019, IPCC 2019). Animals, such as turtles, which use sandy beaches during vulnerable parts of their life cycles, could be particularly impacted.

Beaches are expected to continue to reduce their extent and change their topography due to SLR and increased extreme climatic erosive events. This will be especially important in low-lying coastal areas with high population and infrastructure densities (IPCC 2019).

The observed increase of frequency and intensity of coastal storms, leading to more frequent disturbance and destruction of vegetation on sandy shores locally seems to lead to a permanent transformation of vegetation and habitats (Castelle et al. 2017, Delgado-Fernandez et al. 2019, Zinnert et al. 2019). Originally dense (backdune) vegetation is replaced by sparser (foredune) vegetation. The succession back to more stable and denser backdune vegetation is slow, especially if intense and frequent storm impacts persist, affecting associated fauna composition as well (Castelle et al. 2017, Kuriyama & Yanagishima 2018). Further, sandy beaches show patterns of biogeographical shifts following warming, with increased dominance of species more tolerant to higher temperatures (IPCC 2019).

A2.2 Rocky shores

Rocky shore ecosystems spanning the intertidal and shallow subtidal areas are typically dominated by calcareous mussels or seaweeds. Other organisms that inhabit rocky shores are coralline algae, polychaetes, crustaceans, molluscs, bryozoans, and sponges. Intertidal habitats are characterised by strong environmental gradients and are exposed to marine and atmospheric climate regimes (Hawkins et al. 2016).

South African rocky shores reflect a strong gradient from cold-temperate ecosystems in the west to subtropical ecosystems in the east (Branch & Branch 2018). From the west to the east, biomass on rocky shores decreases by about two-thirds, with a decline in nutrients and productivity (Bustamante et al. 1997), while species richness increases by an order of magnitude because of enhanced competition for more limited resources.

Climate change poses high risk to rocky shore ecosystems' biodiversity, structure and functioning through warming, acidification, SLR and extreme events (Agostini et al. 2018, Duarte and Krause-Jensen 2018, Ullah et al. 2018, Milazzo et al. 2019). Immobile intertidal organisms are especially vulnerable to warming, due to the potential for extreme heat exposure during low tide emersion and prolonged desiccation events (Hawkins et al. 2011, Zamir et al. 2018).

Extreme heat waves are also expected to cause mortality among rocky shore species (Gazeau et al. 2014, Jurgens et al. 2015) and subsequent declines or losses in important species can have cascading effects on the whole intertidal community and the services it provides.

Ocean acidification is expected to decrease the net calcification and abundance of rocky intertidal and reef-associated species (Kroeker et al. 2013). There is increasing evidence that the interactions between multiple climate drivers will determine species vulnerability, and the ecosystem impacts of climate change (Hewitt et al. 2016). Reductions in the abundance of calcareous herbivores that can create space for rarer species by grazing the dominant algae, are expected to contribute to the overgrowth of fleshy macroalgae on rocky shores (Baggini et al. 2015). This shift towards macroalgae is associated with a simplification of the food web at lower trophic levels (Kroeker et al. 2011, IPCC SROCC 2019).

A2.3 Estuaries

South Africa's National Biodiversity Assessment of 2018 defines an estuary as "a partially enclosed permanent water body, either continuously or periodically open to the sea on decadal time scales, extending as far as the upper limit of tidal action, salinity penetration or back-flooding under closed mouth conditions". South Africa has 290 estuaries and 42 micro-estuaries which have been classified into 22 estuarine ecosystems and 3 micro-estuary types. This high diversity of estuary types reflects the country's diverse climatic, oceanographic and geological drivers.

Estuaries are "super" ecosystems. Although they comprise less than 2% of South Africa's territory, these highly productive ecosystems contribute R4.2 billion per annum to the South African economy (Van Niekerk et al. 2019). They are focal points for development, tourism and recreation, as well as important for supporting biodiversity, livelihoods and marine fisheries.

Estuaries are strongly influenced by land, coastal and atmospheric processes. A recent regional-scale vulnerability assessment based on the physical characteristics and predicted/measured changes in the abiotic drivers and ecosystem responses highlighted a range of response to future climate conditions (Van Niekerk et al. 2022).

The major climate change stressors were identified in order of importance as change in (Van Niekerk et al 2022):

- Land climatic/hydrological processes forcing changes in freshwater inflow and associated inputs; shifts in the frequency and duration of estuary mouth closure; modifications in salinity regimes; changes in biochemical inputs; changes in sediment deposition/erosion cycles including accumulation of POM; and changes in contaminant behaviour and accumulation.
- Ocean circulation patterns resulting in shifts in temperature regimes and coastal connectivity.
- Sea level rise and related impact on salinity regime, mouth state and inundation of flood plain.
- Increase in frequency and intensity of coastal storms also impacts salinity regimes and mouth state.
- Coastal acidification amplifies existing pH fluctuations and oceanic phases of estuarine species.

Overall, this analysis showed that KZN and West Coast estuaries will be the most influenced by Climate Change from a structural and functional perspective (Van Niekerk et al. 2022). In KZN, the major driver of change is increased runoff into the numerous small, perched temporarily open/

closed estuaries, resulting in more open mouth conditions, a decrease in retention time and a related decrease in primary productivity and nursery function. Increased occurrence of large floods is also likely to cause frequent resetting of abiotic and biotic processes, potentially disrupting productivity and impacting species with complex life cycles. While the KZN estuarine lakes will be sensitive to increased drought conditions and reduced groundwater input leading to reduced connectivity in the form of mouth closure. Similarly to KZN, West Coast estuaries will also experience a decline in primary production and loss of nursery function, but because of reduced freshwater input, whilst Wild Coast, Eastern and Southern Cape estuaries will show some shifts in mouth state, nutrient supply, salinity regime and ultimately production. The most obvious impacts of Climate Change along warm temperate coastal regions will be the temperature change (nearshore and land), associated species range expansions/contractions and changes in community structure.

