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MOHAMMED BIN RASHID SCHOOL OF GOVERNMENT

Addressing the Physical Risks of Climate Change in the GCC:

The Role of Policy and Finance

Policy Report

Supported by

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Authors and Citation

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Table of Contents

Executive Summary

Physical climate risks constitute one of the most significant and complex threats to human wellbeing, economic stability, and infrastructure resilience in the coming decades.

For the Gulf Cooperation Council (GCC) countries—Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and the United Arab Emirates—these risks are projected to increase in severity and frequency. Recent events, such as the April 2024 floods across the Arabian Peninsula, show that extreme weather events are already a reality. Without effective prevention and response measures, these events threaten lives, livelihoods and ecosystems and impose significant economic losses and operational disruptions.

While the GCC countries have actively engaged in international climate efforts and are increasingly addressing climate change transition risks through economic diversification and low-carbon strategies, the physical dimensions of climate-related risk remain comparatively underexamined.

This policy report fills that informational gap by providing a targeted analysis of climate-related physical risks in the GCC. It aims to support policymakers in identifying strategic responses to enhance climate resilience, with an emphasis on policy and financing options.

Drawing on literature review and expert interviews, the report assesses current vulnerabilities, adaptation measures and finance options, and offers practical recommendations to strengthen adaptation across the region.

Climate-related Physical Risks in the GCC

The GCC region is highly exposed to climate risks, where extreme heat, storms, and coastal risks are intensifying.

> **As the recent deadly heatwaves in Saudi Arabia and unprecedented flooding in the UAE and Oman demonstrate, these hazards are already placing an unsustainable strain on regional health systems and infrastructure.**

Understanding the scope of these physical risks is critical for safeguarding lives, protecting economies, and building long-term resilience for communities and ecosystems

Rising Temperatures & Heatwaves

Rapid regional warming is driving more frequent, severe heat events that approach wet-bulb survivability thresholds in coastal cities. Health risks are highest for outdoor workers and vulnerable groups. Heavy reliance on air-conditioning raises peak power demand and blackout risk. Increased heat threatens vulnerable ecosystems, accelerating coral bleaching and driving surface moisture evaporation, which intensifies desertification.

Intensified Storms & Floods

Short-duration, high-intensity rainfall is becoming more common, triggering flash floods in wadis and overwhelming urban drainage (e.g., April 2024 in the UAE). In coastal areas, storm surge combined with sea-level rise elevates risk to ports, tourism corridors, and critical lifelines.

Rising Sea Levels

Low-lying, subsiding coastlines, especially in Bahrain and along the eastern Arabian Peninsula, face heightened inundation, erosion, and saltwater intrusion. Exposure is acute for cities, industrial zones, desalination plants, transport corridors, and power assets; coastal ecosystems that buffer hazards like mangrove forests are also at risk.

Desertification & Dust Storms

More frequent and intense sand and dust storms degrade air quality and visibility, raising respiratory and cardiovascular morbidity and disrupting road and air transport; seasonal wind regimes (e.g., the Shamal) amplify operational disruptions. All of this is adding to the baseline air pollution generated by traffic and industries.

Cross-Sectoral Impacts

Rising temperatures and extreme weather hazards reduce labour productivity, strain public health systems, and increase contingent liabilities for governments and financiers, while threatening agriculture and food security, water resources, and ecosystems that provide natural protection.

Current Status of Climate Adaptation Planning in the GCC

The GCC countries are at different stages of developing and implementing climate change adaptation plans. Most have included adaptation in their national climate commitments and strategies, and some, like Kuwait, have already submitted a National Adaptation Plan (NAP).

The following is a summary of climate-related risk analysis and planning across the GCC:

Bahrain

Has identified key vulnerabilities and developed a National Adaptation Investment Plan (NAIP), focusing on coastal resilience, water management, disaster risk reduction and afforestation.

Kuwait

Its 2030-2019 NAP focuses on water, land use, health, and technical practices. The plan includes budget requirements for resilience across sectors.

Oman

Its adaptation and mitigation strategy integrates climate resilience into development planning. **It emphasises water resource management, agriculture, infrastructure, and public health.**

Qatar

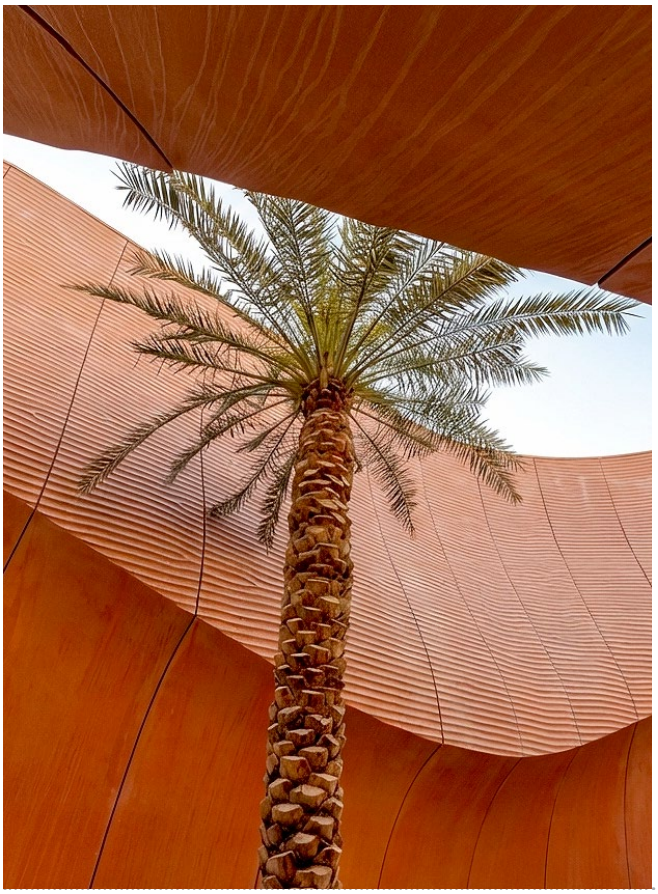
The National Climate Change Action Plan has over 300 adaptation actions, covering sectors like water, energy, and infrastructure. It is currently in the process of developing a NAP and is leveraging its financial sector to support these initiatives.

Saudi Arabia

Is addressing adaptation through economic diversification, renewable energy, urban planning and desertification management. Its financing strategy relies on public-private partnerships and its green finance framework.

United Arab Emirates

While it does not yet have a formal NAP, it has conducted a climate risk assessment and is actively working on a roadmap to develop one. **The UAE also recently enacted a national climate change law that mandates the creation of adaptation plans.**



Challenges & Opportunities

Effective climate adaptation in the GCC depends on creating an enabling environment that supports informed decision-making, coordinated implementation, and scalable action. **Central to this effort is the development and implementation of robust National Adaptation Plans (NAPs)**. While all GCC countries have acknowledged climate risks in their Nationally Determined Contributions (NDCs), **comprehensive NAPs are critical to translate these commitments into actionable strategies**. Aligning NAPs with national development visions—particularly those focused on economic diversification and decarbonisation—offers an opportunity to streamline planning, data systems, and monitoring frameworks.

Strengthened governance and cross-sectoral collaboration are essential, as climate risks cut across sectors such as urban development, water, energy, health, and infrastructure. **However, institutional silos remain a key barrier to policy coherence and efficient implementation**. Empowering local governments, particularly in highly urbanised contexts, can significantly enhance adaptation outcomes by enabling city-level planning tailored to specific vulnerabilities.

Robust data, risk assessment, and monitoring systems are foundational to effective adaptation. While some GCC countries have advanced national climate risk assessments, data gaps, limited accessibility, and fragmented information systems continue to constrain evidence-based policymaking.

> **Integrating monitoring, reporting, and evaluation (MRE) frameworks into NAPs and establishing centralised data coordination mechanisms would strengthen accountability and track progress against adaptation goals.**

A stronger scientific foundation is also required. **Persistent gaps in regional climate science, modelling, and forecasting limit the GCC's ability to anticipate and manage emerging risks**. Enhanced regional cooperation on climate science, including shared modelling platforms and forecasting capabilities, would improve risk assessment, prevent maladaptation, and support harmonised responses to transboundary climate impacts.

Financing climate adaptation remains a critical challenge. Limited data on adaptation investment flows, insufficient quantification of funding needs, and the perception of adaptation as "un-bankable" constrain both public and private investment. **Adaptation financing in the GCC is currently dominated by public budgets, increasing fiscal pressure as climate impacts intensify**. At the same time, early investment in adaptation offers strong economic returns, with global evidence showing that the costs of inaction far exceed the costs of proactive resilience-building.

Significant opportunities exist to unlock adaptation finance by leveraging the region's growing sustainable finance ecosystem. Expanding sustainable finance taxonomies to explicitly include adaptation, embedding climate risk into financial regulation, and engaging central banks, insurers, and the private sector can mobilise capital at scale. **Insurance mechanisms, in particular, remain underutilised and could play a critical role in risk transfer, disaster recovery, and long-term economic stability.**

Finally, awareness-raising and capacity-building are essential enablers of successful adaptation.

> **Strengthening stakeholder engagement—especially at the municipal level—building technical expertise, and improving public understanding of climate risks can foster a culture of resilience and shared responsibility.**

Together, these factor could enable a pathway for the GCC to enhance climate resilience, safeguard economic prosperity, and ensure sustainable development in the face of accelerating climate risks.

Policy Recommendations

Governance

Develop Evidence-based NAPs and Financing Strategies

- Anchor adaptation in **strong governance through a formal political mandate, leadership and inter-ministerial steering committees and delivery units**.
- **Establish evidence-based roadmap** for adaptation.
- Integrate adaptation priorities into **budgets and finance frameworks**.

Scale Impact through Collaborative Action

- **Mainstream risk assessment** across all sectoral and capital planning processes using **standardised open methods.**
- **Establish clear governance for cross-sector delivery** with defined roles and reporting.
- Implement overlapping, multi-sector programs such as **water-resilient cities, heat-safe infrastructure, and integrated coastal risk management**.
- **Establish a multi-stakeholder adaptation platform** to coordinate private sector, academic, and civil society actors in delivering inclusive, evidence-based adaptation.
- Integrate climate risk projections into **municipal plans, land-use regulations, and building codes** to strengthen urban resilience.

Shift Governance from Disaster Response to Risk Management

- Institutionalise risk-informed planning through **updated hazard maps, a national hazard registry, and coastal zone management**.

- Strengthen disaster preparedness by **investing in multi-hazard early warning systems, institutionalising simulations and inter-agency exercises, and expanding training and public awareness** to reduce loss of life, economic disruption, and recovery costs.
- Protect and prioritise **critical network infrastructure and diversify supply routes**
- Protect high-risk populations through **mapping, health early-warning systems, climate-resilient hospitals, and targeted community outreach**.

Implementation

Upscale Nature-based Solutions (NbS)

- **Protect and restore mangroves** using holistic approaches, careful site selection, and strengthened legal protections.
- Establish **national monitoring programs, carbon market frameworks, and collaborative governance models**.
- **Expand NbS beyond mangroves** with urban greening, blue-green corridors, sustainable drainage, dune stabilisation, and aquifer recharge systems.

Identify Mitigation–Adaptation Synergies and Co-benefits

- **Systematically assess synergies** and trade-offs in NAPs and investments.
- **Prioritise measures with proven dual benefits** (e.g., mangroves, green infrastructure, sustainable agriculture).
- Design **integrated policy mixes** instead of stand-alone measures.
- **Build institutional capacity** to manage trade-offs and ensure adaptation objectives remain relevant.

Data and Research

Strengthen Scientific Research for Adaptation

- **Provide sustained funding** for long-term, adaptation-focused climate research on regional and compound risks.
- **Support applied research, pilots, and demonstrations** that translate climate science into practical adaptation solutions.
- Establish and strengthen regional climate and adaptation **research centres of excellence**.
- Incentivise interdisciplinary research teams to align **adaptation science with real-world sectoral needs**.
- Build **stronger science–policy linkages,** including fellowships and embedded experts in ministries and policymaking circles.
- **Conduct localised applied case studies in adaptation** to test real-world constraints.

Advance Data for Climate Resilience

- **Establish robust, shared baselines for hazards** such as sea-level rise, flooding, and heat.
- Invest in **advanced monitoring systems** using sensors, UAVs, and satellites.
- Enhance **early warning and forecasting platforms** linked directly to planning and public advisories.
- Promote **open, interoperable climate risk data systems**.

Encourage Regional Efforts in Modelling Extreme Weather Risks

- Develop a GCC-wide **hazard modelling platform** with standardised methods.
- Create **specialised regional networks for dust storms, heat risk, and coastal flooding**.
- Formalise cooperation through a **GCC Extreme Weather Modelling Consortium**, with open data for governments, insurers, and investors.

