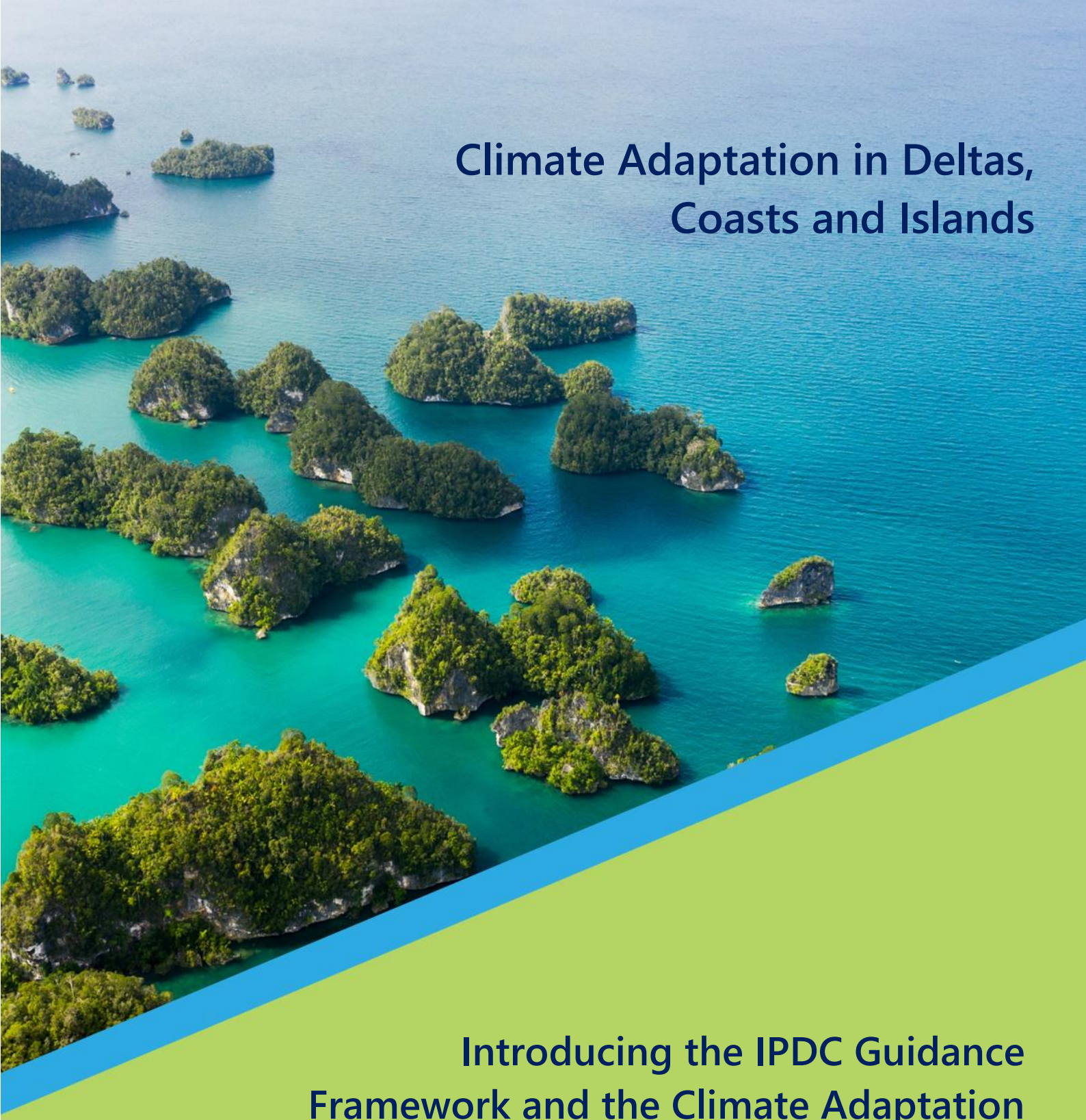

Climate Adaptation in Deltas, Coasts and Islands

Introducing the IPDC Guidance Framework and the Climate Adaptation Context of the IPDC Members

International Panel on Deltas and Coastal Areas (IPDC)

May 2024

International Panel on Deltas and Coastal Areas – IPDC

Climate Adaptation in Deltas, Coasts and Islands: *Introducing the IPDC Guidance Framework and the Climate Adaptation Context of the IPDC Members.*

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Summary

Deltas, coasts and small islands are particularly vulnerable to the impacts of climate change. These areas are often highly populated and of crucial importance to society, economy and ecosystems. Changing weather patterns are causing heavier downpours, more intense storms, heatwaves and droughts. These climate extremes and other climate change impacts will increase pressure on water systems, worsening already existing water-related challenges and disasters. This will affect ecosystems, health, domestic water supply, transport, energy production and economic sectors, such as agriculture, tourism and industries.

To safeguard livelihoods and preserve vulnerable regions such as deltas, coasts, and islands, it is becoming increasingly apparent that adaptation measures are necessary to protect these regions and countries from the impacts of climate change. Despite the progress in global adaptation planning, financing, and implementation, adaptation efforts are not keeping up with the growing climate risks. Additionally, international adaptation finance flows to developing countries are estimated to 10-18 times smaller than the required amount, creating an adaptation implementation gap (United Nations Environment Programme, 2023). To prevent this adaptation gap from widening, robust efforts to accelerate adaptation actions are necessary.

The International Panel for Deltas and Coastal Areas (IPDC) is a flagship initiative by the Dutch Government as a key commitment to the Water Action Agenda. IPDC is a unique partnership, bringing together governments, financial institutions, scientific experts, and practitioners from around the world. IPDC's mission is to bring water to the heart of climate adaptation, and it aims to contribute to bridging the gap between climate adaptation needs and implementation in deltas, coasts and islands. To achieve its objective, IPDC applies a demand-driven approach to overcome implementation barriers and strengthen enabling conditions related to governance, knowledge development, capacity and access to finance. To take stock of its progress in accelerating adaptation implementation, IPDC releases regular updates about its progress.

This first IPDC report describes the unique and complex challenges faced by deltas, coasts and islands and stresses the need to accelerate climate adaptation implementation efforts to bridge the adaptation implementation gap. To align terminologies and identify common barriers to adaptation implementation, the IPDC Guidance Framework is introduced. It describes the adaptation planning and implementation process inherent to conventional policy cycles in most of the IPDC members in three fundamental stages. The first stage comprises the strategic planning phase and describes key steps and elements in the adaptation strategy planning process. The second stage entails key considerations for prioritisation and investment planning. The third stage outlines common enabling conditions and barriers to adaptation implementation. Additionally, it describes financing arrangements and resources.