The effect of sea level rise, and related increase in tidal prisms, will be less apparent along the KZN coastline, where except for estuarine lakes and bays, many estuaries are perched and incised, whilst it will be more apparent along the Southern and Western Cape coast with their more extended coastal floodplains. The effects of ocean acidification in the short term will be negligible in comparison with the land signal (e.g., eutrophication resulting from urban runoff and agricultural return flow). Systems subjected to regular upwelling or increased upwelling, e.g., along the West Coast are likely to display the effects of ocean acidification first, especially those species with oceanic phases in their life cycles. South Africa is a wave-dominated coast sensitive to increased sea storminess. However, highly protected (e.g., Wild Coast) or very exposed (along the KwaZulu-Natal) estuaries are less likely to change character, whereas smaller estuaries along the Western, Southern and Eastern Cape may be very sensitive to the increase in frequency in this type of event.

Only 22% of the total estuarine extent are in a healthy state, comprised mostly of small estuaries. The estuarine realm is the most threatened of all realms in South Africa. Accelerated Climate Change is one of many pressures acting on estuaries and should be viewed as an additional form of anthropogenic stress in an already stressed ecosystem. For example, the interaction between warming, increased nutrient loading, and hypoxia has shown to be related to the increased occurrences of harmful algal bloom. Estuaries with poor water quality will thus have little climate resilience in the future. It is thus necessary to understand the potential amplification of variability that Climate Change may have on existing freshwater resources, the potential impact on estuarine and marine production, as well as the harvesting of resources in the marine and estuarine environments. It is thus necessary to integrate Climate Change and non-Climate Change threats. Climate Change should be seen as a catalyst to fasttrack sustainable resource allocation processes, e.g., allocations of environmental flows (Bunn 2016).

A2.4 Blue carbon ecosystems (salt marshes, mangroves and seagrass)

Salt marshes, seagrass beds, and mangroves are examples of "Blue Carbon" ecosystems (BCE) (Nellemann et al. 2009). These habitats provide important ecological services, such as sequestering and storing of carbon, thus contributing to Ecosystem-based climate mitigation (EbM). Longterm carbon sinks are created when carbon is trapped in blue carbon environments, where it can remain for thousands of years (McLeod et al. 2011, Howard et al. 2014).

These habitats are mainly found in protected estuaries along South Africa's energetic coastline. Salt marshes, seagrass beds, and mangroves are some of South Africa's key sources of Blue Carbon. Of all the Blue Carbon Habitats in South Africa, salt marsh has the biggest areal extent at 14 995 ha (Adams 2020), followed by mangroves at 2 087 ha (Raw et al. 2021, Raw et al. 2023) and seagrasses at 1 100-1 300 ha (Adams 2016). Despite their significance in the past, they have been put to other uses and are currently under high pressure from human activity. Blue carbon habitats exhibit comparable trends to the coast, with more than twice the proportion of modified habitat in the coastal zone compared to the rest of the country, with almost half (47%) of the coastal extent in a modified state compared to only a fifth (20%) of the rest of South Africa (Harris et al. 2019).

Appendices

Climate change threatens Blue Carbon habitats and their Carbon stocks through sea-level rise, increased droughts and storms at subtropical latitudes and warmer temperatures. Mangroves and salt marsh require gently sloping topography, low wave energy and high sediment supply while sea-level rise controls the accommodation space as these estuarine habitats require sediment deposition and landward movement of the intertidal zone to persist (Rogers et al. 2023). Due to increased inundation brought on by sea level rise and higher wave energy, the lowest intertidal zones may disappear because of drowning and erosion (Grenfell et al. 2016, Spencer et al. 2016).

For Blue Carbon habitats in South Africa, climate change impacts are intricately linked with direct anthropogenic pressures. As the estuaries are small, there is limited potential for resilience or adaptation capacity. Natural stressors are expected to be altered by climate change, thus threatening BCEs over a range of spatial extents and temporal periods. A more robust understanding is needed of how climate change will affect coastal wetlands so that realistic and achievable management and conservation strategies can be implemented.

A2.5 Teal Carbon habitats (reeds, sedges and swamp forests)

Teal Carbon habitats consist of reeds, sedges, and swamp forests in South Africa. They occur in the freshwater and brackish zones of estuaries and can indicate sites of freshwater seepage sites along estuaries. Reeds and sedges cover an area of 17 654.9 ha (Raw et al. 2021); they are the most extensive habitat type in South African estuaries. These plants provide an important habitat for many birds, fish, and invertebrate species. When the plants die-back and decompose there is a peak in organic load and released particulate matter into the water.

Swamp forests occur in the fresher upper reaches of estuaries but typically occur in some estuarine lakes and temporarily closed estuaries where the connection to the sea is weak and the estuary mouth closes under low river flow and high coastal wave conditions (Van Niekerk et al. 2019). About 3 430.5 ha swamp forest occurs within estuaries (about ~30 of the total habitat distribution). These ecosystems are suggested as Critically Endangered in South Africa with increasing groundwater pressures resulting in high rates of transformation, despite 67% of their extent occurring in protected areas.