Finance

Integrate Climate-related Physical Risk Assessment in the Financial Sector

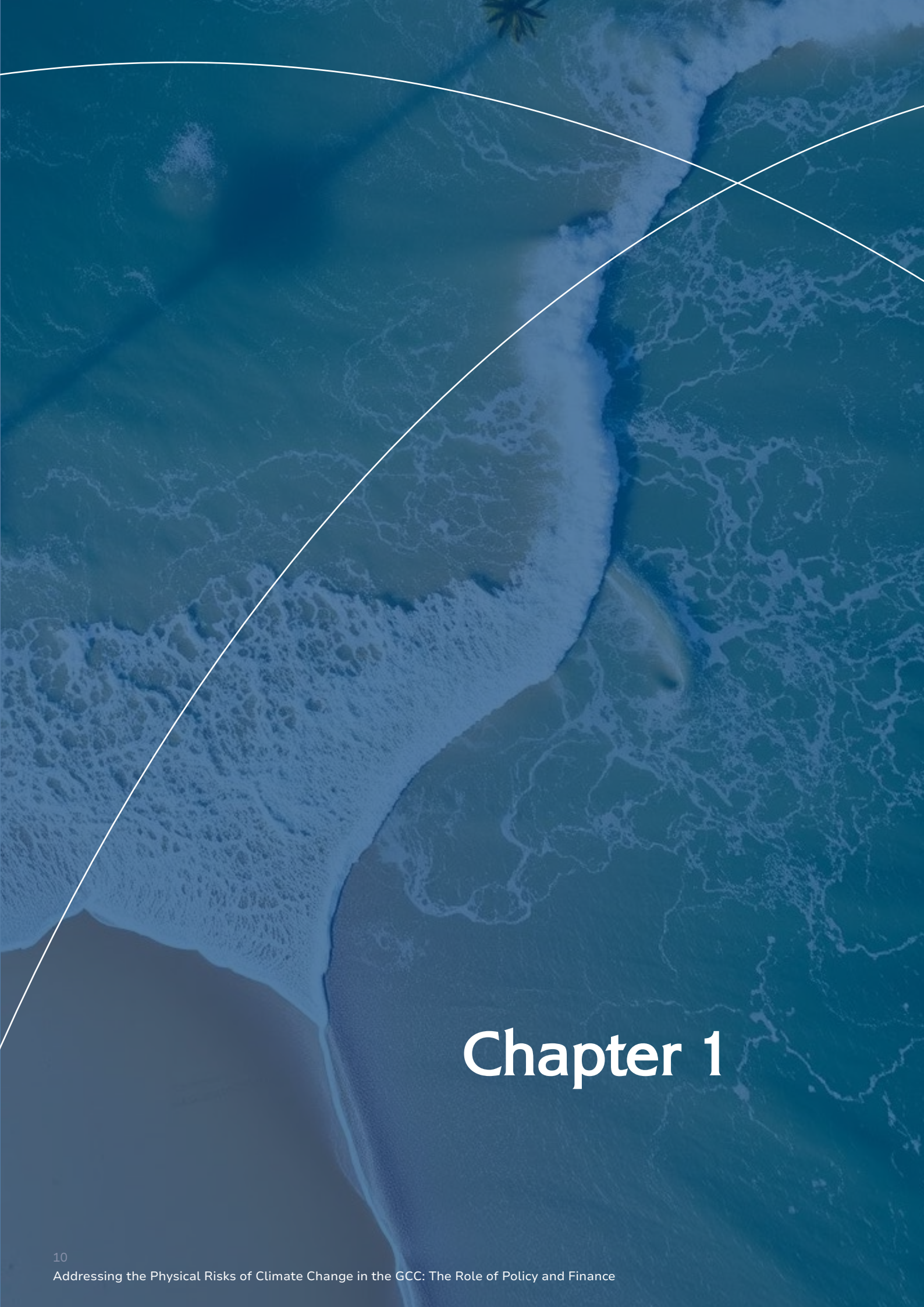
- Embed climate metrics into **credit analysis, portfolio management, and disclosure frameworks**.
- Institutionalise the use of climate risk scenarios in **investment and lending**.
- **Encourage cost-of-inaction assessments in public and private investment, lending, and procurement decisions** to reflect full lifecycle and resilience value.
- Mobilise the insurance sector through **regional risk pools, resilience-linked premium discounts, and climate-informed underwriting**.

Create Sustainable Taxonomies that Include Adaptation Classification

- Explicitly **define adaptation categories, criteria, and outcome metrics** within taxonomies.
- Harmonise national taxonomies into a **GCC-wide framework to improve cross-border comparability.**
- **Link taxonomy adoption** to financing strategies, disclosure requirements, and targeted incentives.

Enhance Finance Flows into Adaptation

- Translate strategies into **bankable, evidence-based project pipelines** to mobilise capital and scale up investment.
- **Leverage the growing green bond and sukuk market** to finance climate adaptation investments and mobilise private capital for resilience.
- Scale blended **finance mechanisms to de-risk climate resilience projects** and crowd in private investment.



Chapter 1

1. Introduction

Climate-related physical risks pose complex challenges for the GCC region. They are highly contextual and vary greatly depending on a country's exposure, vulnerabilities and adaptive capacities. **These risks broadly manifest as physical damages from extreme weather events, impacting human life, critical infrastructure, economies and ecosystems**.

Recent extreme weather events have underscored the growing human and economic costs of climate-related hazards, resulting in loss of life, increased illness, billions of dollars in infrastructure damage, and significant disruption to business and mobility.

> **The April 2024 rainstorm caused tragic fatalities in Oman and the United Arab Emirates, disrupted global aviation and local transport networks, and triggered widespread damage to infrastructure and property.**

In the same year, the impacts of extreme heat were evident during the Hajj pilgrimage in Saudi Arabia, where more than 1,000 deaths were attributed to heat stress. **These events highlight the urgent need for strengthened preparedness, adaptation, and risk-reduction measures,** particularly as the frequency and intensity of such extreme events are projected to increase in the coming decades.


Bahrain


Kuwait


Oman


Qatar


KSA


UAE

While significant gaps remain, **the six countries of the Gulf Cooperation Council (GCC) – Bahrain, Kuwait, Oman, Qatar, KSA and the UAE – have increased attention to understanding and mitigating climate transition risks,** reforming regulations and policies, offering incentives, and investing in sustainable infrastructure, renewable energy, and climate-resilient technologies. **Given their heavy dependence on fossil fuel revenues, GCC countries have recognised the economic risks associated with global energy transitions,** with economic diversification increasingly serving as a key vehicle for managing these risks.

While much of the existing efforts emphasise transition risks, this policy report addresses the critical yet often overlooked physical impacts of climate change in the GCC. The region faces a range of acute weather events and chronic climatological risks. **As climate change impacts unfold, evidence indicates that the frequency, intensity and duration of extreme weather events are projected to increase[1].** These include rising temperatures, increased humidity, shifts in precipitation patterns, and more frequent extreme storms and flooding events. These climate stressors, in turn, have widespread impacts on various sectors, some of which are already climate vulnerable such as water and environment sectors.

> **Understanding current and future climate physical risks is paramount to determine pathways for action to address adverse impacts.**

This policy report explores how the GCC countries can enhance resilience to the physical risks of climate change through policy measures and finance. The report first outlines the different climate physical risks faced by the GCC countries. Then it summarises the current status of climate change adaptation efforts in the GCC, including policies and plans for adaptation and how they are being financed. The report then discusses various enablers needed for advancing climate adaptation in the GCC, followed by some of the most pressing challenges and available opportunities in climate adaptation finance in the GCC. **Finally, the report ends with a series of policy recommendations, divided under four major pillars: governance, implementation, data and research, and finance.** A selection of case studies and critical information boxes were also added added to the report to illustrate key points.

> **The report is based on literature review and a series of interviews with key experts, policy- and decision-makers from government, business, academia, non-governmental organisations and international organisations.**

2. Climate-Related Physical Risks in the GCC

a. Rising Temperatures and Heat-waves

Across the GCC, rapid warming is already outpacing the global average. The broader EMME region has warmed about ~0.45 °C per decade since the early 1980s which is roughly twice the global rate driving more frequent and intense heatwaves and pushing summer conditions toward physiological limits in parts of the Arabian Gulf[2].

Projections for the region indicate ~+1.3 °C (low) to ~+4.7 °C (high) by 2100 based on different climate scenarios, with associated increases in hot extremes[3].

Cities' heavy reliance on air conditioning reduces indoor exposure but raises electricity demand and leaves populations vulnerable to grid stress during peak heat risking blackouts, while outdoor environments remain high-risk[4].

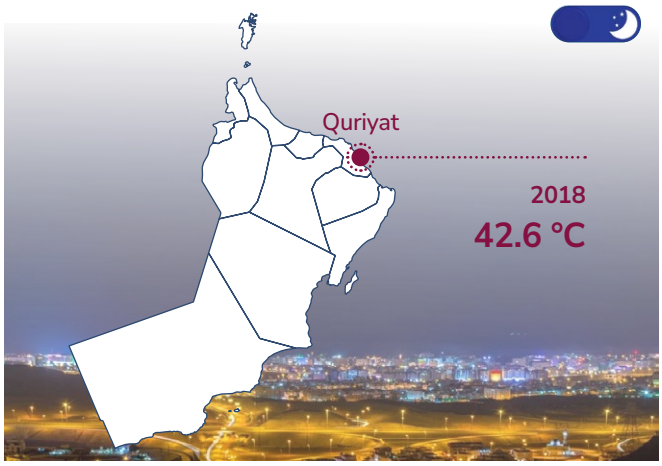
The central risk is to human health. In the GCC, extreme heat, often compounded by high humidity and dust, leads to dehydration, acute kidney and cardiovascular events, diabetes complications, occupational injuries, and excess mortality, especially among outdoor workers, older adults, children, and people with medical conditions like heart and lung disease.

In GCC coastal cities, intense heat combined with high humidity can push wet-bulb temperatures (WPT) toward survivability thresholds, limiting the human body's ability to cool itself through the evaporation of sweat.

For example, compared to interior centre cities, Dubai and Abu Dhabi are particularly vulnerable to WBT[5]. Additionally, Dubai's coastal corridor exhibits pronounced urban heat-island (UHI) effects that elevate nighttime temperatures and worsen outdoor thermal comfort[6].

Kuwait

Oman



Temperature extremes underscore these risks. In 2016, the World Meteorological Organisation (WMO) has officially evaluated temperature record extremes of 54.0 °C in Mitribah, Kuwait[7], while in the Summer of 2018, the city of Quriyat in Oman recorded the highest nighttime temperature (42.6°C)[8].

More recently, in June 2024, the human impact of heatwaves has been magnified as more than 1,000 deaths occurred during the Hajj pilgrimage in Saudi Arabia due to heat stress, with temperatures reaching over 50°C[9].

When combined with increased humidity, these high temperatures can surpass the wet bulb threshold of 35°C, the upper limit of human survivability in shaded, well-ventilated outdoor environments, which greatly increases the risk of mortality. Several GCC cities, including Dubai, Abu Dhabi, and Doha, are projected, under business-as-usual scenario, to experience days exceeding this threshold[10]. **The ramifications of these extreme heat events extend beyond immediate public health concerns.**

In the GCC, heat spikes electricity demand and grid risk leading to increased CO^2 emissions[11], and worsens water stress through higher aquifer salinisation[12].

> **The GCC is among the world's most water-stressed regions, relying on nonconventional water sources (such as desalinated water) for over 75% of their total water supply to decouple their supply from climate-dependent freshwater[13].**

Higher demand on desalination, however, poses environmental risks, as the discharge of brine and increased evaporation due to rising temperatures are projected to increase salinity in GCC coastal waters[14] , threatening fragile ecosystems.

b. Storms and Floods

Despite the arid climate and low annual rainfall in the GCC, evidence indicates a higher likelihood of short-duration, high-intensity rainfall events capable of triggering flash floods, alongside persistent coastal flooding risks from storm surge and sea-level rise. Precipitation patterns over the Arabian Peninsula are highly variable due to diverse climatic influences, including the Mediterranean climate, the Indian monsoon, and changes in elevation[15]. **However, across several hotspots in Arabian Peninsual, warming is associated with heavier precipitation extremes[16].**

> **For Saudi Arabia and neighbouring countries, projections point to mid-century intensification of extremes posing significant challenges for urban drainage systems and emergency management[17].**

On the coasts, compound extreme water levels (surge, waves, and tides) pose material risks to infrastructure, ports and tourism corridors, including along the central Red Sea[18]. In low-lying Gulf conditions, modest sea-level increments can produce large inundation elevating contingent liabilities for coastal cities[19].

> **In the UAE, the April 2024 storm delivered more than 250 mm in 24 hours in parts of Dubai—unprecedented in the instrumental record overwhelming drainage systems and disrupting aviation, ports, and transport[20].**

During the same event, critical inundation occurred in Al Ain, with water depths exceeding 8 m in urban districts such as Rowdah. **Remote-sensing analyses around Al Ain revealed how narrowed wadis and drainage bottlenecks intensified urban flooding, highlighting the vulnerability of rapidly expanding districts and utility corridors[21].** Earlier, January 2020 storms highlighted eastern wadis such as Fujairah as repeat flood hotspots[22].

Similarly, in Oman, heavy rainfall has led to repeated flooding events. Cyclone and tsunami surges across the Omani coastline are more consequential than gradual rise for inundation risk.

> **In Oman, Cyclone Gonu in 2007 led to widespread flooding and destruction, claiming the lives of 49 people and leaving ten of thousands homeless, with damages estimated by Omani authorities to be US$ 4 billion[23].**

Muscat's sensitivity to storm runoff is often highlighted given its low-laying areas and rapid urban sprawl which has expanded into high-risk areas despite the availability of hazard maps[24].

Despite Saudi's aridity, short-duration, high-intensity storms routinely trigger flash floods in wadis and rapidly urbanised catchments. Across Riyadh, Jeddah, Abha and Dammam, risk is amplified by rapid urbanisation, undersised drainage, and intense rainfall interacting with land use and topography—disrupting mobility and concentrating exposure in specific neighbourhoods[25] [26].

Between 2009 and 2011, Jeddah experienced intense flooding events, with the 2009 flood leading to a devastating human toll, causing more than 121 fatalities and forcing approximately 20,000 families from their homes with the financial damage mouting to billions of dollars[27].

The Deluge of April 2024: A Call for Climate Resilience in the Arabian Peninsula

The Arabian Peninsula experienced heavy rainfall in mid-April 2024 triggering flash floods across several states, inundating roads and disrupting transportation. The deluge impacted Oman, the UAE, Bahrain, Saudi Arabia, and Iran. In the UAE, a slow-moving storm dropped more than a year's worth of rain on some cities. Dubai saw heaviest rainfall since records began, with some areas inundated by a staggering 250mm in under 24 hours. While investigating the relation between individual weather events and climate change remains complex, meteorologists highlight the increasing likelihood and severity of such extremes in a warming atmosphere capable of holding more moisture. The 2024 floods were not just a weather anomaly; they were a potential warning of a future demanding urgent action.