The IPDC members actively engage in sharing their national adaptation contexts in relation to the three stages of the IPDC Guidance Framework. This collaborative effort involves each member contributing insights into their respective national adaptation planning and implementation processes, including adaptation strategies, planning and investment processes and procedures, and the enablers and barriers to implementation. Common implementation barriers of the IPDC members relate to insufficient knowledge and a lack of data to inform decision-making, the complexities associated with transitioning from a sectoral to an integrated governance approach, limited institutional capacities at various levels and limited access to financing. Building on these most common barriers, IPDC aims to contribute to bridging the adaptation implementation gap by applying a demand-driven approach to strengthening enabling conditions related to I) knowledge development, 2) suitable governance, 3) capacity strengthening, and 4) access to finance.

Contents

Abbreviations

ADM	Adaptive Delta Management
AIS	Administrative and Institutional System
AR6	IPCC 6th Assessment Report
ASEAN	Association of South East Asian Nations
BCCSAP	Bangladesh Climate Change Strategy and Action Plan
BCCTF	Bangladesh Climate Change Trust Fund
BDP2100	Bangladesh Delta Plan 2100
CAF	Development Bank of Latin America
CAS	Climate Adaptation Services
CC	Climate Change
CCA	Climate Change Adaptation
CCDR	Country Climate and Development Report (WB)
CEA	Cost-effectiveness Analysis
COFEMA	Environmental Federal Council (Argentina)
COP	Conference of the Parties
CRIDA	Climate Risk Informed Decision Analysis
CTCN	Climate Technology Center and Network
DAPP	Dynamic Adaptive Policy Pathways
DRM	Disaster Risk Management
EPIC	Enable, Plan, Invest and Control
GBM	Ganges, Brahmaputra and Meghna
GCCA	Global Climate Change Alliance
GCF	Global Climate Fund
GDP	Gross Domestic Product
GEF	Global Environmental Facility
GHG	Greenhouse Gas
GNCC	National Climate Change Cabinet (Argentina)
IADB	Inter-American Development Bank
IAM	Integrated Assessment Model
ICZM	Integrated Coastal Zone Management
IPCC	International Panel for Climate Change
IPDC	International Panel on Deltas and Coastal Areas
IWRM	Integrated Water Resources Management
KNMI	Royal Dutch Meteorological Institute
LDCF	Least Developed Countries Fund
MCA	Multi-Criteria Analysis
MCDA	Multi-Criteria Decision Analysis
MCPP	Mujib Climate Prosperity Plan 2022-2041 (Bangladesh)
MEL	Monitoring, Evaluation and Learning
MPA	Marine Protected Area
M&E	Monitoring and Evaluation
NAP	National Adaptation Plan
NAS	National Adaptation Strategy
NCCS	National Council for Climate Change (Egypt)
NCRA	National Climate Risk Assessment (The Netherlands)
NCRC	National Climate Resilience Council (Aruba)
NEPP	Nature and Environmental Policy Plan (Bonaire, St. Eustatius, Saba)

NDC	National Determined Contribution
NGO	Non-governmental Organisation
NPAMCC	National Plan for Adaptation and Mitigation to Climate Change (Argentina)
NRS	Natural Resources System
NSP	National Strategic Plan (Aruba)
NWP	National Water Programme (the Netherlands)
O&M	Operation and Maintenance
OECD	Organization for Economic Cooperation and Development
PES	Public Entity Saba
PNACC	National Plan for Adaptation to Climate Change (Colombia)
PPP	Public-Private Partnership
PPRN	Natural Risk Prevention Plans (St. Martin)
PUB	Public Utilities Board (Singapore)
RCP	Representative Concentration Pathway
SCBA	Social Cost-Benefit Analysis
SCCF	Special Climate Change Fund
SDG	Sustainable Development Goal
SEC	Saba Electric Company
SEIA	Social and Environmental Impact Assessment
SES	Socioeconomic System
UNEP	United Nations Environmental Program
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
USD	United States Dollar
VROMI	Ministry of Public Housing, Spatial Planning, Environment and Infrastructure
V3	Third National Climate Change Study (Singapore)
WaL	Water as Leverage

1 Introduction

1.1 Water Climate Adaptation Gaps

Water is a fundamental requirement for all life on our planet. Humans have been managing water systems for centuries to meet their basic needs. Besides drinking and sanitation, freshwater is used for agriculture, industry, energy production, and recreation. Additionally, water systems are essential for flood protection, reducing water pollution, and preserving healthy aquatic ecosystems. This makes deltas, coasts and islands, with often abundant availability of freshwater resources, an adequate environment for human civilisation. Exponential population growth and increased economic activity have increased the demand for freshwater, while supply is exposed to substantial and increasing seasonal fluctuations. As a result, many water systems have become severely stressed. Climate change has further exacerbated these challenges, making deltas, coasts, and islands increasingly vulnerable. According to the IPCC Working Group II Sixth Assessment Report (IPCC, 2022), climate change is widespread, rapid and intensifying, and the world will face severe climate risks before the end of this century, even under low-emission scenarios. Rising sea levels, storm surges, floods, droughts, and water scarcity are some of the most imminent threats faced by deltas, coasts and islands.

Ambitious and accelerated climate change adaptation actions are key to reduce the current climate risks and to prepare for the future. According to UNEP (2022), this calls for groundbreaking acceleration in scientific research, innovative planning, more and better finance and implementation, increased monitoring and evaluation, and deeper international cooperation. At this moment, about 85% of countries have at least one national-level adaptation planning instrument in place (e.g. policies, strategies or plans) (UNEP, 2023). Despite progress, current adaptation efforts do not match the levels needed to respond to the impacts of climate change, creating adaptation gaps[*]. Moreover, most adaptation efforts are fragmented, small-scale, sector-specific, and focused on planning rather than implementation (IPCC, 2022). Adaptation gaps are partially caused by the increasing disparities between the large-scale investments needed to help societies build resilience and adapt to the impacts of climate change, and the public and private finances allocated to climate adaptation. Adaptation finance needs were found to be 10-18 times higher than current international public adaptation finance flows (UNEP, 2023). Lower-income countries experience the largest adaptation gaps, and at current rates of planning and implementation, the adaptation gap will most likely continue to grow (IPCC, 2022; GCA, 2024).