Rising sea levels can lead to an increase in salinity and inundation in teal carbon habitats, affecting species composition and ecosystem functioning. Similarly, predicted increased extreme rainfall events, especially on the KZN coast, can affect connectivity conditions of estuaries and reduce salinity, again affecting species composition and ecosystem functioning. A warming climate will lead to a shift in species composition towards more warm-adapted species.

A2.6 Kelp forests

In South Africa, kelp forests occur on the west coast and south coast with De Hoop being the most eastward extension. Kelp forests occur in temperate to cool waters. Three kelp forest ecosystem types are recognised in South Africa: Agulhas, Cape, and Namaqua Kelp Forest (Sink et al. 2023). Kelp forests comprise four species of large brown macroalgae, with the two common species, Sea Bamboo (Ecklonia maxima) and Split-fan Kelp (Laminaria pallida) being the species of economic significance in South Africa (Blamey & Bolton 2018). Kelp forests are dense submerged forests with floating canopies growing at depths between 5 to 30 m. Kelp forests are important habitat formers that support a range of fish, crustaceans, and molluscs communities, and serve as important nursery areas for a variety of species. Economically important species such as abalone and crayfish depend on kelp forests. Kelp forests link coastal ecosystems through exports of nutrients, e.g. by providing sandy beach invertebrates with valuable nutrient inputs when washed up as kelp wrack (Koop et al. 1982). Kelp forests also provide a myriad of important ecosystem services to people, ranging from commercial to recreational values (Blamey & Bolton 2018, Wernberg et al. 2019).

New global estimates show that the abundance of kelp forests has decreased at a rate of ~2% per year over the past half-century (Wernberg et al. 2016, 2019), mainly due to ocean warming and marine heat waves, as well as from other human stressors (Filbee-Dexter & Wernberg 2018). Because of the warming oceans, kelp forests are observed to be retreating into cooler coastal regions. However, in South Africa, kelp forest is expanding their range towards the warmer east, due to regional inshore cooling trends (Sink et al. 2019). Anthropogenic-driven environmental changes such as coastal eutrophication and pollution are causing severe deterioration of kelp forests globally adding to the loss of these ecosystems from warming, storms, and heat weaves (Filbee-Dexter & Wernberg 2018). Since kelp supports other ecosystem components by providing food, substrate for spawning and habitat that mediate trophic interactions, its degradation reduces species richness, biomass production and dependent flora and fauna species. Loss of kelp forests is followed by the colonisation of turfs, which contributes to the reduction in marine habitat complexity, loss of carbon storage.

At present, carbon storage by kelp forests is not considered a permanent ecosystem service as carbon bound by algae gets released in various forms rather than being stored within the sediment.

A2.7 Coral reefs

Coastal reef ecosystem types in South Africa include coral communities, reef complexes, and reef mosaics (Harris et al. 2019, Sink et al. 2023). Coral ecosystem types are reaching the southern limit of their distribution on South Africa's Western Indian Ocean coast and are protected in iSimangaliso Wetland Park. They comprise algae and zooxanthellate corals, particularly soft corals (Porter et al. 2013, Schleyer & Porter 2018), supporting sharks, rays, fish, cetaceans, sea turtles, and a plethora of invertebrate communities. Thus, they provide important ecosystem services and play an essential role in ecotourism in the area (Walters & Samways 2001, Laing et al. 2020). They also provide essential habitat for economically important shellfish (e.g. oysters, abalone, alikreukel), rock lobsters, and fish, including many line fish species that support food, livelihoods, and cultural identity.

Globally human activities and warming have already led to major impacts on shallow-water coral reefs causing species replacement, bleaching, and decreased coral cover (IPCC 2019).

Ocean warming and acidification enhance reef dissolution and bioerosion, affecting coral species distribution, and leading to community changes (Agostini et al. 2018, Gunderson et al. 2017). Coral reefs are also at risk from enhanced storm intensity, increased turbidity, and runoff from the land. Recovery of coral reefs resulting from repeated disturbance events is slow (Hughes et al. 2019, Ingeman et al. 2019). Warming, ocean acidification and climate hazards will put corals at very high risk even if global` warming can be limited to 1.5°C above pre-industrial level.

Globally coral reefs are projected to decline by 70–90 % at 1.5°C with larger losses (>99%) at 2°C, with substantial changes in the composition and structure of the remaining coral reefs, with large regional differences (IPCC 2019). Alteration of composition of coral reef associated biota is exacerbated by changes in habitat conditions through increased sedimentation and nutrient concentrations from human coastal activities (Fabricius 2005).

Appendix 3: International obligations, national legislation and policies relevant to coastal management

A3.1 Important international obligations and agreements adapted from Taljaard et al. (2019)