The impact of the April rainstrom was far-reaching and disruptive. Dubai International Airport, a global aviation hub, was brought to a standstill, with over 1,200 flights cancelled and many others diverted, causing international travel turmoil. Within Dubai, metro services were disrupted, leaving hundreds stranded, and intercity bus routes were suspended. Tragically, **Oman had at least 19 fatalities, including 10 schoolchildren, underscoring the life-threatening nature of such events.** The UAE reported five deaths in Dubai. Beyond the immediate casualties, the floods caused widespread property damage, washed away vehicles, and raised public health concerns regarding waterborne diseases. Power and water supplies were also interrupted in some areas of Abu Dhabi and Dubai.

> **The economic toll was substantial, with insured losses in the UAE alone estimated to potentially reach USD 2.4 billion.**

> **Emergency response teams in the UAE faced an overwhelming number of emergency calls exceeding 9000 calls. In Oman, the Royal Oman Police carried out rescues of more than 1600 people.**

In the aftermath of the April rainstrom, **the UAE's President directed authorities to assess infrastructure and support affected populations. Additionally, a step towards future resilience was the approval of the 'Tasreef' project in Dubai, a massive AED30 billion initiative aimed at increasing the city's rainwater drainage capacity by 700% by 2033. Similarly, Sharjah approved the initial phase of a Dh400 million drainage project.** These infrastructure projects acknowledge the need to adapt to more frequent and intense rainfall events.

The vulnerability of urban centres like Dubai to extreme rainfall highlights the urgent need to accelerate action against climate physical risks. The event underscores the necessity for proactive investment in robust and future-proof infrastructure, alongside comprehensive urban planning that considers climate projections.

The investments in drainage infrastructure are a positive step, but a broader, multi-faceted approach encompassing emissions reduction, sustainable development practices, and enhanced disaster preparedness is crucial to mitigating future risks and building a climate-resilient future.

Dubai before and after the April 2024 deluge

Source: https://earthobservatory.nasa.gov/images/152703/deluge-in-the-united-arab-emirates

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c. Sea Level Rise (SLR)

Global sea level rise (SLR) depends on the fate of the Antarctic ice sheets and uncertainty is often reported in research on the pace and extent of ice melting[28]. Recent data show that the Global Mean Sea Level (GMSL) has risen by 111 mm since 1993, as the rate of global SLR has doubled in the past three decades[29].

However, sea-level rise varies significantly by location.

For the GCC region, the low-lying and hyper-arid coastal areas are particularly vulnerable to SLR, especially the coastline of the eastern Arabian Peninsula[30].

The northwest Gulf has risen 1.5 ± 0.8 mm/year for the period 1979-2000, adjusted for land subsidence (ground sinking), which agrees with the global estimate for the same period[31].

For Bahrain, SLR is recognised as a priority national concern[32] due to being a low-lying archipelago where past land reclamation and ongoing subsidence increase its vulnerability. **Estimates indicate that 1.5 m of SLR would submerge 17% of the Kingdom's land, while 2.0 m SLR will impact almost quarter of Bahrain's land[33]. Coastal areas in Saudi Arabia are already experiencing SLR on both Red Sea and Arabian Gulf fronts[34]. The Oman national coastal vulnerability index (CVI) maps ~805 km (~37%) of shoreline, especially Al Batinah and Al Sharqiyah,**

as high to very high vulnerability due to low relief, erodible sediments and exposure to Arabian Sea surge and wave climates, making urban centres along the Sea of Oman and low-lying deltas face risk of chronic tidal flooding, beach retreat and saltwater encroachment into aquifers and farms[35].

Regionally, vertical land motion such as subsidence further elevates relative risk in some locales[36].

The impact of storms in the GCC will be further exacerbated by rising sea levels, increasing risks to coastal properties, infrastructure, and economic hubs.

This is particularly significant for the region, as the Arabian Peninsula is surrounded on three sides by seas, with a combined coastline exceeding 9,000 km[37].

Rising sea levels pose a serious threat to critical infrastructure, including cities, ports, roads, desalination plants, and power facilities.

Some major cities, such as Dubai, Abu Dhabi, and Jeddah, are located along the coasts of the Arabian Gulf and the Red Sea, making them highly vulnerable. Additional risks include coastal erosion and saltwater intrusion, further threatening water resources. **Beyond coastal infrastructure, coastal ecosystems (coral reefs, seagrass, mangroves) face habitat loss and salinity stress under SLR, with projections of up to ~35% local marine species richness loss by late century that could undermine fisheries and natural shoreline protection[38].**

d. Sand and Dust Storms (SDS)

Another growing climate-related risk for the GCC is the increasing frequency and intensity of dust storms.

Evidence suggests that dust levels have risen across the GCC countries in the past few decades, posing significant threats to air quality impacting both human and ecosystems health[39]. **Regionally, sand and dust storms (SDS) are transboundary, as plumes from Iraq's Mesopotamian floodplain reach Kuwait and extend to Bahrain and Qatar, broadening impacts and complicating risk management[40].**

> **Sand and dust storms threaten health across GCC. as particulate spikes correltaes with surges in asthma and respiratory admissions (especially in children), straining healthcare and emergency services[41].**

Beyond acute morbidity, long-term exposure to elevated particulate matter (PM2.5) in desert settings is linked to higher all-cause mortality; making recurrent SDS a potential mortality burden[42]. **Risks escalate under compound extremes and chronic exposure. For example, hot–dusty days increase hospitalisation among people with diabetes[43].**

Beyond health, the transport sector is also heavily impacted. Reduced visibility from these events creates significant safety hazards, leading to accidents, closures, and delays. These poor-visibility events are seasonal, linked to specific wind patterns like the Shamal[44]. They also pose a significant risk to aviation. They can reduce visibility at major airports to just a few hundred meters[45], which disrupts operations.

> **For example, Dust days degrade punctuality at Kuwait International Airport, creating delays and costs for airlines[46].**

Environmental risks are multifaceted. Volumes of mineral dust and co-transported contaminants settle into nearshore marine systems, leading to environmental degradation.

In Kuwait Bay, for instance, annual sediment deposits reach hundreds of thousands of tonnes, including metals and nutrients that can alter biogeochemical cycles, harm marine life, and affect fisheries and infrastructure[47].

3. Sectoral Impacts of Climate-related Physical Risks

Climate-related physical risks pose significant risks to key sectors in the GCC, as Table 1 summarises. Infrastructure, including transportation networks and urban development, faces heightened risks from extreme weather events such as flooding and heat stress, leading to costly damages and disruptions. The economic consequences of these climate hazards extend beyond direct losses, affecting productivity, financial stability, and insurance markets due to increased claims and loan defaults. **Public health is also at risk, with rising temperatures and heatwaves leading to increased morbidity and mortality, placing a greater burden on healthcare systems.** Additionally, ecosystems across the region are under growing pressure, with biodiversity loss driven by rising temperatures, habitat fragmentation, and coastal erosion.

Table 1: A Summary of potential impacts on different sectors caused by physical risks of climate change

Sector	Potential Impacts
Health	**Increased morbidity and mortality due to heat stress, vector-borne diseases, and air pollution.** Greater burden on healthcare systems, particularly for vulnerable populations such as the elderly, children, and those with pre-existing conditions like asthma and cardiovascular diseases.
Water	**Increased water stress due to declining freshwater availability, higher evaporation rates, and growing demand.** Greater risk of droughts and reduced groundwater recharge.
Infrastructure	**Damage to critical infrastructure such as roads, bridges, and buildings due to extreme weather events, sea level rise, and flooding.** Higher maintenance and reconstruction costs.
Energy	**Increased energy demand for cooling due to rising temperatures, straining electricity grids.** Potential disruptions to power generation and distribution from extreme weather events.
Economy & Labour	**Direct damage to assets from floods, storms, and extreme heat, affecting residential and commercial buildings, vehicles, and industrial facilities.** Disruptions to economic activities, including supply chains, trade, and key sectors such as airports, ports, and tourism. Rising insurance costs and financial instability.
Agriculture and Food Security	**Declining crop yields due to heat stress, water scarcity, and desertification.** Disruptions in food supply chains, leading to higher food prices. Greater reliance on food imports.
Environment	**Degradation of natural resources, ecosystems, and biodiversity due to rising temperatures, habitat loss, desertification, and ocean acidification**. Increased risk of land degradation and loss of marine and coastal ecosystems.

* This table was developed based on reviewing literature and policy documents including, GCC NDCs, NAPs, and national climate risk assessments.

4. Climate Adaptation and Finance: Defining the Concepts

In the 2023 Sixth Assessment Report by the Intergovernmental Panel on Climate Change (IPCC), adaptation in human systems is defined as "the process of adjustment to actual or expected climate and its effects, in order to moderate harm or exploit beneficial opportunities"[48]. Despite the well-established definition of climate adaptation provided by the IPCC, **'adaptation finance' -the financial mechanisms intended to support it- remain inconsistently defined**. This lack of a shared understanding stems from the diverse perspectives of stakeholders, each with their own organisational priorities, investment goals, and approaches responding to climate change. Consequently, this ambiguity creates challenges in effectively allocating and utilising resources for climate adaptation action.

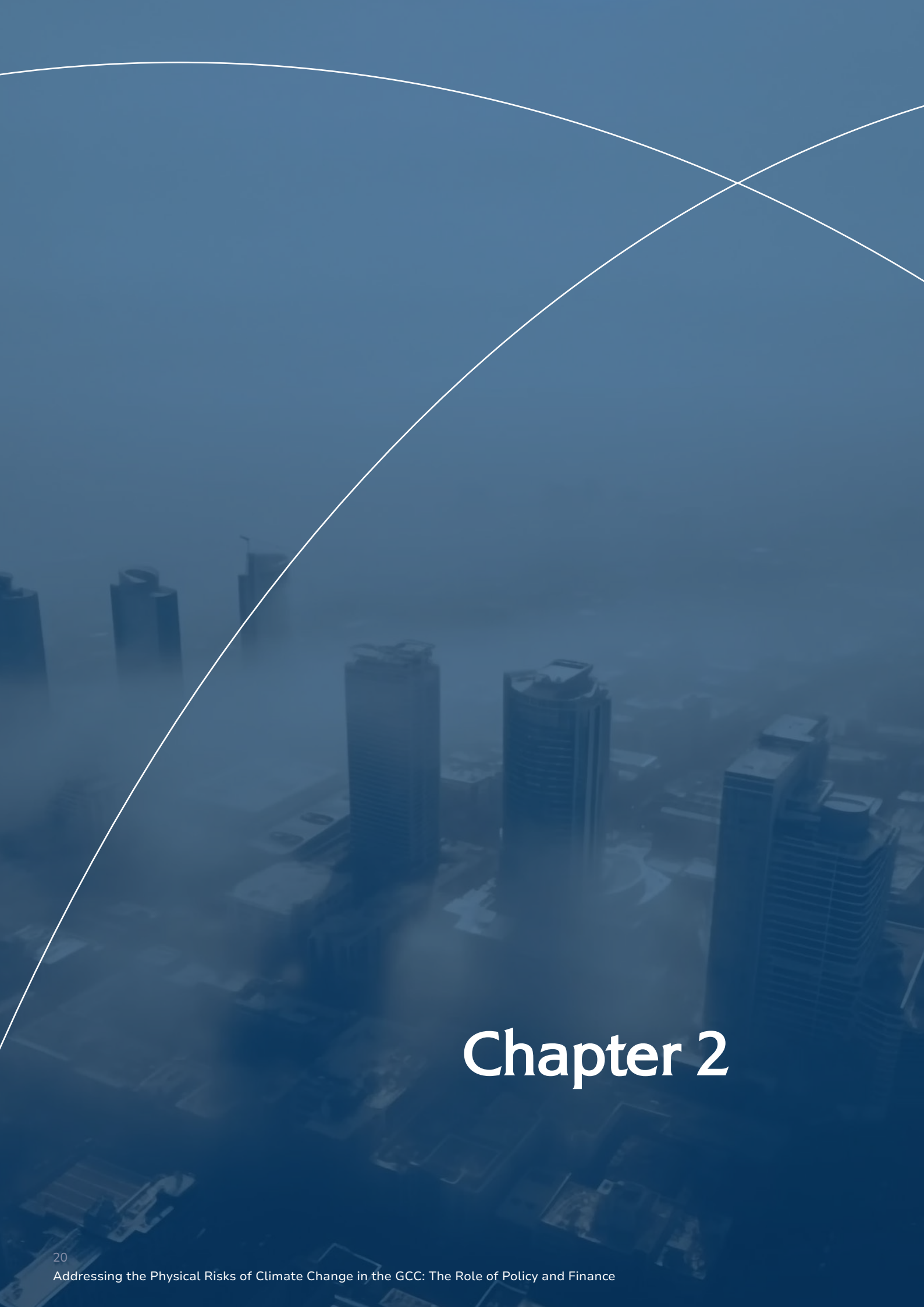
> **In this report, adaptation finance refers to financial resources allocated for actions that prepare for and respond to the impacts of climate change, with a focus on physical impacts.**

Regardless of what approch a country follows or how finance is managed,

> **The message is clear: addressing physical climate risks is paramount, and a failure to act will result in substantial costs.**

Therefore, countries are challenged with the critical task of effectively identifying, mobilising, and scaling up finance to meet needs required for climate adaptation.

To provide a better understanding of the current status, the next section explores how the six GCC countries have approached climate adaptation in their national policies.



Chapter 2

This chapter was authored by Tanzeed Alam and edited by Lama Zakzak.

Progress towards Climate Adaptation in the GCC

Faced with increasing climate physical risks, the GCC is accelerating the development of adaptation plans and the adoption of climate resilience policies. Below, Table 2 highlights the status of climate adaptation planning for all GCC countries. The table was developed based on a review of publicly available data and official submissions by each country of NDCs, National Adaptation Plans (NAP), National Communications (NC), Biennial Update Reports (BUR) to the UNFCCC, relevant national policies and strategies and information obtained from the expert interviews. The information about city-level adaptation plans is based on publicly available information as well as the databases of the C40 Cities network[49] and the Global Covenant of Mayors for Climate and Energy[50].