Besides sufficient finance flows, other barriers hinder the implementation of appropriate adaptation measures, even when climate adaptation strategies have been formulated. An example of such a barrier is the complex process of evaluating the feasibility, cost-effectiveness, sustainability, and fairness of adaptation measures necessary to make information-based choices. Climate change is rarely the exclusive driver for interventions in the respective area. Therefore, climate change adaptation requires an integrative and comprehensive approach that considers the unique characteristics of local and regional contexts and development transitions.

[*] An adaptation gap is defined as the difference between implemented adaptation and a societally set goal, determined largely by preferences related to tolerated climate change impacts and reflecting resource limitations and competing priorities (IPCC, 2022).

1.2 International Panel on Deltas and Coastal Areas (IPDC)

The Dutch Ministry of Infrastructure and Water Management initiated the International Panel on Deltas and Coastal Areas (IPDC) as a flagship initiative of the Government of the Netherlands and as a critical commitment to the Water Action Agenda. Ultimately, IPDC aims to contribute to safeguarding millions of people from the impacts of climate change and other pressures by bridging the gap between adaptation needs and implementation in deltas, coasts and islands. Accordingly, IPDC's mission is set as follows:

IPDC's Mission
Bridging the gap between adaptation needs and implementation, allowing the scaling-up and accelerating of climate adaptation actions and investment for climate resilient deltas, coasts, and islands.

To achieve its mission, IPDC aims to improve enabling conditions related to governance, knowledge development, capacity strengthening and access to adaptation finance, see Figure 1. IPDC aims to leverage the power of multi-actor collaboration by connecting three layers of decision-making and financing, knowledge development, and practice. The *Policy Layer* consists of high-level leaders for political and financial commitment and leadership. The *Science Community* comprises top-level scientists and adaptation experts, that link shared knowledge to local planning and implementation needs. The *Implementation Layer* consists of knowledge networks and implementation agencies working together with local and international experts to support accelerated adaptation actions on the ground.

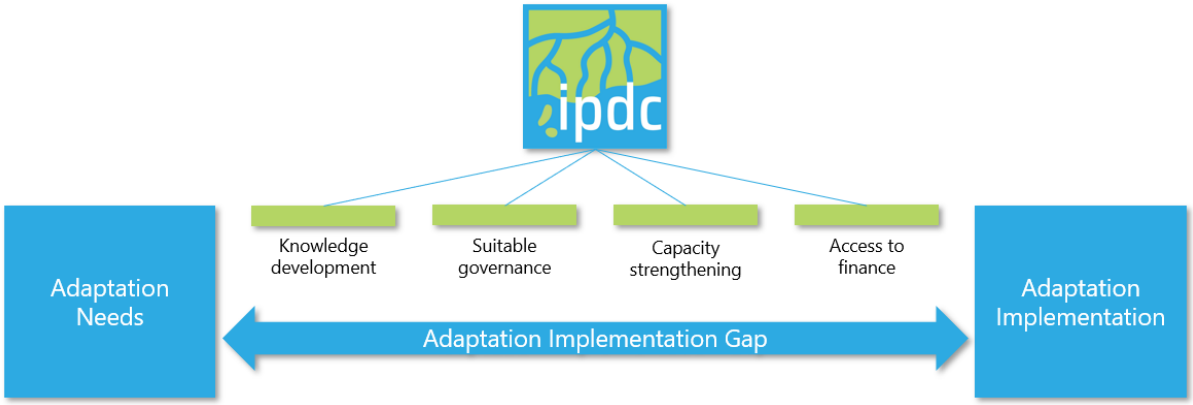

Figure 1. IPDC's focus on enhancing enabling conditions to bridge the adaptation implementation gap.

1.3 Report Structure

Chapter 2 presents the climate adaptation landscape and its intersection with the management of deltas, coasts, and islands. It briefly elaborates on major pressures (including climate change) and (re)iterates a "call to action" to incorporate these environmental trends in the development of policies.

Chapter 3 introduces the IPDC's Guidance Framework for Water Climate Adaptation, which covers the process from the development of climate adaptation strategies to financing and project-based implementation. By outlining key elements and processes that are integral to national policy cycles, it aims to create a shared understanding among IPDC members.

Chapter 4 entails the national adaptation contexts of the IPDC members. These concise chapters describe relevant strategies, plans, and implementation efforts and provide an inventory of the most important barriers to adaptation implementation. These chapters are the result of a collaborative effort by dedicated country teams comprising national experts.

Chapter 5 draws several conclusions about the Guidance Framework and the country contributions, and gives several recommendations regarding the future direction of IPDC to achieve its mission to accelerate climate adaptation implementation.

2 Water Climate Adaption in Deltas, Coasts, and Islands

2.1 Deltas, Coasts, and Islands as Vulnerability Hotspots

Deltas and coasts are often highly populated areas; approximately 40% of the world's population resides within 100 km of the coast (Martinez et al., 2007). Low-lying deltas are home to 450 million people (Schmitt et al., 2023), most of whom live in developing or least-developed economies (Edmonds et al., 2020). Many of these inhabitants are structurally exposed to rising sea levels, storm surges, floods, droughts, and water scarcity. Additionally, the frequency of major natural disasters has nearly doubled from 10 per year before the 2000s to 20 per year over the past two decades (CRED, 2020). Approximately 90% of the people living in deltas reside in areas most affected by tropical cyclones (Edmonds et al., 2020).

Small islands share similarities such as geographical remoteness, isolation, narrow resource bases and heavy dependency on external trade. Many islands experience a disproportionate impact of natural hazards associated with climate change. Compared to larger landmasses, many climate change-driven impacts and risks are amplified for small islands (Mycoo et al., 2022). Storms, floods, coastal erosion and permanent inundation may even threaten their sheer existence. Climate adaptation is often hampered by limited access to climate finance and lack of capacity. Data limitations for adaptation projects, high transaction costs, and small project sizes make it difficult for small island states to attract investments and compete for access to climate-resilient financing (UN-OHRLLS, 2022).

The impact of climate change will be felt stronger along coastlines that already suffer from ecosystem decline. For instance, the worldwide degradation of 50% of salt marshes, 35% of mangroves, 30% of coral reefs, and 29% of seagrasses has already increased the vulnerability to flooding and economic damage in coastal areas (Barbier et al., 2011). Increased development pressures, such as rapid urbanisation, tourism, overexploited fisheries, and pollution, drastically affect marine and coastal resources (UNESCO-IOC, 2021).

Meanwhile, deltas, coasts and islands are regions of national and international importance to society, the economy, ecosystems and cultural heritage. Despite covering less than 0.5% of the world's land area, river deltas contribute to over 4% of the global Gross Domestic Product (GDP) and 3% of worldwide crop production (Schmitt et al., 2023).