International obligation/agreement	Short description
Agenda 2030 (2015)	This agenda is a plan of action for people, planet, and prosperity. It also seeks to strengthen universal peace in larger freedom with goals and targets aimed at stimulating action in areas of critical importance for humanity and the planet (as expressed in the sustainable development goal – SDGs) (2015-2030).
Agenda 2063: The Africa we want (2015)	This agenda is Africa's blueprint and strategy for transforming the continent into a future global powerhouse by 2063. It provides for a shared strategic framework for inclusive growth and sustainable development with a global strategy to optimize the use of Africa's resources for the benefit of all Africans, including Africa's port environments.
International Convention for the Regulation of Whaling (1946)	This Convention provides for the conservation of whale stocks and makes possible the orderly development of the whaling industry.
International Convention for the Conservation of Atlantic Tunas (ICCAT) (1966)	The Convention provides for the conservation of tunas and tuna-like species in the Atlantic Ocean.
Civil Liability Convention (1969) as replaced by its 1992 Protocol and amended in 2000	The Convention provides for adequate compensation to persons who suffer oil pollution damage resulting from maritime casualties involving oil-carrying ships, placing the liability for such damage on the owner of the ship from which the polluting oil escaped or was discharged.
Convention on Wetlands of International Importance especially as Waterfowl Habitat (1971) (Ramsar Convention)	The Ramsar Convention promotes wise use of all wetlands and to prevent loss (includes estuaries and coastal lakes in its definition of wetlands).
Convention Concerning the Protection of the World Cultural and Natural Heritage (1972) (World Heritage Convention)	This Convention holds state party to recognising the duty of ensuring the identification, protection, conservation, presentation, and transmission to future generations of the cultural and natural heritage situated in its territory (which may include estuaries).
Convention on the Prevention of Marine Pollution by Dumping of Waste and Other Matter (1972, as amended) (London Convention)	The Convention (and its Protocol) is an international treaty that limits the discharge of waste that are generated on land and disposed of at sea. The 1996 Protocol is a separate agreement that modernised and updated the London Convention, following a detailed review that began in 1993. In 1996 Protocol replaced the London Convention.
Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) (1973)	CITES provides for the protection of endangered plants and animals, including marine organisms. It also governs the trade in critically endangered and endangered species such as seahorses, eels, hard corals, abalone, and great white sharks.
International Convention for the Prevention of Pollution from Ships (MARPOL) (1973/1978)	The Convention is the main international convention covering prevention of pollution of the marine environment by ships from operational or accidental causes. It is a combination of two treaties adopted in 1973 and 1978 respectively and updated by amendments through the years. The Convention includes regulations aimed at preventing and minimising pollution from ships and includes various technical annexes.
Convention of Migratory Species of Wild Animals (1979) (Bonn Convention)	The Convention provides for cooperation of nations in the conservation of animals that migrate across their borders. These include terrestrial mammals, reptiles, marine species, and birds.
Abidjan Convention (1981)	These regional Conventions were developed as part of the United Nations Environment Programme's
Nairobi Convention (1985)	Regional Seas Programme to improve the control of marine pollution and management of marine and coastal resources (including estuaries) in countries of the West and Central African region (Abidjan Convention) and the Eastern African or West Indian Ocean region (Nairobi Convention).

International obligation/agreement	Short description
United Nations Convention on the Law of the Sea (UNCLOS) (1982)	The Convention provides for regulation by the international community of all aspects of the resources of the sea and its uses, such as navigational rights, territorial sea limits, economic jurisdiction, legal status of resources on the seabed beyond the limits of national jurisdiction, passage of ships through narrow straits, conservation and management of living marine resources, protection of the marine environment, a marine research regime and, a more unique feature, a binding procedure for settlement of disputes between States.
International Convention on Salvage (1989)	The Convention provides for matter relating to marine salvage, which is the recovering a ship and its cargo after a shipwreck or other maritime casualty.
Southern African Developing Countries (SADC) Protocol on Fisheries (1992)	The Protocol promotes responsible and sustainable use of the living aquatic resources and ecosystems of interest to state parties in order to promote and enhance food security and human health, safeguard the livelihood of fishing communities, to generate economic opportunities for nationals in the region, to ensure that future generations benefit from these renewable resources and to alleviate poverty with the ultimate objective of its eradication.
Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal (1992) (Basel Convention)	The Convention provides for the reduction of the production of hazardous waste and the restriction of transboundary movement and disposal of such waste. It also aims to ensure that any transboundary movement and disposal of hazardous waste, when allowed, is strictly controlled, and takes place in an environmentally sound and responsible way.
United Nations Framework Convention on Climate Change (1992)	The Convention sets an "ultimate objective' by stabilising greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system, considering in such matters as agriculture, energy, natural resources, and activities involving seacoasts.
United Nations Convention on Biological Diversity (1993)	The Convention provides for the conservation of biological diversity, the sustainable use of biological resources and the fair and equitable sharing of benefits arising from the use of genetic resources.
Global Programme of Action for the Protection of the Marine Environment from Land-based Activities (GPA) (1995)	The international programme aids states in taking action, individually or jointly, within their respective policies, priorities and resources, that will lead to the prevention, reduction, control or elimination of the degradation of the marine environment, as well as to its recovery, from the impacts of land-based activities (including pollution and developments/activities leading to the destruction of marine habitat). The Regional Seas Programme of UNEP is used as framework for delivery of this programme at regional level.
Code of Conduct for Responsible Fisheries (1995)	The Code takes cognisance of the state of world fisheries and aquaculture and proposes actions towards implementing fundamental changes within the fisheries sector to encourage the rational and sustainable utilisation of fisheries and aquaculture. The Code is a voluntary instrument rather than a legally binding international agreement.
Convention on the Conservation and Management of Fishery Resources in the Southeast Atlantic Ocean (2001)	The Convention provides for long-term conservation and sustainable use of fish stocks other than highly migratory stocks found in areas of the Southeast Atlantic beyond the limits of national jurisdiction.
International Convention for the Control and Management of Ships' Ballast Water and Sediments (2004)	The Convention provides for control and reduced transfer of harmful aquatic organisms and pathogens in ships' ballast water.
Paris Agreement (2015)	This agreement is a legally binding international treaty on climate change that was adopted by 196 Contracting Parties at the 21st United Nations Climate Change Conference held in 2015, with the aim of limiting global warming to well below 20C compared with pre-industrial levels and to pursue efforts to limit this increase even further to 1.50C
Sothern African Development Community (SADC) Protocol on Wildlife Conservation and Law Enforcement (Wildlife Protocol) (1999)	The Protocol aims to establish a common framework for conservation and sustainable use of wildlife in the region.
Protocol on Shared Watercourses in the SADC (Watercourse Protocol) (2000)	The Protocol aims to foster closer cooperation for judicious, sustainable, and coordinated management, protection and utilisation of shared watercourses and advance the SADC agenda of regional integration and poverty alleviation.
SADC Protocol on Fisheries (2006)	The Protocol aims to support national initiatives taken and international conventions for the sustainable use and protection of the living aquatic resources and aquatic environment of the region