All countries have now submitted NDCs to the UNFCCC, and some, like the UAE, have updated theirs recently during COP29 in Baku, Azerbaijan. Only one country, Kuwait, has developed and submitted a NAP to the UNFCCC.

NAPs are the main planning tool for countries to understand their vulnerabilities and develop plans to adapt to those impacts. They also facilitate the identification of financing strategies. **Five countries, Bahrain, KSA, Oman, Qatar and UAE, are currently working on developing their NAPs.**

On a local level, the City of Dubai, UAE, has a city-level adaptation strategy and plan, which was finalised by the Executive Council in 2018[51]. Abu Dhabi is currently developing one as part of the Abu Dhabi Climate Change Strategy[52].

While there is no publicly available evidence that other cities in the GCC are developing their specific plans, the ongoing national NAP development presents a unique and important opportunity for the countries to ensure their major cities develop specific city-level actions as part of the NAP process.

Table 1 Current status of adaptation plans and policies for the GCC countries

	Bahrain	Kuwait	Oman	Qatar	KSA	UAE
Latest NDC	2021	2021	2023	2021	2021	2024
National Adaption Plan	→	✓	→	→	→	→
1 City-Level Adaptation or Resilience Plan	✗	✗	✗	✗	✗	✓
Nature-based Solutions in national climate or urban plans	✓	✓	✓	✗	✓	✓

✓ Yes → Work in Progress (WIP) ✗ No

https://www.c40.org/cities/

https://www.globalcovenantofmayors.org/region/middle-east-and-north-africa/

Government of Dubai (2018) Dubai Agenda: 2018. Accessed online: https://dubaiplan.ae/en/home

Government of Abu Dhabi: Abu Dhabi Climate Change Strategy - 2nd Pillar, Adaptation. Accessed online: www.abudhabi.gov.ae/en/programmes/abu-dhabi-climate-change-strategy

Bahrain

Bahrain's latest NDC highlights national information regarding precipitation and temperatures. Key vulnerabilities identified in the Third National Communication to the UNFCCC include water, agriculture, biodiversity, and urban development. **While the urgency to build resilience and adapt is recognised, Bahrain does highlight that it has limited capacity and resources Bahrain's NDC also highlights that support from the international community, the Green Climate Fund (GCF), and the UNFCCC** is essential[53]. However, it does not highlight whether the support needed is financial, technological or capacity building.

Key actions include:

National Adaption Investment Plan (NAIP)	Developed by the Global Green Growth Institute by the end of 2023[54], it is not yet publicly available or included in the submissions to the UNFCCC. **The NAIP aims to contextualise adaptation for Bahrain, set objectives, identify interventions, develop a finance strategy, identify stakeholders, and recommend institutional arrangements.**
Coastal Resilience	Measures to address SLR and flood risk include a 2008 technical manual with adaptation measures and height codes, updated in 2020 to align with the latest IPCC scenarios.
Water Resources Management	**Bahrain's National Water Resources Council is formulating an integrated policy and strategy.** The Water Resources Management Unit, funded by the GCF, is enhancing climate resilience through freshwater modelling, greywater use, auditing water management, and rainwater harvesting, all of which strengthens adaptation efforts.
Disaster Risk Reduction	**Bahrain has developed a National Strategy for Risk reduction aligned with the Sendai Framework for Disaster Risk Reduction 2015-2030.**
Adaptation - Mitigation Co-Benefits	Include afforestation to address heat stress and sequester carbon, and monitoring, protecting, and restoring mangroves in Tubli Bay.

Kuwait

Kuwait's NAP for 2019-2030 aims to enhance climate resilience and improve community livelihoods[55]. The Environment Public Authority (EPA) of Kuwait developed the NAP in partnership with governmental and non-governmental institutions.

The plan focuses on four key sectors:

Water Management

Addressing water scarcity and improving water resource management.

Land Use Planning

Implementing sustainable land use practices to mitigate the impacts of climate change.

Human Health Protection

Enhancing public health systems to cope with climate-related health risks.

Technical Practices

Adopting advanced technologies to improve climate resilience.

Kuwait's financing strategy for the NAP involves leveraging international climate finance, national budget allocations, and public-private partnerships. From its NAP, the following budget requirements are outlined.

$3.4M USD

Increase the resilience of the fisheries and marine sectors to climate change

$6.2M USD

Improve the resilience of systems for the water sector

$7.8M USD

Enhancing the resilience of coastal zones to face SLR risks

$4.1M USD

Enhance and build the capacity of the health sector to be prepared for increased health risks due to climate change

Oman

Oman's adaptation plans, policies, and actions are outlined in its NDCs, NCs[56], and the GCF National Adaptation Readiness Report. The National Strategy for Adaptation and Mitigation to Climate Change (2020-2040), developed by the Ministry of Environment and Climate Affairs with support from Sultan Qaboos University, identifies key sectors vulnerable to climate change, including;

- Water resources
- agriculture
- fisheries
- Marine resources
- infrastructure
- Urban areas
- Tourism
- Public health

The NAP process aims to integrate climate adaptation into development planning, focusing on medium- and long-term needs. The National Adaptation Readiness Report and the latest NDC identify strategies and programs to address climate impacts and vulnerabilities, with a strong emphasis on water resources management, agricultural and fisheries resilience, infrastructure adaptation and public health[57]. Actions are outlined for each of these areas and for disaster preparedness.

> **The GCF National Adaptation Readiness Report supports the NAP process by strengthening the implementation of adaptation components.**

It addresses barriers such as inadequate policy frameworks, limited sectoral vulnerability assessments, and low societal awareness of climate impacts[58].

There are no financing needs outlined but in general **Oman's financing strategy involves mobilising local funds, accessing international climate finance, and leveraging support from the GCF. Oman's Sustainable Finance Framework aims to diversify the economy, reduce dependence on fossil fuels, and promote renewable energy investments[59].**

Qatar

Qatar's climate change adaptation plans, policies, and actions are outlined in its NDCs, National Climate Change Action Plan and NC[60]. The NDC aims to reduce greenhouse gas (GHG) emissions by 25% by 2030 relative to a business-as-usual (BAU) scenario[61]. Key sectors include energy, transport, construction, water management, waste, and infrastructure. **GGGI offices in Qatar also issued a request for proposal in 2024 for assistance with developing a NAP for Qatar[62].**

> **The National Climate Change Action Plan 2030 includes over 30 mitigation measures and more than 300 adaptation actions[63].**

Qatar's financing strategy for these actions involves leveraging its banking sector and financial institutions. The Third Financial Sector Strategic Plan issued by the Qatar Central Bank in 2023 aims to create a financial market that supports sustainability and innovation. This includes investments in green bonds and sukuk, which attract substantial interest and reinforce Qatar's commitment to sustainability[64].

The plan emphasises economic diversification and sustainable development, and actions focus on:

Water Management	Implementing water conservation regulations, improving irrigation techniques, and promoting the use of treated wastewater for non-potable purposes.
Energy Efficiency	Enhancing energy efficiency in buildings, promoting the use of renewable energy sources, and developing energy conservation programs.
Agirculture	Introducing drought-resistant crop varieties, improving irrigation systems, and promoting sustainable agricultural practices.
Health	Strengthening the healthcare system to cope with climate-related health issues, such as heat stress and vector-borne diseases.
Infrastructure	Designing climate-resilient infrastructure, such as flood-resistant buildings and roads, and improving urban planning to reduce heat island effects.
Education and Awareness	Conducting public awareness campaigns on climate change and promoting environmental education in schools.
Research and Innovation	Supporting research on climate change impacts and adaptation strategies and encouraging the development of innovative solutions.

Saudi Arabia

In Saudi Arabia, climate change is projected to impact biodiversity, freshwater resources, agricultural productivity, and human health[65]. KSA has outlined several adaptation plans, policies, and actions in its NDCs, NCs[66], and BURs[67]. These documents emphasise economic diversification, reducing greenhouse gas (GHG) emissions, and enhancing resilience to climate impacts.

Key areas that KSA plans to implement that are related to adaptation include:

> **KSA's financing strategy for these actions includes leveraging public-private partnerships, attracting foreign investments and through the Green Finance Framework of the Public Investment Fund[69].**

Economic Diversification	KSA aims to reduce its dependency on oil revenues by diversifying its economy. This includes investing in renewable energy, water desalination, and sustainable agriculture[68].
Energy Efficiency	Improving energy efficiency in various sectors, such as home appliances, air conditioning, and transportation.
Renewable Energy	**Increasing the share of renewable energy in the national energy mix to 50% by 2030.**
Water Management	Implementing advanced desalination technologies and improving water distribution systems to minimise leaks.
Coastal Management	Developing strategies to reduce coastal erosion and protect marine ecosystems.
Desertification Management	Promoting the stabilisation of sand movements and planting trees to combat desertification.
Urban Planning	Enhancing mass transport systems in urban areas and developing early warning systems for extreme weather events.

United Arab Emirates

The UAE has been working on adaptation issues since 2017, when it started working on its National Climate Change Adaptation Programme, with the assistance of GGGI.

The country's approach has been to conduct a climate change risk assessment and identify adaptation measures in key sectors, including health, energy, infrastructure and environment. However, these have not yet been converted into a NAP with associated financial needs. **The UAE has a roadmap to develop a NAP and is currently working on its implementation[70].** Aligned with the UNFCCC Technical Guidelines for the NAP process, the UAE NAP Roadmap outlines the key components and implementation strategy for advancing national adaptation efforts.

From 30th May 2025, the UAE will also start implementing its new national climate change law[71]. Article 7 of this law outlines the requirements for the development of adaptation plans, focusing on the same sectors from the Adaptation Programme, but also allows for the addition of new sectors. It also outlines the following requirements for NAPs:

In 2019, the Government of Dubai also developed and approved the Climate Change Adaptation Strategy for the emirate, making it the first and so far only city-level adaptation plan in the GCC.

Abu Dhabi is also in the process of developing its own adaptation plan for the Emirate.

In general, the UAE has not outlined the associated costs of its adaptation plans nor a strategy for financing them[72]. However, it is likely to lean heavily on its already maturing sustainable financing framework and hubs being developed in Dubai and Abu Dhabi.

Furthermore, the UAE Central Bank recently issued seven principles for the management of climate change-related financial risks,

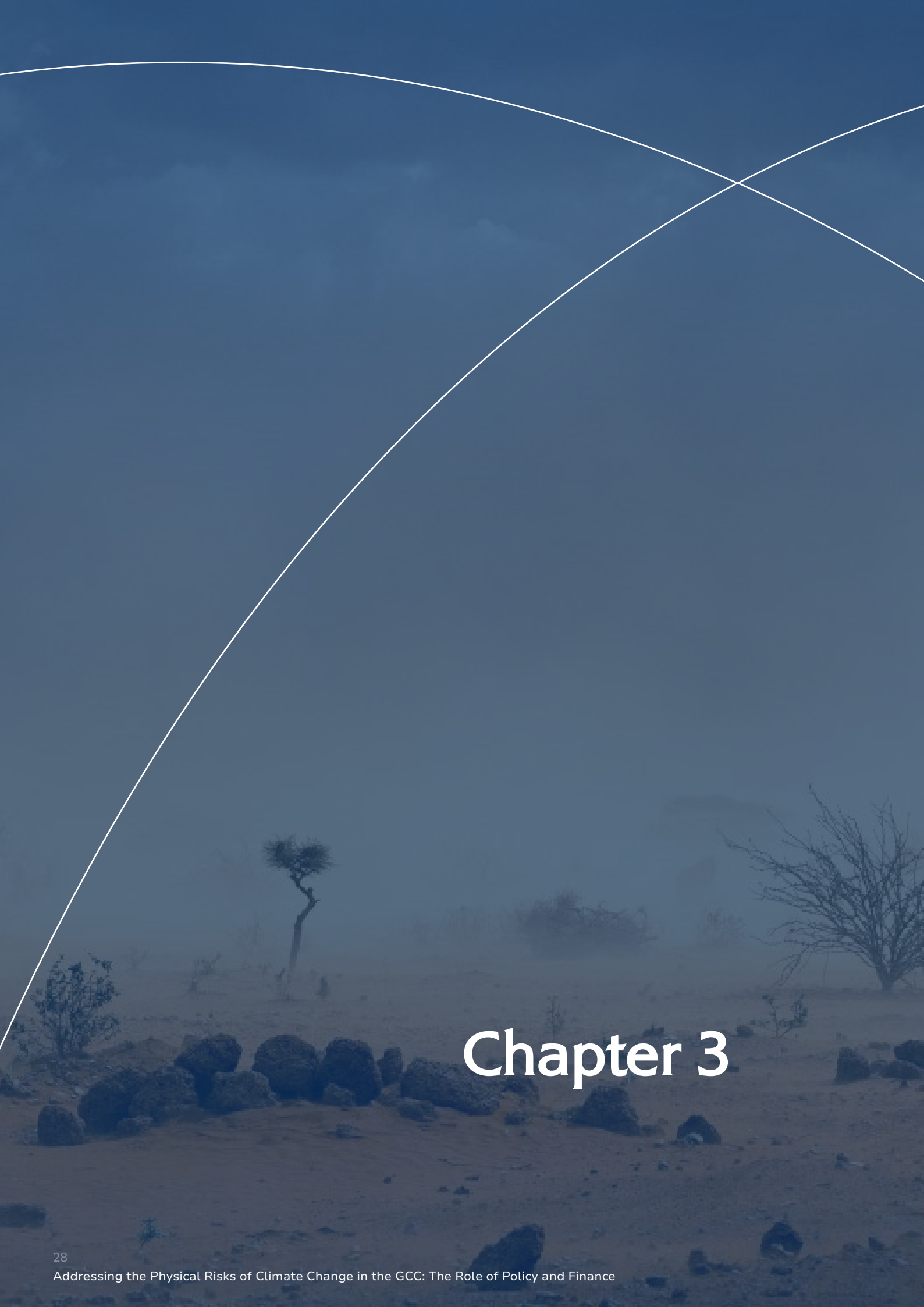
which require the financial services sector to assess the risk to their asset portfolio posed by climate change[73]. This should also result in increased action by these institutions to finance adaptation.