2.2 Overview of Current and Future Risks, Pressures and Drivers

Deltas, coasts and islands are already under pressure from many natural and anthropogenic drivers (see Figure 2). Geological compaction and weather extremes result in coastal erosion, land subsidence, regular flooding and salt intrusion. Additionally, many deltas, coasts and islands are exposed to temperate or tropical storms and typhoons, giving rise to disasters due to strong winds, floods and landslides. Furthermore, deltas are under pressure from upstream developments in river basins, such as hydropower dams, water diversions and wastewater discharges, which often cause significant changes in the river regime, both in terms of water quantity and water quality. Particularly, reductions in sediment transport downstream may cause significant coastal and riverbank erosion in deltas. Economic developments, population growth and tourism expansion in the low-lying deltas and coastal zones put existing ecosystems and natural resources under pressure. All these pressures and risks are often mutually connected. Therefore, the presentation in Figure 2 is a mere simplification of the complexity of the human-environmental interactions.

As shown in Figure 2, climate change pressures mostly intensify the already existing risks. One of the most conspicuous risks to deltas, coasts and islands is accelerated sea level rise. Additionally, heavier downpours and more intense storms as a result of changing weather patterns will worsen existing issues related to erosion and natural disasters.

From Figure 2, it is evident that there are many risks related to water management. Climate extremes and climate change will increase the stress on water systems, which in turn have repercussions on ecosystems, society and economic sectors, such as agriculture, industries and energy production. This is why IPDC focuses on Water Climate Adaptation, which evidently has a pivotal role in reducing climate risks for societies and economies of deltas, coasts and islands.

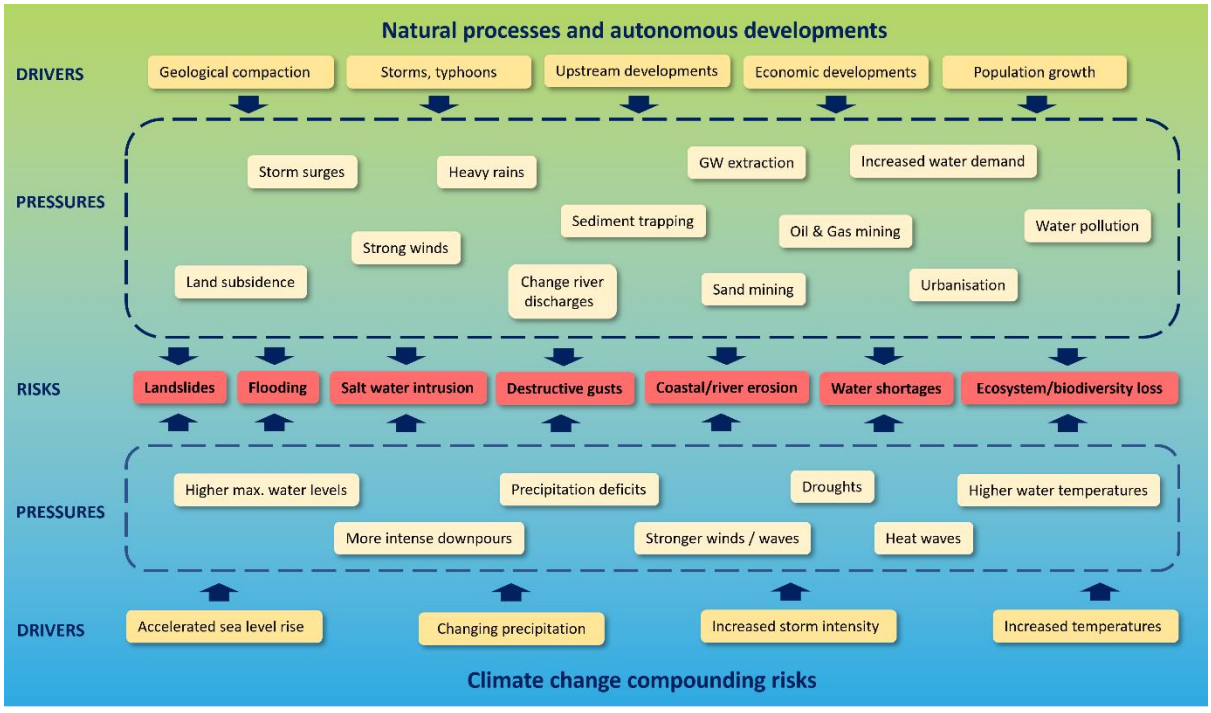

Figure 2. Illustration of the connection between key drivers, pressures and risks in deltas, coasts and islands.

2.3 Introducing Water Climate Adaptation

Water Climate Adaptation is inevitably closely related to existing policy domains, including water resource management, disaster management and coastal zone management. It is therefore important that Water Climate Adaptation should not be considered a separate policy domain. Instead, it should be integrated into existing (development-related) regulations and policies.

To adopt a preventive approach to water-related risks, it is imperative to include risk considerations and related adaptation interventions in existing plans and strategies. Intervention approaches that support integration and systems thinking, such as Ecosystem-Based Adaptation, Landscape approaches, Integrated Water Resource Management (IWRM), and Integrated Coastal Zone Management (ICZM), can be utilised. Novel approaches to address hydroclimate risks have emerged in recent years, such as CRIDA (Mendoza et al., 2018) and EPIC (Browder et al., 2021). The CRIDA (Climate Risk Informed Decision Analysis) approach provides a framework to assess the impact of climate uncertainty and change on water resources and works towards effective adaptation strategies. The EPIC (Enable, Plan, Invest and Control) Response is a new institutional approach aimed at better managing and responding to hydro-climatic risks: it considers floods and droughts not as independent events but rather as different ends of the same hydro-climatic spectrum.

Since global agreements such as the Paris Agreement, the Sendai Framework for Disaster Risk Reduction and the Agenda 2030 for Sustainable Development have raised the bar for climate action internationally, planning and implementation at the national level is also gaining more attention. Nationally Determined Contributions (NDCs) and National Adaptation Plans (NAPs) are being developed to coordinate climate action (UNFCCC, 2022). Despite encouraging trends, adaptation progress at the national level does not appear to be at the appropriate scale (UNEP, 2021). Progress on adaptation is slowing down across three areas: finance, planning and implementation (UNEP, 2023). Hence, to safeguard livelihoods and preserve vulnerable regions such as deltas, coasts, and islands, strategic amplification of climate adaptation efforts is needed. Enabling conditions related to governance, capacities, knowledge and access to financing need to be strengthened in the appropriate institutional settings to improve the implementation of Water Climate Adaptation efforts.