A3.2 Key national legislation (Acts) adapted from Taljaard et al. (2019)

Sector	Act	Lead agent	Short description
rvation	National Environmental Management: Biodiversity Act (Act 10 of 2004)	Environment	The Act gives legal status to Convention on Biological Diversity, Convention on Wetlands of International Importance especially Waterfowl Habitat (Ramsar Convention) and Convention on Migratory Species (Bonn Convention). It provides for the conservation of biological diversity and regulates the sustainable use of biological resources and to ensure a fair and equitable sharing of the benefits arising from the use of genetic resources. According to the Act the state is the custodian of South Africa's biological diversity and is committed to respect, protect, promote, and fulfil the constitutional rights of its citizens.
	National Environmental Management: Protected Areas Act (No. 57 of 2003)	Environment	The Act provides for the protection and conservation of ecologically viable areas representative of South Africa's biological diversity and its natural landscapes and seascapes, the establishment of a national register of all national, provincial, and local protected areas and for management of those areas in accordance with national norms and standards.
Cons	Marine Living Resources Act (Act 18 of 1998, as amended in 2000)	Fisheries (delegated to Environment)	The Act provides for the declaration of marine protected areas to facilitate fisheries management by protecting spawning stock, allowing stock recovery, enhancing stock abundance, and providing pristine communities for research. These functions are currently delegated to Department responsible for Environment.
	National Parks Act (No. 57 of 1976)	Environment (through South African National Parks)	The Act provides for the establishment of National Parks. National Park status establishes the strongest claim to permanent protection that is possible. Areas above and below the intertidal zone may be included in a National Park.
	Sea Bird and Seal Protection Act (No. 46 of 1973)	Environment	The Act governs the protection and control of the capture, killing and products produced from seabirds and seals. Parts of this act has now been repealed under the Marine Living Resources Act (Act 18 of 1998).
	Marine Living Resources Act (Act 18 of 1998, as amended in 2000)	Fisheries (delegated to Environment)	The Act provides for control of tourism activities related to marine living resource (e.g. sharks, whales, and dolphins). This includes the control of fishing activities and appointment of harbour masters in the small fishing harbours.
ourism	Sea Bird and Seal Protection Act (No. 46 of 1973)	Environment	The Act governs the protection and control of the capture, killing and products produced from seabirds and seals. Parts of this act has now been repealed under the Marine Living Resources Act (Act 18 of 1998).
Ţ	National Health Act (No. 61 of 2003)	Health &t Municipalities	The Act delegates responsibility for environmental health to metropolitan and district municipalities, where these organs of state must ensure that appropriate municipal health services are effectively and equitably provided in their respective areas. These include (as far as it influences human health, except in ports) water quality monitoring, waste management and environmental pollution control.
Heritage	World Heritage Convention Act (No. 49 of 1999)	Environment	The Act provides for the incorporation of the World Heritage Convention into South African Law, as well as for recognition and establishment of world heritage sites and related authorities The Act acknowledging the urgent national need for development and poverty alleviation. The Act requires government to find innovative and effective ways of combining the conservation of South Africa's extraordinary endowment of natural resources with wealth-creating sustainable economic development. iSimangaliso Wetland Park was entered on the World Heritage List in 1999.
	National Heritage Resources Act (No. 25 of 1999)	Environment (through South African Heritage Resources Agency)	The Act provides for an integrated and interactive system for the managements of national heritage resources (which include landscapes and natural features of cultural significance), providing opportunity for communities to participate in the identification, conservation, and management of cultural resources. Anyone who intends to undertake a development must notify the heritage resources authority and if there is reason to believe that heritage resources will be affected, an impact assessment report must be compiled at the developer's cost.
Water	National Water Act (No. 36 of 1998)	Water	This Act ensures protection of the aquatic ecosystems of South Africa's water resources, including estuaries and groundwater. It requires establishment of resource quality objectives, i.e. specifying targets for freshwater inflow, water quality, habitat integrity, biotic composition, and functioning requirements. The act does not recognise the coastal or marine environment as a receiving environment or water resource in need of an allocation.
	Water Services Act (No. 108 of 1997)	Water & Sanitation	This Act amongst other matters provides for right of access to basic water supply and basic sanitation necessary to secure sufficient water and an environment not harmful to human health or well-being. Management and control of water services, in general, including water supply and sanitation.