Assessment of the main climate-related risks in the sectors

Measures of response to risks and identified early warning systems

Implementation of the plan and adaptation measures.

Monitoring and reporting requirements are also outlined, as well as the need to track data on economic and non-economic losses and damages resulting from the impacts of climate change and any other climate change-related data. Track the implementation of adaptation plans according to the requirements for each sector at the local level to be included in the international reports submitted to the UNFCCC.



Chapter 3

Climate Adaptation in the GCC: Enabling Factors

As discussed in Chapter 1, **the GCC countries face serious climate physical risks, like rising temperature and extreme weather events, necessitating urgent action and substantial investment in resilience.** These vulnerabilities, including extreme heat and water scarcity, necessitate substantial investments in adaptation.

Therefore, **understanding the key challenges and opportunities for enhanced action against climate physical risks is essential for the GCC to build resilience.** Effective climate adaptation is enabled by creating a supportive environment where informed decisions and impactful actions can be empowered and scaled-up. This section explores these key enablers that are crucial for advancing climate adaptation efforts across the GCC region.

Strong Governance and Frameworks

National Adaptation Plans (NAPs)

> **All GCC countries are working towards establishing their National Adaptation Plans (NAPs), or already have one like Kuwait.**

While submitted NDCs by GCC countries acknowledge critical climate-related risks such as extreme temperatures, floods, desertification, and rising sea levels, and outline impacts on sectors like health, energy, and water, **comprehensive NAPs are vital for strategic climate adaptation** planning and implementation. These plans facilitate a holistic approach by helping countries identify short- and long-term needs, engage stakeholders, assess evidence, conduct gap analyses, and establish monitoring mechanisms to drive collective action.

> **The ongoing development of NAPs in GCC countries is a unique opportunity to integrate the latest climate science and national development strategies, ensuring tailored responses to specific vulnerabilities. Aligning NAPs with existing national visions, which emphasise economic diversification and decarbonisation, can leverage existing frameworks and streamline data collection, measurement and reporting processes.**

Cross-Sectoral Collaboration

> **Addressing the complexity of climate-related risks requires a robust cross-sectoral approach.**

For example, managing increased flood risks in coastal cities necessitate integrated planning across urban development, water management, infrastructure, and emergency services. This involves joint initiatives for enhanced drainage, stricter building codes, and early warning systems.

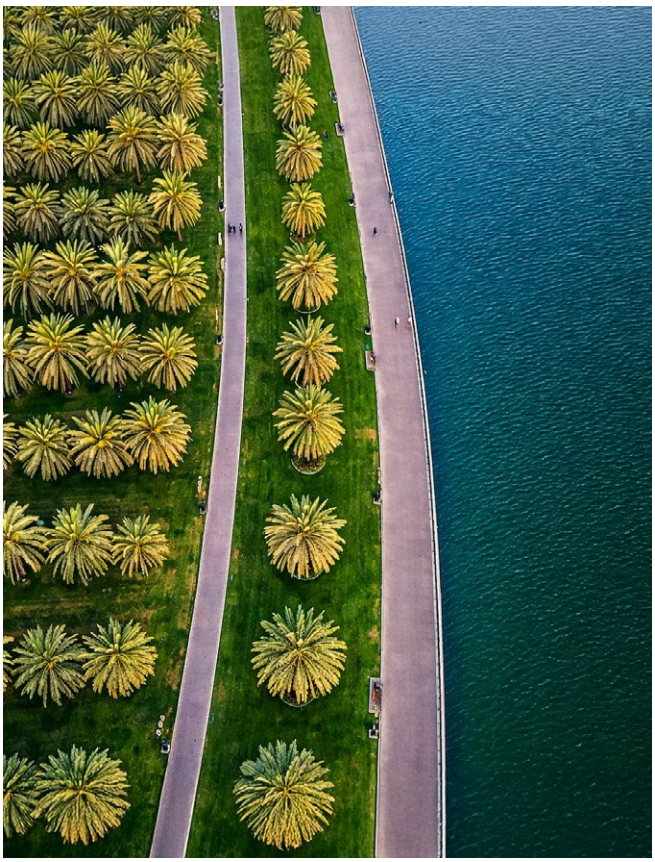
However, achieving effective intergovernmental and inter-ministerial collaboration remains a challenge due to prevalent siloed approaches, which can hinder efficient interventions and policy coherence.

Empowering Local Action

> **Given the GCC's heavily urbanised population, localising climate adaptation action can be beneficial in certain contexts.**

Major cities, central to national economies and home to the majority of GCC residents, face distinct climate vulnerabilities. **While some cities, such as Dubai and Abu Dhabi, have made progress on localised climate resilience strategies, there is a significant opportunity for other cities to develop tailored adaptation plans or programs.** These plans should address specific threats and integrate resilience into infrastructure and development projects, particularly in newly planned urban centres.

Furthermore, the ongoing NAP development process provides a valuable opportunity to engage municipal and planning authorities. This engagement will ensure that national policies are effectively translated, financed, and implemented at the local level.



Robust Data and Information Systems

Climate Risk Assessment

> **Effective climate adaptation in the GCC region hinges on robust risk assessment frameworks.**

These frameworks are essential for understanding climate risks and their impacts across various sectors, enabling proactive planning and prioritisation. **National-level assessments, such as the UAE's 2019 Climate Risk Assessment Framework, demonstrate the importance of standardised methodologies** for evaluating risks in public health, energy, infrastructure, and the environment.

Sector-specific risk assessments further enhance adaptation efforts by identifying vulnerabilities and enabling targeted strategies.

> **Strengthening collaboration with the private sector can improve data collection and risk mapping, leading to a more comprehensive understanding of climate risks.**

The financial sector also plays a key role in promoting climate resilience. Central banks in the GCC are increasingly integrating climate risk into financial policies. For instance, the UAE's Central Bank has issued principles for managing climate-related financial risks[74], and Oman's Central Bank introduced a circular in 2024 to enhance banking sector resilience[75]. **These regulatory measures emphasise the need to embed climate risk assessments into economic and development strategies**, reinforcing the region's ability to withstand rising challenges.

Enhanced Monitoring, Reporting and Evaluation (MRE)

> **A robust evidence base is crucial for informed policymaking and for tracking the performance of adaptation interventions.**

However, the GCC countries currently face challenges with limited data availability and accessibility regarding extreme weather events and their sectoral impacts. **Even when data is collected, it is often siloed**, which hinders information sharing and collaborative or multi-sectoral decision-making. **A deficient evidence base compromises the design of effective NAPs and limits the ability to track progress against adaptation targets.**

Integrating MRE frameworks into NAPs to address these challenges is a valuable opportunity. Establishing a centralised government focal point for data consolidation can facilitate information sharing and improve data accessibility across ministries and agencies.

Scientific Foundation for Decision Making

> **A strong scientific foundation is essential for effective climate adaptation.**

However, significant gaps in regional climate science persist, particularly in quantitative sectoral risk and vulnerability assessments that are crucial for policymaking. **Closing these gaps is key to understanding emerging risks such as rising temperatures, extreme events (e.g., flooding, dust storms), and their impacts on public health, key economic sectors, and diverse ecosystems.**

Despite shared exposure to climate-related extreme events, the GCC lacks a regional weather forecasting centre or coordinated efforts in this area. The Absence of a unified climate modelling platform limits the region's ability to accurately project climate risks. Strengthening climate science through improved modelling and forecasting would enhance risk assessment and inform targeted adaptation measures.

Additionally, using evidence-based approaches is critical to prevent maladaptation—actions that inadvertently increase vulnerability to climate change— and to ensure sustainable adaptation strategies. Since many climate impacts transcend national borders, regional collaboration is essential to harmonise methodologies, share knowledge, and align adaptation efforts with the latest scientific evidence.

Cooperation and Partnership

Private Sector Partnership

> **While the private sector engagement in adaptation remains limited, a significant opportunity exists to increase its participation through targeted incentives and regulatory frameworks that promote investments in climate-resilient infrastructure and sustainable business practices.**

Facilitating the integration of climate risk assessments into business planning and financial reporting will enhance corporate awareness and drive proactive adaptation measures. Additionally **given that climate change pose direct risks to businesses, including supply chain disruptions and asset damage, greater private sector participation will secure more stable and sustainable returns in the long run.**

Regional Cooperation

> **Regional cooperation is a key driver for advancing climate adaptation in the GCC.**

Fostering regional cooperation among GCC countries is paramount. Given that climate risks in the Gulf are inherently transboundary, regional collaboration is an imperative rather than an option. **A coordinated approach is essential for the real-time monitoring and tracking of extreme weather events, which frequently transcend national borders. By synchronising the development of NAPs, GCC member states can unlock scalable benefits for both institutional frameworks and shared ecosystems.** Beyond risk mitigation, deep-seated regional cooperation fosters cross-border economic opportunities and provides a platform for sharing best practices. Utilising existing GCC cooperation channels across diverse sectors will ensure more cohesive, resilient adaptation strategies, yielding long-term stability and prosperity for the entire region.

Awareness and Capacity Building

Stakeholder Engagement

> **Effective climate adaptation requires strong stakeholder engagement, especially at the city level.**

Given the GCC's high urbanisation, it is crucial to involve municipal and planning authorities in developing and implementing NAPs. **This ensures that strategies address specific city vulnerabilities and facilitates local finance opportunities.** Collaboration across government, the private sector, and communities is also essential to break down silos and promote shared responsibility. **The ongoing NAP process offers a key opportunity to build these partnerships and integrate climate resilience into broader policy.**

Capacity-building

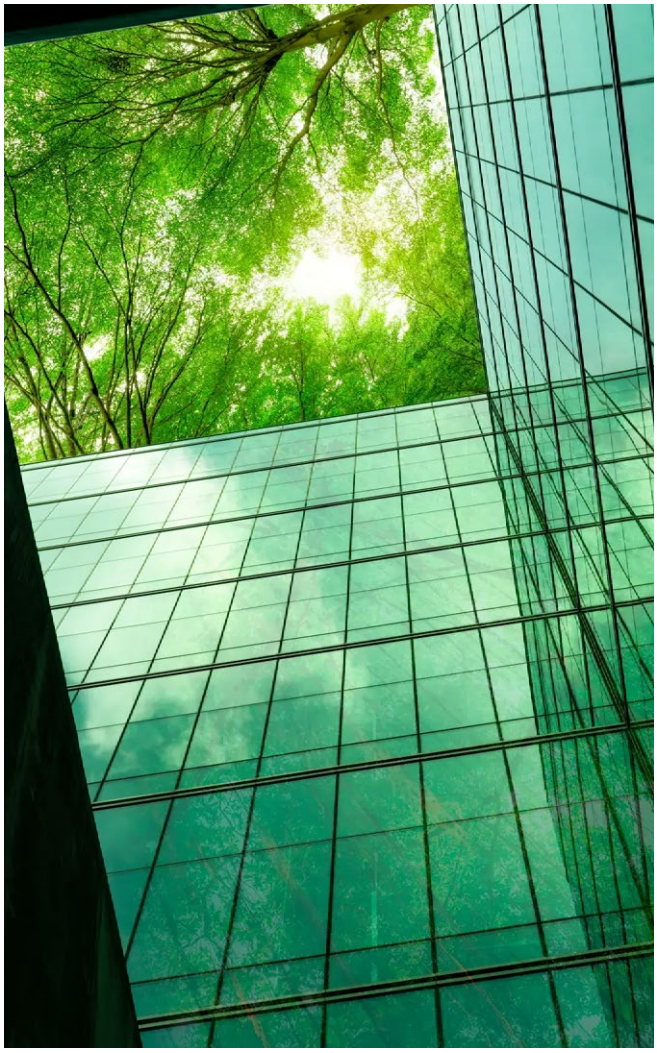
> **To effectively address escalating climate challenges, targeted capacity-building initiatives are essential.**

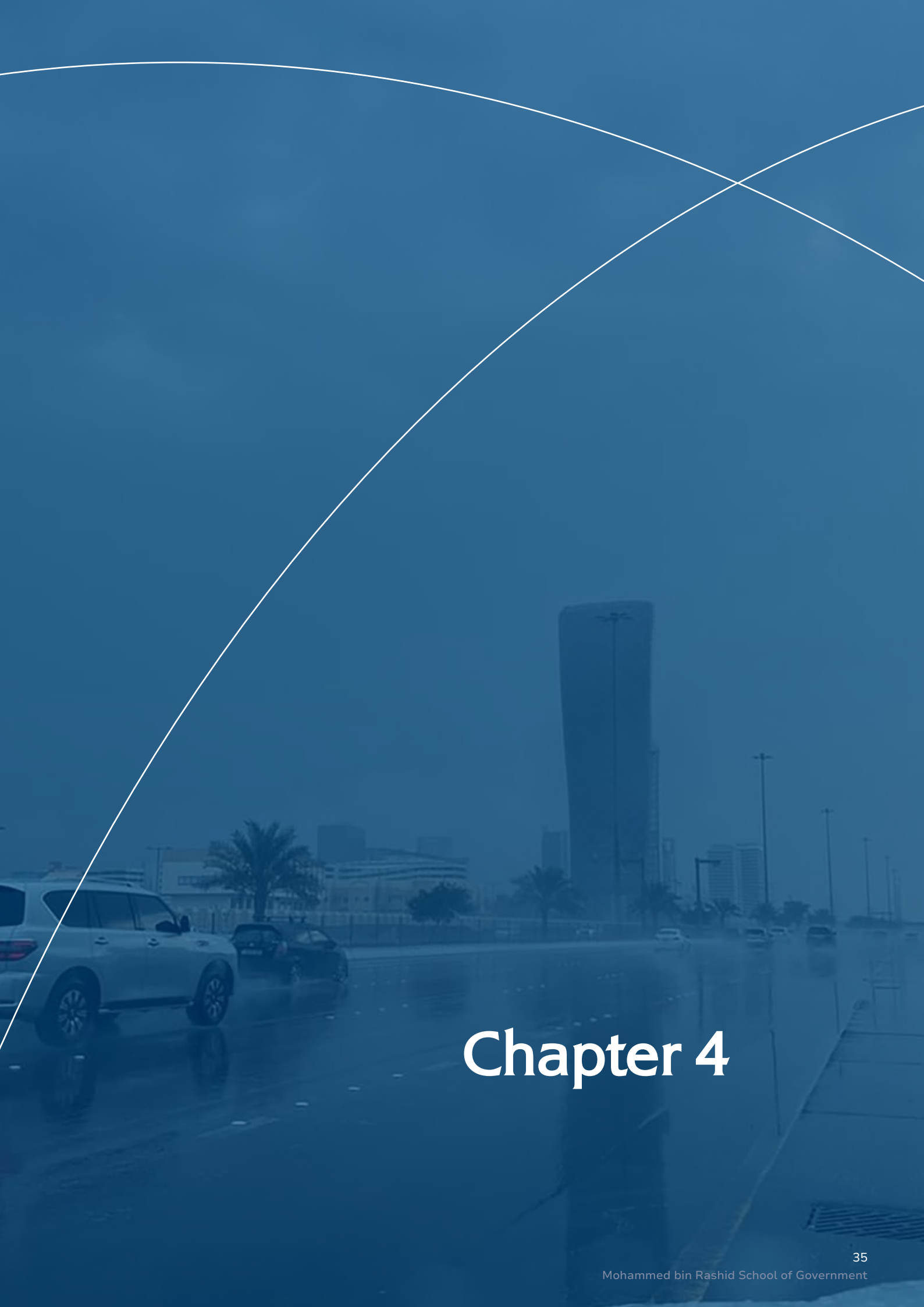
This includes bridging the gap between scientific knowledge and policy implementation by investing in training programmes for adaptation experts. **Building a regional community of climate scientists and modelers will strengthen the scientific foundation for informed decision-making and help prevent maladaptation.** By developing the necessary expertise and promoting knowledge sharing, the GCC can ensure its strategies are grounded in evidence and effectively address the region's unique vulnerabilities.