3 IPDC's Guidance Framework for Climate Adaptation

The need to implement climate adaptation measures to safeguard regions and nations from the damaging impacts of climate change is becoming ever more apparent. IPDC aims to accelerate the implementation of climate adaptation in its member states.

Various methodological approaches to adaptation planning and implementation are described in the literature and carried out in practice. Additionally, IPDC members have established a legacy of strategic planning and assessment principles that have evolved to meet locally explicit goals and procedures. IPDC recognises and acknowledges the range of methodologies employed by its members in crafting these policies and strategies.

The IPDC presents a methodological standard to create a shared understanding among IPDC members by outlining key elements and processes that are integral to national policy cycles. The **IPDC Guidance Framework** aligns terminologies and can be regarded as a protocol comprising an integrative and adaptive approach with a robust scientific basis, and a focus on enabling conditions.

Water-related risks, and thus Water Climate Adaptation efforts, are linked to many other aspects, such as disaster risks, climate change, and sustainable development. Three key international policy frameworks that aim to enhance resilience to these challenges and promote sustainable development include the Sendai Framework, the Paris Agreement, and Agenda 2030. These frameworks are closely linked to Water Climate Adaptation, and all strive to reduce vulnerabilities and enhance resilience (Figure 3). Box 1 provides a more detailed description of the connections between Water Climate Adaptation and these frameworks.

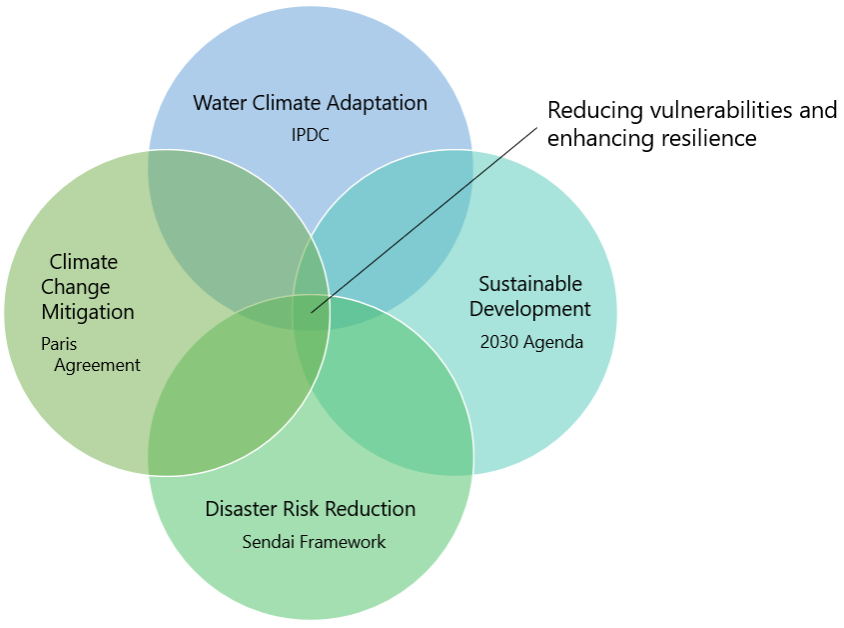

Figure 3. The connection between Water Climate Adaptation and the 2030 Agenda, Sendai Framework and the Paris Agreement.

Box 1. Connections between Water Climate Adaptation and other relevant frameworks

The **Sendai Framework** for Disaster Risk Reduction advocates for "The substantial reduction of disaster risk and losses in lives, livelihoods and health and in the economic, physical, social, cultural and environmental assets of persons, businesses, communities and countries". It outlines several targets aimed at achieving the following priorities: I) understanding disaster risk, II) strengthening governance, III) increasing investment in disaster reduction for resilience, and IV) enhancing disaster preparedness.

The **Paris Agreement** aims to strengthen the global response to climate change by keeping the global temperature rise well below two degrees Celsius above pre-industrial levels before the end of this century and stresses making efforts to limit the temperature increase even further to 1.5 degrees Celsius. These temperature goals directly impact water systems and relate to water-related risks, such as sea level rise, precipitation patterns and extreme weather events.

The **Global Sustainable Development Goals** (SDGs) are a set of 17 interconnected objectives established by the United Nations in 2015. These goals aim to address global challenges and promote sustainable development by 2030.

Connections to Water Climate Adaptation

- The Sendai Framework and the Paris Agreement recognise the need to increase countries' resilience and their abilities to deal with the impacts of climate change. Water Climate Adaptation efforts play a crucial role in enhancing adaptive capacity; by addressing water challenges, countries strengthen their resilience to climate impacts and reduce disaster losses.
- The Sendai Framework recognises the importance of protective Green Infrastructure solutions. Such solutions, including wetlands, mangroves and other natural buffers, can serve as entry points for disaster risk reduction in water-related contexts.
- The Paris Agreement requires all parties to submit their Nationally Determined Contributions (NDCs), outlining their emission reductions and adaptation measures. This creates transparency by ensuring that water adaptation efforts are tracked and shared globally.
- There are many connections between the Sustainable Development Goals (SDGs) and Water Climate Adaptation. One of the most obvious connections is through Goal 13.1, which aims to strengthen resilience and adaptive capacity to climate-related hazards and natural disasters. However, the importance of addressing water-related challenges goes beyond this goal. Sustainable water management is crucial for both climate adaptation and achieving the SDGs. It plays a central role in building resilience, protecting health, and mitigating climate change itself.

Additional information about connections between climate adaptation, the SDGs and the Sendai Framework can be found in (UNFCCC, 2017).

The Three Stages in Water Climate Adaptation

The Guidance Framework addresses the policy cycle between strategy development and implementation, discerning three stages (Figure 4). The first stage comprises the strategic planning phase and describes key elements in the Water Climate Adaptation strategy building processes. The second stage entails the prioritisation process of strategies and elaborates on the necessary steps that must be taken to prepare Water Climate Adaptation strategies towards implementation. In the third stage, implementation barriers and enabling conditions are set out, and financing resources and arrangements are discussed. It is important to note that the strategy-building and implementation process is a continuous process involving regular feedback loops. Revisions of strategies may be required when new information becomes available or when the objectives of the policy change.