Sector	Act	Lead agent	Short description
	Climate Change Act (No. 22 of 2024)	Environment	The Act enables the development of an effective climate change response and a long- term, just transition to a low-carbon and climate-resilient economy and society for South Africa in the context of sustainable development
Urban and spatial development	Disaster Management Act (No. 57 of 2002)	Cabinet	The Act provides for an integrated and co-ordinated disaster management policy that focusses on preventing or reducing the risk of disasters, mitigating the severity of disasters, emergency preparedness, rapid and effective response to disasters and post-disaster recovery; the establishment of national, provincial and municipal disaster management centres; disaster management volunteers; and matters incidental thereto. The act also governs artificial breaching of estuary mouths in urban settings once approval have been granted under the National Environmental Management Act (No. 107 of 1998).
	Local Government: Municipal Systems Act (Act 32 of 2000)	Provincial and Local Government	The Act provides for integrated development planning (which municipalities are obliged to prepare and to update regularly) intended to encompass and harmonise planning over a range of sectors such as water, transport, land use and environmental management.
	Spatial Planning and Land Use Management Act (No. 16 of 2013)	Rural Development and Land Reform	The Act provides for a framework to govern planning permissions and approvals, sets parameters for new developments, and provides for different lawful land uses.
	National Environmental Management Act (No. 107 of 1998)	Environment	The Act amongst other matters provides that sensitive, vulnerable, highly dynamic, or stressed ecosystems require specific attention in management and planning procedures, especially were subjected to significant human resource usage and development, through mandating EIAs for specific listed activities.
	Marine Spatial Planning Act (No. 16 of 2018)	Environment	The Act provides South Africa's framework for marine spatial planning (MSP) and for the development of marine spatial plans and for the institutional arrangements required for governance and implementation
	National Environmental Management: Integrated Coastal Management Act (No. 24 of 2008)	Environment	The Act amongst other matters ensures that development and the use of natural resources within the coastal zone is socially and economically justifiable and ecologically sustainable.
	National Buildings Regulations and Building Standards Act (No. 103 of 1977, as amended)	Economic Affairs and Technology	The Act provides for promotion of uniformity in the law relating to the erection of buildings in municipal areas, including coastal areas.
	Conservation of Agricultural Resources Act (No. 43 of 1983)	Agriculture	The Act provides for conservation of the natural agricultural resources in South Africa through for example, combating and preventing erosion and weakening or destruction of water sources, and the protection of the vegetation and the combating of weeds and invader plants.
	Conservation of Agricultural Resources Act (No. 43 of 1983)	Agriculture	The Act provides for conservation of the natural agricultural resources in South Africa through for example, combating and preventing erosion and weakening or destruction of water sources, and the protection of the vegetation and the combating of weeds and invader plants.
lution	National Environmental Management: Integrated Coastal Management Act (No. 24 of 2008)	Environment	The Act gives legal status to South Africa's international obligations related to coastal matters. It stablishes a system of integrated coastal and estuarine management in South Africa to promote the conservation of the coastal environment and maintain the natural attributes of coastal landscapes and seascapes, and to ensure that development and the use of natural resources within the coastal zone is socially and economically justifiable and ecologically sustainable. It defines rights and duties in relation to coastal
and-based p			areas and determines the responsibilities of organs of state in relation to coastal areas. It prohibits incineration at sea, and controls dumping at sea, land-based pollution in the coastal, inappropriate development in coastal environment and other adverse effects on the coastal environment.
L	National Environmental Management: Waste Act (No. 59 of 2008)	Environment	The Act regulates (solid) waste management to protect health and the environment by providing reasonable measures for the prevention of pollution and ecological degradation and for securing ecologically sustainable development, as well as governance of thereof.

Sector	Act	Lead agent	Short description
	National Environmental Management: Air Quality Act (No. 39 of 2004)	Environment	The Act regulates air quality in South Africa to protect the environment by providing reasonable measures for the prevention of pollution and ecological degradation and for securing ecologically sustainable development while promoting justifiable economic and social development and governance therefor.
E	Conservation of Agricultural Resources Act (No. 43 of 1983)	Agriculture	The Act provides for conservation of the natural agricultural resources in South Africa through for example, combating and preventing erosion and weakening or destruction of water sources, and the protection of the vegetation and the combating of weeds and invader plants.
Land-based pollutior	National Water Act (No. 36 of 1998)	Water	The Act (section 21) identifies certain land uses (e.g. activities resulting in stream-flow reduction such as afforestation and cultivation of crops), infrastructural developments (e.g. altering the bed, banks, course or characteristics of a watercourse), water supply/demand and waste disposal (from land-based activities) as 'water uses' that require authorisation (licensing).
	Hazardous Substances Act (No. 15 of 1973)	Health	The Act provides for the control of substances which may cause injury or ill health to, or death, of human beings by reason of their toxic, corrosive, irritant, strongly sensitising or flammable nature. Also, it provides for the prohibition and control of the importation, manufacture, sale, use, operation, application, modification, disposal or dumping of such substances and products.
	National Ports Act (No. 12 of 2005)	Transport (through National Port Authority)	The Act provides for management of commercial ports, including environmental matters.
_	Government Immovable Asset Management Act (No. 19 of 2007)	Public Works	The Act provides for the maintenance and repairs of infrastructure in proclaimed fishing (or small) harbours along the coast (also other coastal land and properties owned by the state). However, the control of fishing activities and appointment of harbour masters falls under the Marine Living Resources Act (Act 18 of 1998, as amended in 2000).
	Marine Living Resources Act (Act 18 of 1998, as amended in 2000)	Fisheries	The act regulates the control of fishing activities (e.g. selling of fish, compliance management) and appointment of harbour masters in the small fishing harbours.
	South African Maritime Safety Authority Act (Act 5 of 1998)	Transport	The Act provides for the establishment and functions of the South African Maritime Safety Authority (SAMSA)
hipping	Maritime Zone Act (No. 15 of 1994)	Transport	The Act provides for the demarcation of maritime zones of the Republic (e.g. internal waters, territorial waters, contiguous zone, maritime cultural zone, exclusive economic zone, continental shelf) and to provide for matters relating to installations, maritime casualties, and self-defence.
Port and Shi	International Convention for Prevention of Pollution from Ships Act (No. 2 of 1986)	Transport	The Act gives legal effect to MARPOL in South Africa, as well as Annex I (regulations on oil) and Annex II (regulations on noxious liquid substances in bulk) of the Convention.
	Marine Traffic Act (No. 2 of 1981)	Transport	The Act regulates marine traffic in South Africa and provides for matters such as regulating ship traffic and the stopping or anchoring of ships outside fishing harbours and the sinking and abandoning of ships.
	Marine Pollution (Control and Civil Liability) Act (No. 6 of 1981)	Transport (prevention) and Environment (combating)	The Act provides for the protection of the marine environment from pollution by oil and other harmful substances, the prevention and combating of such pollution; as well as the determination of liability in certain respects for loss or damage caused by the discharge of oil from ships, tankers, and offshore installations. It prohibits the discharge of oil from ships, tankers, and offshore installations, but provides exemptions in the case of, for example, the oil being released as a result of damage and steps being taken as soon as practicable to stop or reduce the escape of oil.
	International Health Regulations Act (No. 28 of 1974)	Ports Authority	The Act requires seaports to be provided with a system for the removal and disposal of excrement, refuse, wastewater, condemned food and other matter dangerous to health.
	Wreck and Salvage Act (No. 94 of 1996)	Transport	The Act provides for the salvage of certain vessels and for the application and incorporates requirements of International Convention on Salvage.