Public Awareness

> **Public awareness campaigns are vital for driving behavioural change and fostering a culture of climate resilience.**

Utilising diverse communication channels—including media, digital platforms, and community outreach—can effectively disseminate information on climate risks and adaptation strategies. **Highlighting success stories and best practices can inspire action at both individual and community levels.** NGOs, such as the Environment Society of Oman and Emirates Nature-WWF, play a crucial role in raising public awareness through dialogues and community initiatives, contributing to a more informed and engaged population.





Chapter 4

Climate Adaptation in the GCC: Finance

The GCC faces unique and intensifying climate physical risks, demanding urgent response. Funding this response is a strategic imperative to ensure the region's continued economic resilience and environmental health.

This section evaluates the landscape of adaptation investment, identifying barriers and opportunities while outlining mechanisms to unlock necessary capital flows across the region.

Challenges

Informational Gaps on Climate Adaptation Needs and Funding

> **A major challenge in the GCC is the scarcity of data on financial flows into adaptation.**

This data deficit impedes strategic planning, resource allocation, and the overall execution and monitoring of NAPs and their associated targets. This challenge is further exacerbated by the insufficient quantification of adaptation investment requirements. Furthermore, while aligning NAPs with national development plans helps mainstream resilience, it can obscure the tracking of dedicated capital, as adaptation funds often remain embedded within broader state infrastructure budgets.

Perceptual Challenges

In the GCC, climate adaptation is often not perceived as a pressing priority within the public sector. Several interconnected factors contribute to this.

> **First, GCC countries are generally regarded as having high adaptive capacity, which can foster an underestimation of vulnerability in the face of climate-related extreme events.**

Second, there is limited understanding among policymakers regarding the frequency, severity, and long-term impacts of such events, weakening both urgency and advocacy in decision-making. **Additionally, the region's harsh environmental conditions can lead to a normalisation of climate extremes, diminishing the perceived need to invest in further resilience.**

Furthermore, adaptation faces a perceptual barrier regarding its financial framing.

> **Adaptation is frequently seen as unprofitable or "un-bankable," restricting the flow of funds into climate-resilient initiatives—particularly from the private sector[76 77].**

While some projects receive support through corporate social responsibility (CSR) programs, mainstream commercial investment remains limited because many adaptation initiatives fall outside what is traditionally considered commercially viable. **At the same time, private investments continue to favour mitigation projects, which are more familiar and associated with clearer, short-term financial returns.** By contrast, adaptation is linked to long-term, uncertain outcomes, reinforcing existing barriers to investment and reflecting a broader cultural challenge within the ffinancial system.

Institutional Challenges

As an investment with consideration for wider public and societal good, climate adaptation is often regarded as a government responsibility. **States therefore play a central role in enabling financing opportunities and conducting structural reforms that support adaptation.** In the GCC, adaptation financing primarily relies on national budgets, which cover a wide range of activities, from emergency disaster response to major infrastructure investments. As extreme weather events become more frequent and severe, these public finances will face mounting pressure to fund both immediate recovery efforts and long-term adaptation measures.

Institutionally, this reliance on public budgets limits the diversity and scale of adaptation finance. **Without stronger mechanisms to attract private capital, develop blended finance structures, or integrate adaptation into broader economic planning, governments face challenges in meeting rising climate resilience needs.** While certain sectors, such as water, energy, and environmental services, offer promising opportunities for investment, the institutional frameworks needed to systematically mobilise such financing are still evolving across the region.

Opportunities

Early Action Lowers Costs and Risks

The costs of inaction on climate risks far exceed the benefits of early investment in resilience. The costs of inaction on climate change far exceed the benefits of early investment in adaptation.

While no specific cost-benefit analysis is available for the GCC countries, return on investment in adaptation. For instance, every US$1 spent on coastal protection avoids US$14 in damages.

This presents a significant opportunity for the GCC to finance investments in adaptation. Building the case for investing by conducting similar assessments for GCC countries would be an important step for increasing adaptation financing.

Determining the economic, social, and environmental costs of inaction can be a driver for accelerating adaptation efforts and mobilising both public and private finance.

> **For example, the recent extreme weather events in the UAE, Oman, and Saudi Arabia bring the issue of floods to the forefront in government, commercial and public perception, building momentum for proactive adaptation planning.**

Case Study:
The National Delta Program – The Netherlands

The Netherlands, a low-lying country with nearly a third of its land below sea level, faces increasing threats from climate change, including rising sea levels, extreme weather events, and freshwater shortages.

In response, the Delta Programme was established as a long-term, adaptive strategy to strengthen flood protection, secure freshwater supply, and enhance spatial resilience.

Key Adaptation Measures

The Delta Programme employs a phased and adaptive approach, ensuring continuous evaluation and adjustment through six-year reviews. Its core measures include:

Flood Risk Management

The Flood Protection Programme aims to reinforce dykes and flood defences to meet updated safety standards by 2050. Spatial planning is also integrated to mitigate flood risks.

Freshwater Supply

Recognising increasing drought risks, the programme invests €800 million in climate-proofing the water supply, improving retention, and promoting water-efficient land use.

Spatial Adaption

A seven-step framework encourages local governments to conduct climate stress tests, risk dialogues, and integrate adaptation into planning, supported by €300 million in funding.

Sea Level Rise Knowledge Programme

This initiative ensures preparedness for future climate uncertainties by advancing research and scenario planning beyond 2050.

Governance and Implementation

The Delta Programme operates through a collaborative governance model, involving national and regional governments, water boards, businesses, and research institutions. The Delta Fund ensures long-term financial sustainability, allowing for continued investments in infrastructure and innovation.

References:
https://english.deltaprogramma.nl/

> **In the latest review report, the Delta Program has shifted from controlling water to «learning to live with water again,»**

as climate impacts, including wetter winters and drier summers, become increasingly evident. **Adapting to these changes requires fundamental shifts in land use and spatial planning, beyond optimising existing water management systems.** Financially, **the rising cost of dike upgrades (€16-33 billion) highlights the need for sustained investment** in flood risk management, freshwater supply, and human resources to ensure timely project completion.

Leveraging the Sustainable Finance Sector

> **"Given the growing momentum across the GCC towards developing sustainable finance frameworks, there is a substantial opportunity to align these financial mechanisms with National Adaptation Plan (NAP) processes."**

Despite an increasing appetite for sustainable investment, a critical barrier remains: the lack of standardised metrics for integrating climate resilience into investment decisions. **Current regional initiatives to develop sustainable finance taxonomies, alongside the successful issuance of instruments such as Green Sukuks and bonds for renewable energy, provide a proven foundation.** There is now a strategic opening to broaden these frameworks to specifically encompass and incentivise adaptation-focused activities.

Case Study: The EU Taxonomy – A Framework for Sustainable Investment

What the EU is Doing and Why

> **The EU Taxonomy is a cornerstone of the European Union's sustainable finance framework, designed to guide investments toward environmentally sustainable activities.**

It serves as a classification system that defines clear criteria for economic activities aligned with the EU Green Deal and the 2050 net-zero target. **By providing a common language for sustainability, the taxonomy enhances market transparency, mitigates greenwashing, and ensures that investments contribute to climate adaptation and mitigation efforts.**

Implementation and Impact

> **The Taxonomy Regulation, which came into force in July 2020, establishes four key conditions an economic activity must meet to qualify as environmentally sustainable.**

It focuses on six environmental objectives, including climate change mitigation, adaptation, biodiversity protection, and circular economy principles. **To operationalisation the taxonomy, the European Commission has developed technical screening criteria and digital tools such as the EU Taxonomy Navigator,** which helps financial and non-financial entities comply with reporting obligations.

> **By setting a standardised framework, the EU Taxonomy aims to facilitate greater investment in sustainable projects, support financial institutions in risk assessment, and ensure that both public and private investments contribute to long-term resilience and sustainability.**

Reference:
https://finance.ec.europa.eu/sustainable-finance/tools-and-standards/eu-taxonomy-sustainable-activities_en

The Role of Central Banks

Central banks play a crucial role in strengthening economic resilience to climate change by ensuring that financial systems adequately account for climate-related risks, including those associated with adaptation.

This can be achieved through soft power or regulatory frameworks. For example, the UAE's Central Bank has issued principles for managing climate-related financial risks, while Oman's Central Bank introduced a 2024 circular to enhance banking sector resilience. These regulatory measures emphasise the need to embed climate risk assessments into economic and development strategies, reinforcing the region's ability to withstand climate challenges.

UAE Central Bank – Establishing Principles for Climate-Related Financial Risk Management

Setting the Stage for Sustainable Finance

The UAE ratified the Paris agreement and submitted its first NDC in 2015. This aligns with the global adoption of the 2030 Agenda for Sustainable Development and its Sustainable Development Goals (SDGs) by UN Member States in 2015. **Domestically, the UAE has proactively established frameworks like the UAE Green Agenda 2015-2030, the National Climate Change Plan 2017-2050, and the UAE Net Zero by 2050 Strategic Initiative.**

> **To guide the country's economic transition and foster sustainable finance practices, the UAE Sustainable Finance Working Group (SFWG) was established in 2019.**

This collaborative body brought together key stakeholders:

Ministries

Ministry of Finance, Ministry of Economy, Ministry of Climate Change and Environment.

Financial Services Regulators

Central Bank of the UAE, Securities and Commodities Authority, Financial Services Regulatory Authority (FSRA) of Abu Dhabi Global Market (ADGM), Dubai Financial Services Authority (DFSA).

UAE Exchanges

Abu Dhabi Securities Exchange (ADX), Dubai Financial Market (DFM), Nasdaq Dubai.

In 2020, the SFWG issued its "Guiding Principles on Sustainable Finance in the UAE," signalling a commitment to develop standards for integrating Environmental, Social, and Governance (ESG) factors into corporate governance, strategy, and risk management within the financial sector. Later, SFWG announced it would start working on developing enhanced standards to help embed and address climate-related risks in corporate governance and risk management in financial services entities in the UAE.

Defining the Scope: Understanding Climate-Related Financial Risks

The principles are built upon a clarified understanding of climate-related financial risk, defined as the financial risks stemming from climate change. This encompasses:

Physical Risks

Financial impacts arising from the physical effects of climate change (e.g., damage to assets from extreme weather events).

Transition Risks

Financial impacts associated with the transition to a lower-carbon economy (e.g., policy changes, technological shifts, changing market sentiment).

Liability Risks

Financial risks arising from potential litigation seeking compensation for climate change-related damages.

The Core Guiding Principles for Climate-Related Financial Risk Management

Principle 1	Oversight and responsibility of climate-related financial risk exposures (emphasising board and senior management accountability).
Principle 2	Incorporation of climate-related financial risk exposures into overall business strategy.
Principle 3	Assigning climate-related financial risk management responsibilities clearly within the organisation.
Principle 4	Incorporation of climate-related financial risks into the comprehensive risk management framework.
Principle 5	Monitoring and reporting of climate-related financial risks.
Principle 6	Incorporation of climate-related financial risks into capital and liquidity adequacy assessment processes.
Principle 7	Utilisation of scenario analysis to assess the resilience of business models to climate-related financial risks.