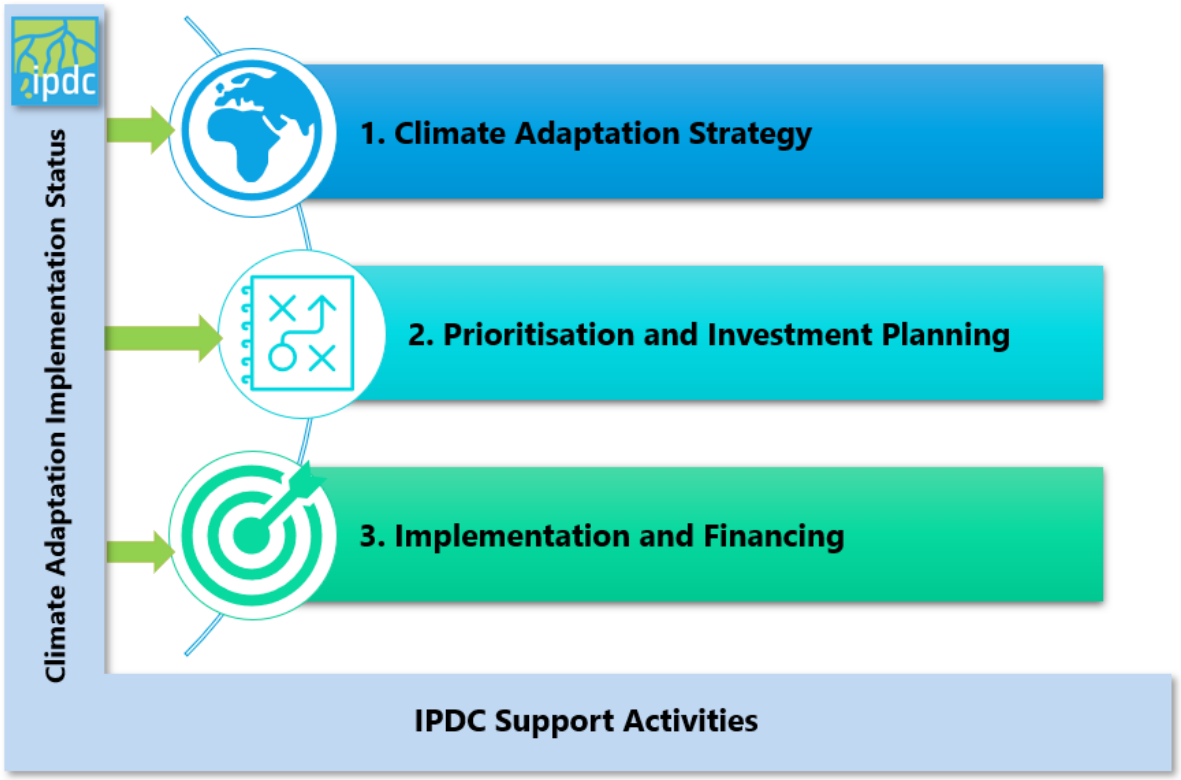

Figure 4. The three stages of the IPDC's Guidance Framework for Water Climate Adaptation.

3.1 Stage 1: Water Climate Adaptation Strategy

Stage 1 provides crucial elements, planning processes, and tools essential to climate adaptation strategies. These elements and tools can be consulted if national climate adaptation strategies are in place but do not adequately consider water-related aspects. If no national adaptation strategies or plans have been developed, Stage 1 may be used as a starting guide for developing such a strategy. Stage 1 of the IPDC Framework is not intended to replace existing climate adaptation strategies, such as National Adaptation Plans (NAPs), nor does it suggest investing in developing a new strategy if one is already in place.

Box 2. National Adaptation Plans

NAPs aim to identify the medium- and long-term adaptation needs and strategies and programmes to address those needs. Additionally, NAPs aim to mainstream climate adaptation into national policies, plans and programs. Water-related challenges are an integral aspect of this process; by integrating Water Climate Adaptation in NAPs, countries can enhance their resilience to climate change.

Water and climate change are inextricably linked. Therefore, Water Climate Adaptation goals and objectives should be an integral part of NAPs (GWP, 2019). Water Tracker for National Climate Planning is a tool designed to assist countries in performing a self-assessment and integrating water resilience into their national climate plan (Harpman, 2023). Such an assessment reveals the hidden water needs of a national climate plan. It allows countries to make informed decisions about how to best allocate water and how to prepare for water shortage cases. Trade-offs in this decision-making process should be made with stakeholders from multiple sectors to create achievable and impactful projects (Alliance for Global Water Adaptation, 2024).

3.1.1 Elements of a Water Climate Adaptation Strategy

Rationale and Risk Assessments

A Water Climate Adaptation strategy should answer to the following questions:

- Problem statement — What issues require a strategic response?
- Vision, goal and objectives — What are the intended accomplishments of the strategy?
- Interventions and solutions — How will the identified goals be accomplished?

Water-related risks are often tied to climate and non-climatic factors and pressures. This necessitates an examination of the interconnections between these risks and their impacts on development goals and efforts to enhance resilience. Numerous approaches are at our disposal to identify threats and challenges, such as the CRIDA methodological framework for assessing climate risk and impacts on water security (Mendoza et al., 2018), Water Security Diagnostic Framework from the World Bank (WB, 2021), the Green Climate Fund Water Security Sectoral Guide (GCF, 2022) and the National Water Security Framework developed by the Asian Development Bank (Panella et al., 2020) (see Figure 5). Despite the occasional lack of a comprehensive evidence base, many countries have already conducted national risk assessments. It's worth noting that the IPCC, UNEP, and other agencies provide guidance for assessing climate impacts and risks.

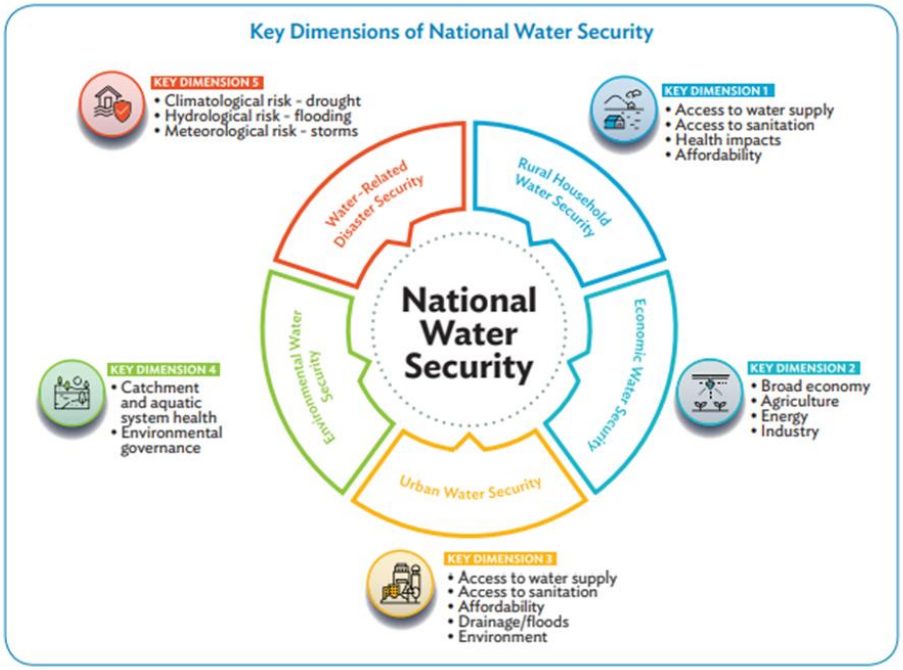

Figure 5. The Water Security framework, developed by the Asian Development Bank (Panella et al., 2020).