Sector	Act	Lead agent	Short description	
Fisheries and Aquaculture	Marine Living Resources Fisheries Act (Act 18 of 1998, as amended in 2000)		The Act governs the utilisation, conservation and management of marine living resources which includes any aquatic plant or animal, and any mollusc, crustacean, coral, sponge, holothurian, or other echinoderm, reptile, and marine mammals (all life stages), except sea birds and seals. Currently orderly control and development of marine aquaculture is also regulated under this Act (sections 18 and 27).	
	Foodstuffs, Cosmetics and Disinfectant Act (No. 54 of 1972)	Health	The Act regulates the limits of chemical and microbiological constituents in the flesh of different marine organisms used for human consumption.	
Mining and petroleum exploration	Mineral and Petroleum Resources Development Act (No. 28 of 2002)	Mineral Resources	The Act, in addition to regulating mining and petroleum resource exploitation, also regulates environmental protection and management of mining impacts, including sand, diamond, heavy minerals, phosphate, manganese, oil and gas in coastal and marine environments. It requires environmental management programmes (EMPs) that must identify environmental impacts, based on and EIA, and must provide a clear programme on how these will be managed. To ensure compliance with environmental issues, the act requires consultation with relevant departments charged with administration of any law that relates to any matter affecting the environment before approval of EMPs.	

A3.3 Important policies, regulations and guidelines adapted from Taljaard et al. (2019)

Sector	Act	Important policies, regulations and guidelines
Conservation	National Environmental Management: Biodiversity Act (2004)	Guidelines regarding the determination of bioregions and the preparation of and publication of bioregional plans (Government Gazette, 16 March 2009)
		South Africa's National Biodiversity Strategy and Action Plan (2015 – 2025) (July 2015)
		Alien and invasive species Regulations (Government Gazette, 1 August 2014)
		Threatened and protected species marine Regulations (Government Gazette, 30 May 2017)
	National Environmental Management: Protected Areas Act (2003)	Guidelines for offshore marine protected areas in South Africa (2008)
		National Protected Areas Expansion Strategy (NPAES), currently in the process of being revised with revised strategy in commenting phase (2008)
	National Water Act (1998)	Water Resource Protection and Assessment Policy Implementation Process. Resource Directed Measures for protection of water resources: Methodology for the Determination of the Ecological Water Requirements for Estuaries. Version 2 (2008)
	Marine Living Resources Act (1998)	Regulations for the management of boat-based whale watching and protection of turtles (Government Gazette, 4 July 2008)
		Regulations for the management of white shark cage diving (Government Gazette, 4 July 2008)
E		Policy on white shark cage diving (Government Gazette, 31 May 2017)
Tourisn	National Environmental Management: Biodiversity Act (2004)	Policy on boat-based whale and dolphin watching (Government Gazette, 31 May 2017)
	National Health Act (2003)	South African water quality guidelines for coastal marine waters. Volume 2: Recreational use (March 2012)
	Sea Bird and Seal Protection Act (1973)	Policy on the management of seals, seabirds, and shorebirds (Government Gazette, 7 December 2007)
Heritage	World Heritage Convention Act (1999)	Regulations in connection with the Greater St Lucia Wetland Park (Government Gazette, 24 November 2000)
	National Heritage Resources Act (1999)	National Heritage Resources Act Regulations (Government Gazette, 2 June 2000)
Water	National Water Act (1998)	National Water Resources Strategy. 2nd Edition (June 2013, as reviewed in Government Gazette, 16 August 2013)
		Regulations for establishment of the classification systems (Government Gazette, 17 September 2010)
		Regulations on use of water for mining and related activities aimed at protection of water resources (Government Gazette, 4 June 1999)
		Regulations requiring that the taking of water for irrigation purposes be measured, recorded, and reported (Government Gazette 17 February 2017)
		Water use licence and appeals Regulations (Government Gazette (24 March 2017)
	Water Services Act (1997)	Regulations relating to compulsory national standards and measures to conserve water (Government Gazette, 8 June 2001)