Incorporating physical climate-related risks into financial risk management is essential for safeguarding the resilience and stability of the UAE's financial system. More recently, the CBUAE performed a climate physical risk scenario analysis in 2024, examining banks' real estate lending exposure to rainfall flood and storm surge hazards under two IPCC scenarios. **Climate-driven events, such as storm surges and extreme rainfall, directly impair collateral valuations. This, in turn, necessitates higher provisioning by UAE banks, highlighting the systemic link between environmental resilience and financial stability.**

References:

https://rulebook.centralbank.ae/en/rulebook/principles-effective-management-climate-related-financial-risks

https://www.centralbank.ae/media/ymgnwy3x/2024-en-annualreport.pdf

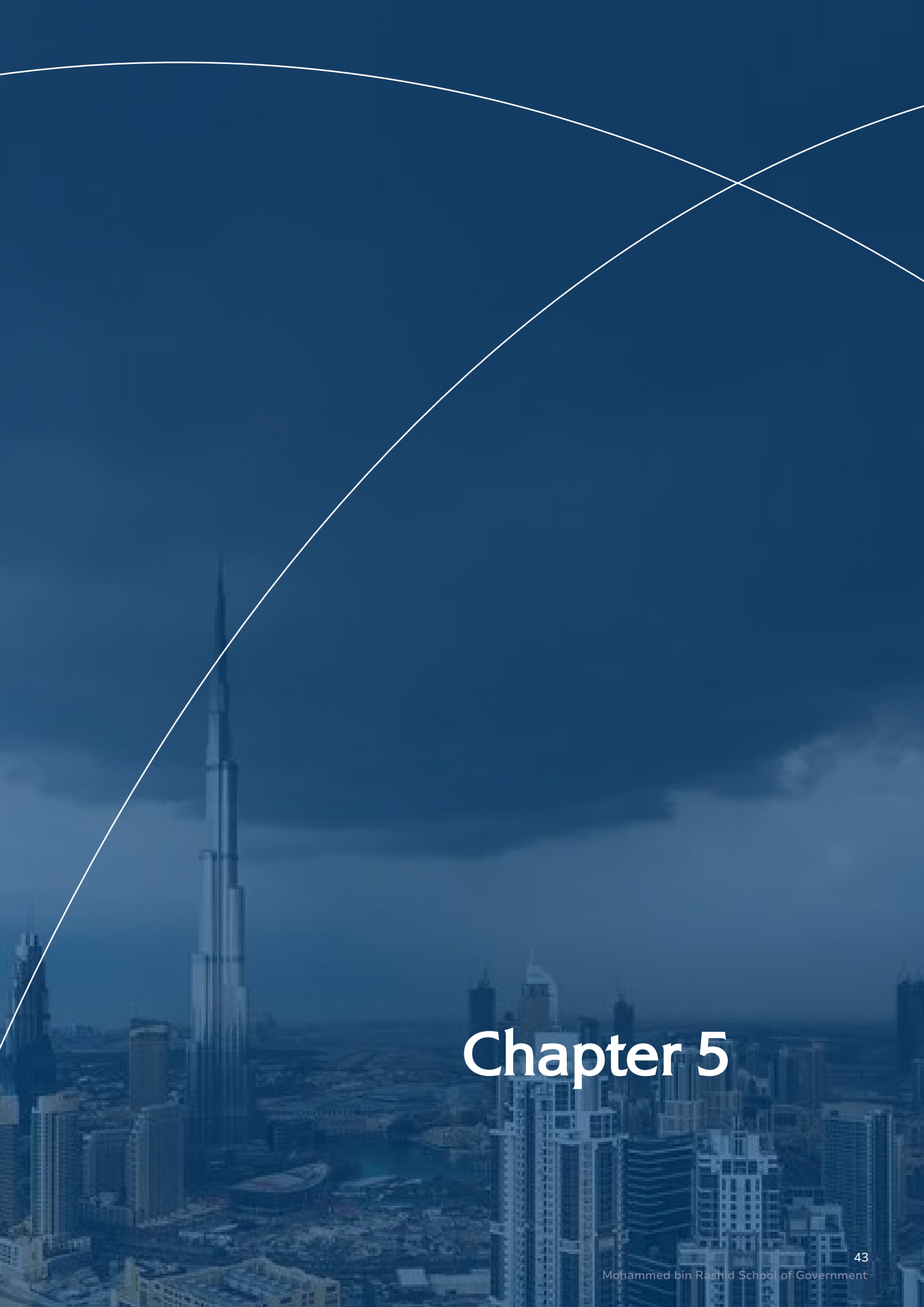
Engaging the Insurance Sector

Climate risk insurance can play a vital role in adaptation efforts by increasing savings and establishing more comprehensive risk management strategies, thereby enabling faster recovery after climate disasters.

The Sendai Framework for Disaster Risk Reduction 2015–2030 recommends promoting risk transfer and insurance—both for public and private investments—to reduce the financial burden of disasters on governments, businesses, and societies.

However, in the GCC, the insurance sector remains underutilised in advancing climate resilience. There is significant potential to enhance its role by engaging stakeholders on how insurance companies can integrate climate-related risks into their business operations, investments, and projects. Additionally, collaboration between regulatory bodies and industry stakeholders can help identify and address emerging threats and challenges posed by climate change.

> **In the short and medium term, risks such as rising costs and investment losses due to more frequent natural disasters underscore the urgency of incorporating climate considerations into insurance frameworks. Strengthening climate risk insurance mechanisms could provide much-needed financial protection and promote long-term economic stability in the region.**



Chapter 5

Policy Recommendations

The following policy recommendations offer a strategic framework to strengthen climate adaptation outcomes and facilitate the mobilisation of capital towards regional resilience. **These insights are evidence-based, derived from an extensive literature review and targeted consultations with regional experts.**

They address four key areas:

Governance

Implementation

Data & Research

Finance

Governance

Develop Evidence-based NAPs and Associated Financing Strategies

While GCC member states are at varying stages of NAP development, the transition from planning to implementation remains a shared challenge. **To ensure NAPs are actionable and attractive to investors, they must be grounded in regional climate data, aligned with national visions, and translated into bankable project pipelines.**

To achieve this, countries can focus on four priority areas:

Strengthen mandates and governance

Establish a formal political mandate through high-level approval, such as a Cabinet decree or Ministerial law, ensuring cross-departmental cooperation.

This mandate is operationalised by defining institutional arrangements, specifically identifying a lead agency—typically the Ministry of Environment—and creating a robust coordinating mechanism to integrate critical sectors.

Create a shared evidence and decision framework

Establish a national (or GCC-linked) risk observatory designed to curate datasets, climate scenarios, and standardised methods. By adopting common approaches for prioritisation and uncertainty management, the observatory provides the analytical foundation necessary for informed decision-making.

Building on this evidence, a formal Roadmap is defined. This step involves setting a clear execution timeline and identifying the specific financial and human resources required.

Anchor adaptation in budgets and finance

Integrate NAP priorities into expenditure frameworks and tag adaptation spending in budgets, allowing the government to monitor progress against national targets and identify fiscal gaps.

Translate strategy into a bankable pipeline

Establish a clear framework for prioritising and sequencing investments, ensuring projects are grounded in evidence and aligned with national adaptation goals. Standardise preparation processes to demonstrate outcomes and costs in multi-year programs.

This structured approach aids in turning ambitious, high-level national climate resilience targets into specific, financially viable projects, and potentially attracting private sector participation for scale delivery.

Scaling Impact through Collaborative Action

> **Impacts of climate physical risks cut across sectors, necessitating a collaborative approach.**

Extreme rain events overwhelm drainage and disrupt transport, power and health services; heat waves simultaneously stress public health, buildings and power grids; dust events affect air quality, aviation and labour productivity.

Addressing these risks in silos leads to fragmented responses that duplicate costs, overlook critical interdependencies, and often result in ‹maladaptation› where a solution in one sector inadvertently creates a vulnerability in another.

To respond effectively, countries can prioritise cross-cutting actions:

Create clear governance for cross-sector delivery

Establish an inter-ministerial steering committee and a delivery unit that convenes line ministries, municipalities, and regulators; these bodies should have authority over standards, budgeting, and reporting, with clearly defined roles, escalation paths, and mandates to ensure adaptation is mainstreamed into sector plans and public investment processes.

Mainstream risk assessment across sectors

Use standardised methods for identifying shared hotspots (e.g., flood nodes, heat-health thresholds, dust exceedances) and embed them in sector plans and projects.

Evidence emerging from climate risks research in the GCC stresses the need for standardised and comparable data.

Work through overlapping action areas

Organise programs where benefits span sectors, for example, water-resilient cities (stormwater, wastewater reuse, groundwater recharge), heat-safe buildings and public health, and coastal risk management that combines SLR, surge and land-use.

Evidence indicates that these bundles deliver greater impact per cost.

Establish a Multi-Stakeholder Adaptation Platform

promote a collaborative ecosystem that leverages private sector innovation and finance, academic research for evidence-based policy, and NGO and communities to ensure adaptation strategies are inclusive and socially grounded.

Embed Resilience into City-Level Planning

Integrate climate-risk projections directly into municipal master plans and land-use regulations to ensure urban development, infrastructure zoning, and local building codes are proactively designed for future environmental extremes.

Shift Governance from Disaster Response to Risk Management

Because climate risks in the GCC are system-wide and cascading, there is a critical need to shift from costly, destabilising disaster responses toward proactive, integrated risk management.

Countries can reduce losses and safeguard stability by shifting to proactive, risk mitigation governance, using shared evidence, clear mandates, and budgeted delivery programs.

The recommendations below translate this shift into practical steps:

Risk-informed spatial planning & national hazard registry

Adopt risk-based land-use rules grounded in updated multi-hazard maps (e.g., coastal vulnerability, floodplains, extreme heat, subsidence). Establish a living national hazards registry that compiles hazard exposure, critical assets, and incident losses, and links this information to permitting processes and public disclosure.

Across the GCC, strengthening national Integrated Coastal Zone Management plans (ICZM) is essential with dedicated funding, monitoring, and adaptive pathways.

Strengthen Disaster Preparedness

Governments should invest in robust, multi-hazard early warning systems and ensure timely, clear communication of risk alerts to the public and businesses. Regular scenario planning, simulations, and inter-agency exercises should be institutionalised to test readiness for extreme weather events and cascading impacts. **Targeted training programs and public awareness campaigns are needed to improve preparedness, clarify roles and responsibilities, and promote practical actions before, during, and after disasters, thereby reducing loss of life, economic disruption, and long-term recovery costs.**

Protect and prioritise critical network infrastructure

Map and harden ports, desalination plants, power stations, and transport vulnerable points on low-lying ground.

Elevate or flood-proof essential equipment; add redundancy and alternative supply routes. Implement selective seawalls/levees where benefits exceed costs.

Protect high-risk populations and health zones

Map and register vulnerable populations (e.g., the elderly, children, those with pre-existing medical conditions) and their proximity to high-risk zones (e.g., floodplains, heat islands, dust storm corridors).

Establish a public health early warning and response system for climate-related events, ensuring that hospitals and clinics are climate-resilient and equipped for hazardous events. Develop targeted outreach programs to disseminate health alerts and provide disaster response and medical aid to at-risk communities.

Implementation

Upscale Nature-based Solutions (NbS)

Nature-based solutions (NbS) refer to the contribution of nature conservation or restoration to climate mitigation and adaptation goals.

> **These solutions not only strengthen resilience to climate change but also serve as tangible examples of effective adaptation and mitigation measures, which can help attract further investment.**

Mangroves – A regional Opportunity for Adaptation

Regional reviews of the period from 1996 to 2020 show decreases in mangrove cover in Saudi Arabia, Oman, Bahrain, and Kuwait, stability in the UAE, and appreciable gains in Qatar, the latter two are largely attributed to government-led conservation, direct seeding and seedling planting[78].

For example, local expansion documented that mangroves (A. marina) in Al Khor/Al Thakhira in Qatar, expanded

~21% (~40 ha) between 2014–2023[79].

However, mangroves face multiple challenges: ongoing coastal development through land reclamation, ports, marinas, dredging, and fragmentation continues to stress habitats; pollution from oil spills, treated-water discharges, and urban or industrial impacts degrades ecosystem health; and climate stressors such as sea-level rise, hyper-salinity, heat extremes, desertification and drought further compound risks[80 81]. **Moreover, poorly planned restorations, such as planting in unsuitable sites or replacing other coastal habitats, can deliver only short-term gains while causing long-term ecological losses, highlighting the need for rigorous site selection in arid, saline conditions.**

The following recommendations target promoting and improving mangrove conservation in the GCC:

Protect and restore

Expand legally designated marine protected areas and establish coastal buffer zones that include mangroves, ensuring they are integrated into coastal spatial plans and supported by clear institutional coordination. Evidence shows that long-term success comes not from large-scale mass planting, but from holistic approaches to restoring mangrove ecosystems.

Select mangrove sites carefully

Site-selection is critical. Hypersaline, polluted, or heavily reclaimed areas rarely support survival. Remote sensing combined with field surveys can be used to identify priority zones, assess forest health, and secure inland migration corridors as sea levels rise.

Strengthen legal and regulatory instruments

Clarify and enforce prohibitions on mangrove clearance, degradation, and pollution, making them explicit in national environmental laws and coastal planning regulations. Environmental impact assessments should move beyond narrow technical reviews to include social and health dimensions, such as impacts on fisheries, biodiversity and community resilience.

Monitor, measure & report

Establish national programs with open, country-level mangrove inventories, integrating remote sensing, unmanned ariel vehicles (UAVs) and machine-learning to harmonise baselines and track biomass/blue carbon storage.

Finance & markets

Develop compliance and carbon market frameworks for blue-carbon credits tailored to arid mangroves. This can mobilise industry finance for conservation and restoration; explore payments for ecosystem services and blended-finance opportunities.

Encourage collaborative governance

Use co-management, public–private partnerships, and cross-border coordination to reconcile conservation with competing coastal land uses.

Other forms of Nature-based or Ecosystem-based Solutions

Beyond mangrove conservation and restoration, the measures below broaden the NbS portfolio to tackle urban heat, pluvial flooding (rain flooding), dust storms, and water security in GCC settings.

> **Each action can be embedded in masterplans, development codes, and capital programs to deliver measurable risk reduction and co-benefits.**

Design blue-green corridors and expand urban canopy

Create blue-green corridors and native tree canopy along streets and ventilation paths. Prioritise drought-tolerant species and treated-wastewater irrigation. Target heat islands near schools, transit, and labour accommodations; monitor thermal comfort and shade provision.

Stabilise dunes and control dust with native vegetation

Plant native species and hardy perennials, forming shelterbelts around settlements, corridors, and critical assets. Combine vegetation with sand fencing and moisture-retention measures.

Track Particulate Matter (PM 10 and PM 2.5) levels and plant survival indices to refine solutions.