As Figure 5 clearly shows, water is essential for many sectors and services. Therefore, it is crucial to place the challenges related to the water system in the broader development context. Consequently, Water Climate Adaptation strategies should be integrated across sectors and services (i.e. sanitation, agriculture, energy production and ecosystem health), natural systems (i.e. surface water and groundwater, quantity and quality) and national policies (i.e. food security, public health and water safety).

In-depth analyses are required to attain a detailed inventory of the impacts of climate change and other pressures on the water sector and beyond. The analysis specifications and conditions must be secured at the study's outset to ensure broad endorsement of the analysis outcomes among stakeholders and societal actors. More information can be found, for instance, in the Strategic Water Systems Planning Framework (Beek et al., 2022).

An explicit inclusion of an inventory of enabling conditions and barriers to implementation during the formulation of a Water Climate Adaptation strategy will provide a powerful implementation feasibility dimension. An early inventory of these aspects may give rise to the formulation of alternative interventions in case essential enabling conditions are not in place. Enabling conditions and barriers to adaptation implementation are described in more detail in Stage 3 of the IPDC Guidance Framework.

Goals and Assessment Criteria

The goals and objectives of a Water Climate Adaptation strategy can be captured by the concept of water security. Grey & Sadoff (2007) defined water security as "*the availability of an acceptable quantity and quality of water for health, livelihoods, ecosystems and production, coupled with an acceptable level of water-related risks to people, environments and economies*". Other concepts can also be used to formulate water adaptation goals, including the targets of SDGs 6 (Clean Water and Sanitation), 13 (Climate Action), 14 (Life Below Water) and 15 (Life on Land).

These goals provide a good starting point for a Water Climate Adaptation strategy but must be made concrete and location specific. Ideally, they are operationalised into quantifiable objectives (e.g., the fraction of time during which freshwater supply is secured, safety standards for flood defences, or

ecological vitality indicators). Such measurable objectives and assessment criteria ease the process of formulating measures, tracking progress, and making necessary adjustments.

Many countries have already formulated specific goals and objectives related to Water Climate Adaptation in their national planning instruments and related documents (e.g. NAPs). In addition, countries may have developed sectoral plans in which water adaptation goals and measures appear, such as River Basin Management and Coastal Zone Management Strategies, National Water Plans, Delta Development Plans, etc. Still, many adaptation efforts remain fragmented, small-scale, sector-specific, and focused on planning rather than implementation (IPCC, 2022). Therefore, integrating Water Climate Adaptation goals and assessment criteria into national plans can improve the effectiveness of adaptation efforts.

Measures and Interventions

Developing measures and interventions to achieve adaptation goals and objectives does not only require technical expertise. It also involves dealing with general and country-specific ideas, concepts, regulations and policies. In some countries, Water Climate Adaptation strategies may be guided by state-led interventions, while in other countries, legal and regulatory boundary conditions guide the design of adaptation measures by local actors, private enterprises and other stakeholders.

Some particularly interesting measures are those that utilise unconventional and innovative concepts, such as nature-based solutions or ecosystem-based adaptation. Such measures have the potential to be highly efficient, cost-effective, and synergetic to accomplish multiple objectives. However, such innovative solutions may face different implementation barriers than traditional engineering measures (Seddon et al., 2020). For example, the lack of favourable mechanisms, incentives and enablers make the return on investment of nature-based solutions less straightforward compared to grey infrastructure, which offers more tangible benefits and direct payments.

Legal and Regulatory Frameworks

The importance of a legal and regulatory framework for climate adaptation is twofold. Firstly, it legitimises taking action and allocating public funds to implement measures. Secondly, it clarifies the responsibilities and roles of different national, regional and local governments, the private sector and other stakeholders.

At a practical and operational level, adaptation measures are most effective and efficient when they are aligned with and incorporated into existing regulations related to spatial planning, infrastructure maintenance, water management, emergency response, and other relevant aspects. For instance, design regulations for coastal protection, such as those related to sea dikes, can be modified to include climate change adaptation. Additionally, many climate adaptation frameworks are rightfully associated with disaster risk reduction, given the increase in extreme weather events caused by climate change.

Stringent regulations can impede the implementation of adaptation measures, especially if they go against traditional methods, such as nature-based solutions, or require a significant deviation from the norm. Updating such regulations or introducing new legislation can be a time-consuming process, making it difficult to take prompt action. In such circumstances, it may be advisable to adopt a parallel approach, combining practical short-term actions under the existing framework and a longer-term legislative process, either to update or establish a new regulatory framework.

According to the first global review of climate change adaptation laws and policies conducted by the Grantham Research Institute on Climate Change and the Environment and Centre for Climate Change Economics and Policy (Nachmany et al., 2019), many countries have taken action to address climate change adaptation. Specifically, 91 countries have passed at least one law that deals with climate change adaptation. In addition, half of the 100 countries analysed have given some responsibility for managing adaptation to local governments.

3.1.2 Planning Process and Tools

Policy Analysis

Policy Analysis is a commonly used method for designing policies. It intends to support policy-making processes using analytical tools with a systemic perspective. It initially was a rather technocratic method using systems analysis to solve problems. More recently, it has been applied in multi-actor settings, acknowledging that different parties, actors and stakeholders have different views and preferred solutions. Ultimately, settings with many actors and different interests require policy decisions and plans (Enserink et al., 2022).

There are many references and guidance documents available to help perform a policy analysis and understand the steps involved in the process. Ideally, the approach uses elements such as causal system analysis, actor/network analysis, and future scenario analysis, leading to an agreed problem description and alternative strategies and measures. Additionally, it acknowledges that the actual choice of strategy remains with the decision-maker(s).