Sector	Act	Important policies, regulations and guidelines
Urban and spatial development	Climate Change Act (No. 22 of 2024)	National Climate Change Adaptation Strategy (November 2019)
	Disaster Management Act (2002)	Disaster management policy framework (Government Gazette, 29 April 2005)
		Guidelines on the development and structure of a disaster management plan (Government Gazette, 26 May 2017)
	National Environmental Management: Integrated Coastal Management Act (No. 24 of 2008)	National Estuarine Management Protocol (Government Gazette, 10 May 2013)
		Guidelines for Development and Implementation of Estuarine Management Plans in terms of National Estuarine Management Protocol (March 2015)
		National Strategy for the facilitation of coastal access (March 2014)
		National guidelines National Guideline Towards the Establishment of coastal management lines (August 2017)
	Local Government: Municipal Systems Act (2000)	Local government: Municipal planning and performance management Regulations (Government Gazette, 24 August 2001)
	Spatial Planning and Land Use Management Act (2013)	Regulations in terms of the Spatial Planning and Land Use Management Act (Government Gazette, 23 March 2015)
		Eastern Cape Spatial Development Framework (Draft 2019)
		Eastern Cape Provincial Development Plan 2030
	National Environmental Management Act (1998)	Environmental Impact Assessment Regulations (Government Gazette, 4 December 2014)
	National Buildings Regulations and Building Standards Act (1977)	Guidelines for human settlement planning and design (Red Book) (2000, under review)
		National Building Regulations and the application of the National Building Regulations (SANS10400)
	National Environmental Management: Integrated Coastal Management Act (2008)	Guidelines for the assessment of wastes or other material that may be considered for dumping at sea (Schedule I of ICM Act)
		National Guideline for the Discharge of Effluent from Land-based Sources into the Coastal Environment (2014)
		National Action List: Screening of dredged material proposed for marine disposal (2012)
		South African water quality guidelines for coastal marine waters: Natural Environment & Mariculture (1995, under revision)
		Coastal Waters Discharge Permit Regulations (Government Gazette, 15 March 2019)
		General authorisation in terms of Section 69(2) of ICM Act (coastal discharges)
	National Environmental Management: Waste Act (2008)	Guideline for the development of Integrated Waste Management Plans (IWMP)
ution		National Waste Management Strategy (November 2011)
and-based pollu		Waste classification and management Regulations (Government Gazette, 23 August 2013)
	National Environmental Management: Air Quality Act (2004)	List of activities which result in atmospheric emissions which have or may have a significant detrimental effect on the environment, including health, social conditions, economic conditions, ecological conditions, or cultural heritage (Government Gazette, 31 March 2010)
-		National Dust Control Regulations (Government Gazette, 1 November 2013)
		National pollution prevention plans Regulations (Government Gazette, 21 July 2017)
		National framework for air quality assessment in the Republic of South Africa (Government Gazette, 26 October 2018)
	Conservation of Agricultural Resources Act (1983)	Regulations: Conservation of agricultural resources (Government Gazette, 25 May 1984, as amended)
	National Water Act (1998)	Revision of general authorisation in terms of section 39 of the National Water Act (Government Gazette, 6 September 2013) (estuaries)
	Hazardous Substances Act (1973)	Hazardous substances Regulations (Government Gazette, 25 March 1977)

Appendices

Sector	Act	Important policies, regulations and guidelines
Port and Shipping	National Ports Act (2005)	National Safety, Health and Environmental Corporate Requirements for commercial Ports (http://www.transnetnationalportsauthority.net/DoingBusinesswithUs/SafetyHealthEnvironment/Pages/Introduction.aspx)
		Port rules (Government Gazette, 6 March 2009)
	International Convention for Prevention of Pollution from Ships Act (1986)	Prevention of pollution from ships Regulations (Government Gazette, 29 May 1992)
	Marine Traffic Act (1981)	Marine traffic (inshore vessel traffic services Regulations (Government Gazette, 5 May 2000)
		Marine traffic Regulations (Government Gazette, 1 February 1985)
	Marine Pollution (Control and Civil Liability) Act (1981)	Marine pollution Regulations (linked to Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk) Government Gazette, 23 January 1998)
		Regulations under the prevention and combating of pollution at sea by oil Act (Government Gazette, 29 June 1984)
Fisheries and Aquaculture	Marine Living Resources Act (1998)	Regulations in terms of Marine Living Resources Act (Government Gazette, September 1998, as amended)
		Regulations for the protection of wild abalone (Government Gazette, February 2008)
		Regulations on the prohibition of fishing at night in estuary of Breede River (Government Gazette, 18 November 2013)
		Regulations relating to small-scale fishing (Government Gazette, 8 March 2016)
		Environmental integrity framework for marine aquaculture (2012)
		Aquaculture policy framework (Government Gazette, 11 October 2013)
		Legal guide for the aquaculture sector in South Africa. 1st Edition (2013)
	Foodstuffs, Cosmetics and Disinfectant Act (1972)	Regulations governing microbiological standards for foodstuffs and related matters (Government Gazette, 16 May 1997, and as amended)
		Regulations related to maximum levels of metals and foodstuffs (Government Gazette, 15 June 2018)
Mining	Mineral and Petroleum Resources Development Act (2002)	Mineral and Petroleum Resources Development Regulations (Government Gazette, 24 April 2004)
		Guidelines for the compilation of an environmental impact assessment and an environmental management programme (2013)
		Mining and biodiversity guidelines: Mainstreaming biodiversity into the mining sector (2013)


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