Retrofit drainage and embed green infrastructure in drainage

Deploy sustainable drainage and nature-based storage like detention, infiltration, permeable surfaces, constructed wetlands, linked to managed aquifer recharge. Prioritise flood hotspots and public estates.

Maintain routinely and use sensors to track performance during storms.

Identify Mitigation–Adaptation Synergies and Co-benefits

> **Mitigation and adaptation are often addressed separately, however, they are heavily interconnected which calls for integrated approaches. Actions taken to reduce or capture GHG emissions can yield adaptation benefits, and vice versa.**

However, potential negative impacts, such as biodiversity loss from large-scale installations or increased emissions resulting from adaptation measures (e.g. cooling), must be considered. Identifying and leveraging synergies between mitigation and adaptation can improve data flows, reporting, and the realisation of co-benefits, while simultaneously avoiding detrimental outcomes.

Crucially, this integration should not compromise or dilute primary adaptation objectives. Examples of such co-benefit actions are water and energy conservation, NbSs, smart agriculture, and sustainable land management practices, which can simultaneously reduce emissions, enhance ecosystem resilience to climate impacts like droughts and floods.**Tangible steps can be recommended to bridge the gaps between mitigation and adaptation:**

Mainstream synergy assessments into planning and finance

Direct climate action plans, NAPs, and investment proposals to systematically identify where mitigation and adaptation reinforce each other or create trade-offs.

Prioritise high-value synergy measures

Focus on interventions consistently shown to contribute to the delivery of both goals, such as green infrastructure (urban greening, mangroves), integrated water–energy management, and sustainable agriculture.

Evidence from research reviews shows these are "sweet spots" with proven adaptation–mitigation benefits[82].

Design policy mixes, not stand-alone measures

Avoid implementing isolated actions that address only one objective. Instead, bundle complementary mitigation and adaptation measures—such as combining green infrastructure, flood zoning, and low-carbon urban design—to maximise co-benefits while managing trade-offs.[83].

Invest in capacity for trade-off management

Train planners, financiers, and sector agencies to anticipate, quantify, and manage conflicts, such as adaptation actions that increase emissions, or mitigation projects that worsen adaptation (e.g. water scarcity) to ensure adaptation objectives remain primary.

Data and Research

Strengthen Scientific Research for Adaptation

> **To be climate resilient, GCC countries should leverage their universities and research centres through targeted, long-horizon funding and tighter science–policy linkages.**

Priority themes should reflect the region's highest, well-documented risks: (i) coastal change and sea-level rise (e.g., observed sea rise in the north-western Arabian Gulf and coasts flagged as highly exposed or vulnerable); (ii) extreme heat and urban health, heat and humidity trends, indoor air quality, and cooling demand are central to risk; (iii) sand and dust storms and air quality (frequent exceedances of PM10/PM2.5 and health impacts); and (iv) flash-flood and rainfall hazards (validated hotspot mapping for the UAE, Saudi and Oman and rising urban flood risk in Doha). **Key actions to advance climate-related research in the GCC include:**

Funding research for climate resilience

Provide sustained, programmatic funding for long-horizon, multi-year research programs focused on adaptation-relevant climate risks, including high-resolution climate modelling, compound hazards (e.g., heat × humidity; surge × rainfall), and applied impact studies.

Encouraging innovation and solutions

Support applied research, pilot projects, and demonstration initiatives that translate climate science into practical adaptation solutions, such as nature-based coastal protection, heat-resilient urban design, and flood mitigation measures tailored to local conditions.

Developing climate research centres

Establish and strengthen dedicated climate and adaptation research centres of excellence within GCC universities and national research institutions, with mandates to focus on region-specific risks and policy-relevant outputs.

Promoting interdisciplinary teams

Incentivise collaboration across climate science, engineering, public health, urban planning, economics, and social sciences to ensure that adaptation research reflects real-world constraints and sectoral needs.

Programs and training

Invest in education, training, and capacity-building programs, including graduate programs, professional training, and fellowships that build a skilled workforce in climate science, adaptation planning, and science–policy translation. Mechanisms such as embedded researchers in ministries or policy fellowships can further strengthen science–policy integration.

Bridge science and policy

Create co-production pipelines between science and policy. For example, having fellowships programs for policy makers or embedded "science translators/ communicators" in ministries, as well as annual adaptation calls co-designed with line agencies. Results can move directly into impacted sectors, such as coastal zoning, building codes, health surveillance, and flood design standards.

Applied case studies for real-world constraints

Prioritise localised case studies that test interventions under real constraints. These for instance can include nature-based shoreline solutions and managed retreat where hard defences risk maladaptation.

Enhance Data for Climate Resilience

Reliable, shared data is the backbone of climate resilience. For GCC cities and coasts, locally calibrated evidence, capturing land movement, compound coastal extremes, heat, dust, and ecosystem stress, enables earlier action and smarter investment. The recommendations below guide efforts towards better data related practices:

Build robust baselines for climate hazards

Establish consistent and shared baselines for multiple hazards, including sea-level rise, flooding, heat, and dust. Use technology and multi-approach methods, such as tide gauges, weather radars, drones, and health surveillance, to generate reliable reference points for future planning.

For example, research from the GCC show how land movement alters local sea-level trends and how combined tide/wind extremes affect coastal cities like Abu Dhabi, underscoring the importance of long-term, locally relevant baselines.

Invest in advanced monitoring technologies

Expand the use of sensors, satellites, UAVs, and real-time data systems to track changing conditions across coasts, cities, and ecosystems.

This allows capturing complex impacts of climate-related hazards, like those affecting mangroves across the GCC.

Enhance early warning and forecasting systems

GCC countries have a regional opportunity to upgrade early warning systems to address major risks including floods, storm surge, marine heatwaves, and extreme heat. This includes expanding and modernising the tide-gauge network along the Arabian Gulf, co-locating GPS to detect land subsidence, and adopting uniform data processing standards

The region would also benefit from integrating high-resolution regional ocean and weather models, developing risk dashboards for decision-makers, and strengthening last-mile alerting through drills and community preparedness.

Promote open, interoperable climate data systems

Ensure that climate and environmental data are openly accessible, well-documented, and interoperable across agencies, researchers, and the private sector.

Decision tools for deep uncertainty

Invest in uncertainty-aware decision tools (ensembles, scenario analysis, adaptive pathways) so policies are robust to shifting baselines, explicitly tracking deep uncertainty in rainfall, surge, and dust regimes.

Promote Regional Efforts in Modelling Extreme Weather risks

Effectively mitigating physical climate risks requires a clear understanding of how extreme weather events are projected in terms of frequency and intensity. Risks that cannot be accurately measured are difficult to manage, making data availability, transparency, and regional collaboration essential.

Given the transboundary nature of extreme weather events, GCC countries could benefit from sharing exposure data and collaborating on regional climate risk modelling efforts. Without reliable and accessible modelling of extreme weather hazards, assessing and disclosing physical risk exposures will remain challenging. This lack of information limits the ability of businesses and governments to take proactive measures—such as securing insurance coverage or implementing climate-resilient infrastructure—while also weakening overall financial and strategic planning.

> **Strengthening regional data collection, improving access to climate risk projections, and developing standardised disclosure frameworks will support informed decision-making, enhance resilience, and drive investment in adaptation across the GCC.**

Develop a GCC-wide hazard modelling platform

Establish a shared regional platform that integrates models for rainfall and urban flooding, coastal flooding and SLR, heat stress, and sand/dust storms. Use shared data standards and verification.

The record rains of 16 April 2024 in Dubai, driven by tropical moisture colliding with a mid-latitude storm, underscore the need for models that link large-scale weather systems to neighbourhood-level impacts.

Standardise hazard metrics and thresholds

Agree on shared methods for SLR allowances, extreme rainfall design curves, dust metrics, and heat-health thresholds.

Standardisation will ensure comparability across countries, accelerate adoption in planning and building codes, and provide a consistent basis for infrastructure and health protection measures.

Create a regional hazards network

Build specialised networks to address cross-border hazards, such as a dust and sandstorm modelling system, a heat-risk projection framework to guide health and labour standards, and a regional coastal flooding archive combining tide, surge, and wave records.

These networks would provide early warnings and inform adaptation roadmaps.

Establish a GCC Extreme Weather Consortium

Formalise cooperation through a consortium that curates shared observational baselines, coordinates post-event rapid reviews, and trains analysts across ministries and utilities.

Open data hazard layers published through a GCC geoportal would ensure data access for governments, insurers, and investors.

Finance

Integrate Climate-related Physical Risk Assessment in the Financial Sector

Across the GCC and beyond, there is growing recognition of the value of integrating climate-related physical risk considerations into financial decision-making. Financial institutions, market participants and other stakeholders can benefit from the wider use of standardised, transparent and science-based approaches to assessing physical climate risks across different types of assets and over the short and longer term.

> **Giving greater consideration to climate risk metrics in investment and lending decisions can help support more resilient and well-informed financial practices.**

Strengthen evidence for risk assessment

Encourage financial institutions to use standardised, science-based, and locally calibrated data, including flood maps, heat indices, and coastal projections, when assessing exposures across asset classes and time horizons.

Institutionalise climate risk scenarios

Promote the regular use of multi-hazard climate scenarios on both short- and long-term horizons. Link scenario results to investment, lending, and underwriting decisions.

The cost of inaction in decision making

Encourage public agencies, regulators, banks, and firms to embed climate-risk and “cost-of-inaction” assessments in capital budgeting, lending, and procurement. Assess the full value of a project over its lifecycle including how well it prevents disruptions or downtime, not just upfront cost.

The price on inaction in decision making

Encourage public agencies, regulators, banks, and large firms to embed climate-risk and “cost-of-inaction” assessments in capital budgeting, lending, and procurement.

Assess the full value of a project over its lifecycle including how well it prevents disruptions or downtime, not just upfront cost.

Mobilise the insurance sector to price and reduce risk

Establish public–private insurance partnerships for regional risk pools and covers for extreme climate-related events, with premium discounts for verified resilience upgrades.

Require insurers to integrate forward-looking climate hazards into pricing and assessments, and to share anonymised loss data to inform planning.

Create Sustainable Taxonomies that Includes Adaptation Classification

Green and sustainable taxonomies play a crucial role in aligning long-term sustainability objectives by establishing a common language for investors, developers, and policymakers. They provide clarity on investment options and help prevent greenwashing.

Several GCC countries are currently developing their own national green taxonomies, presenting an opportunity to create a regional taxonomy through existing GCC cooperation mechanisms. While green taxonomies are powerful tools for directing capital toward environmentally sustainable economic activities, they have primarily focused on mitigation, leaving adaptation underrepresented. To address these gaps, GCC taxonomies can utilise the following actions:

Explicit classification of adaptation and resilience activities

Define clear adaptation categories, eligibility criteria, and outcome metrics (e.g., expected-loss reduction, service continuity) alongside safeguards. Include nature-based and "dual-benefit" options—such as mangroves preservation and/or restoration, ecosystem-based adaptation, and distributed renewables with resilience functions so integrated actions are recognised and rewarded.

Harmonise of a GCC-wide taxonomy

Leverage existing GCC cooperation mechanisms to align national taxonomies into a regional framework with common definitions, sector annexes (water, coastal, health, agriculture, energy), and a regular update cycle.

A shared taxonomy creates a common language for investors and improves cross-border comparability and capital flows.

Link the taxonomy to financing and disclosure

Encourage systematic reporting of investments aligned with climate adaptation or resilience and embed taxonomy use within national financing strategies and disclosure frameworks

Strengthen uptake by tying eligibility to targeted incentives, such as guarantees or concessional rates, and by requiring robust verification and assurance to ensure credibility and scale up investment in resilience.

Enhance finance flows

Financing climate adaptation remains a persistent challenge, shaped various barriers that limit investment in climate resilience.

> **These challenges often stem from an incomplete understanding of the long-term benefits of adaptation and an underestimation of the economic and social risks associated with inaction.**

Addressing these constraints requires targeted efforts to enhance finance flows by translating high-level climate strategies into bankable, evidence-based project pipelines. **Leveraging innovative financing instruments—such as green bonds and blended finance—can help mobilise private capital at scale, reduce investment risk, and align adaptation investments with national development priorities.** Together, these approaches can unlock new sources of finance and accelerate the delivery of resilient, climate-smart projects across the region.

Translate strategy into a bankable project pipeline

Establish a clear framework for prioritising and sequencing investments, ensuring projects are grounded in evidence and aligned with national adaptation goals. Standardise preparation processes to demonstrate outcomes and costs in multi-year programs. **This structured approach can help in turning ambitious, high-level national climate goals into specific, financially viable projects.**

Utilise Growing Green Bonds Market

Green bonds are an increasingly important instrument for financing climate adaptation while mobilising private capital. **Green bonds enable governments and public-sector entities with strong credit ratings to raise funds specifically for adaptation investments, such as flood protection, resilient infrastructure, and climate-resilient water systems[84].**

The issuance of green bonds and sukuks is growing across the GCC—particularly in the UAE, Saudi Arabia, and Qatar. **For example, Saudi Arabia's Green Finance Framework, aligned with the country's Vision 2030 and the Sustainable Development Goals (SDGs), explicitly recognise green bonds opportunities related to water management, biodiversity, and NbS, including coastal management and combating desertification, with clear adaptation objectives and mitigation co-benefits[85].**

Scale blended finance for climate resilience

Blended finance is a structuring approach that deploys catalytic capital from public or philanthropic sources to mobilise private investment in sustainable development. **By mitigating risk and enhancing risk-adjusted returns, blended finance helps unlock much-needed capital for climate adaptation and resilience projects.**

Blended finance is gaining traction across the GCC, particularly as a mechanism to support startups and scale climate innovation and solutions. **Abu Dhabi has identified blended finance as a key instrument for achieving its net-zero objectives, while Saudi Arabia's Public Investment Fund updated its Green Finance Framework in 2024 to incorporate concessional capital within green bond offerings[86].** Early momentum is evident in projects focused on climate resilient agriculture, NbS, and climate technologies.

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