Stakeholder Involvement

The way in which a water system is managed will influence the entire population that utilises it. To ensure fair and equal decision-making, a "whole-of-society" approach may be adopted when developing a Water Climate Adaptation strategy. This involves promoting inclusive participation across all individuals, including those in vulnerable groups, to support community-led initiatives and encourage social acceptance and compliance by the public.

Due to the interconnected nature of water systems across sectoral domains, links can be made across national laws, policies, and programs. A cross-sectoral collaboration between governments, NGOs, civil society, citizens, private entities, and academia can foster innovative and interdisciplinary solutions, as it allows for a diverse range of expertise to be utilised (see for instance Ostrom, 2010; Pahl-Wostl, 2009).

Although stakeholder inclusion is a crucial aspect of adaptation planning and implementation, it is not feasible to involve everyone during each stage of the process. Therefore, it is recommended to strategically select actors who are directly involved in the respective stage of the process and those who are affected by the outcome of the stage. Several tools and approaches are available to carry out a stakeholder identification and engagement process, such as the Importance against Influence Matrix and the Problem Tree Analysis, or more complex tools such as Community Institutional Resources Mapping (CIRM) and an Institutional Analysis (Brouwer et al., 2012).

It is important to maintain regular communication and keep stakeholders informed throughout all phases of developing a strategy. This involves recognising and addressing differences between stakeholders and establishing a common language that can be understood by all, including the public and private sectors, different levels of government, and various stakeholder groups. Creating platforms that allow individuals to express themselves using their own words can foster understanding, build trust, and promote a sense of ownership.

Computational Framework and Toolboxes

For effective climate adaptation decision-making, it is crucial to have a comprehensive understanding of current and future climate and socio-economic conditions, as well as the impact of various interventions. This understanding should be built on credible, relevant, and legitimate information. This necessitates the use of tested models and concepts that are specifically designed for the decision-making context. These models should have transparent and understandable assumptions about boundary conditions and process representation (Van den Hurk, 2022). A multitude of models and toolboxes are available to facilitate such analyses. For example, the NDC Partnership provides a set of tools, guidance, platforms and advisory support in its 'Climate Toolbox' to support planning and implementation of climate actions.

A Computational Framework of the water system is a powerful tool in the planning process of Water Climate Adaptation strategies. When combined with quantitative information, it becomes a potent instrument for assessing the effectiveness of potential measures. Such a framework is constructed by dividing the water system into three sub-systems - the Natural Resources System (NRS), the Socio-Economic System (SES), and the Administrative and Institutional System (AIS) (Figure 6). A detailed analysis of each sub-system equips stakeholders with a comprehensive understanding of its operation, which is crucial to informed decision-making. Moreover, it promotes a holistic comprehension of the water system's functionality, enabling stakeholders to discern the effects of interventions in one part of the system on other system components.

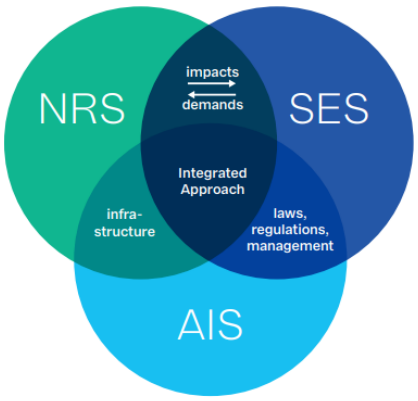

Figure 6. The interactions between the three sub-systems of the water system (Source: Beek et al., 2022).

One step further in complexity are Integrated Assessment Models (IAMs), that integrate climate and economic processes into one model. Although often applied in adaptation science, these models are highly aggregated and do not necessarily consider the variety of adaptation possibilities at the local, regional and sectoral levels (Schwarze et al., 2022). Additionally, many IAMs still provide information with a spatial-temporal resolution that is too coarse to be relevant for many adaptation policy decisions, particularly those at urban and municipal levels (Bosello, 2022).

Dealing with Uncertainties: Scenarios and Adaptation Pathways

The impact of future socio-economic developments and climate change on water systems are highly uncertain. Acknowledging and considering these uncertainties is crucial to making well-informed decisions about water system management. Developing and incorporating scenarios into adaptation strategies enables us to determine the extent to which the adaptation measures are sensitive to changes in biophysical boundary conditions. Additionally, analysing scenarios provides valuable insight into how hydro-climatic extremes can be managed while avoiding harm to the current water system.

There are multiple ways to incorporate scenarios into strategic planning These include projecting climate extremes through stress tests, applying incremental climate change and sea-level rise scenarios, or downscaling Global Climate Model projections. A literature review can provide qualitative insights into climate hazards, such as sea-level rise, flooding, drought, salinisation, coastal erosion, and storm surges, both historically and in the future. For more quantitative estimations, (sub-)national and climate model projections based on IPCC emission scenarios can be utilised.

One approach to manage uncertainty in climate risks and impacts for a water system is to use an adaptive management approach. The Dynamic Adaptive Policy Pathways (DAPP) approach is a planning tool designed to help create adaptable and robust strategies for different future scenarios (Haasnoot et al., 2013). It conceptualises an adaptive plan as a series of actions over time including their triggers and effectivity range, referred to as pathways. The objective of this exploratory model-based planning tool is to support the creation of practical strategies that can respond and adapt to future changes. The approach identifies tipping points that determine when a change in policy. This approach is widely used for designing strategies that can withstand the uncertainties of an ever-evolving future.

Storylines are a useful tool to support scenario development for climate risk assessments and designing climate adaptation strategies and pathways (Baulenas et al., 2023). They provide a compelling and consistent narrative of a future that is deemed plausible and relevant (Van den Hurk, 2022). In the context of climate adaptation, a storyline can be used as a narrative of plausible developments towards a sustainable and climate-resilient future, indicating the possible pathways with bottlenecks and potential solutions to reach this future.

3.2 Stage 2: Prioritisation and Investment Planning

3.2.1 Prioritisation Process

Political Dimension

Climate adaptation policies are developed within a complex political landscape that involves different governance actors embedded in various political structures. Besides the uncertainties about the impact of climate change, perceptions vary about the vulnerability to the risks posed by climate change as well (Adger et al., 2009; Adger et al., 2013). Consequently, incentives are shaped by different perceptions about (climate) risks, priorities, and resource constraints. This combination of factors introduces a great level of complexity to achieving climate adaptation policy optimums (Dolšak & Prakash, 2018).

Varying perceptions within different political contexts may influence the prioritisation process. In other words, selecting an adaptation strategy is usually not merely a rational choice based solely on scientific evidence. Being aware of the political dimension is a precondition to making the decision-making process more transparent and inclusive. It also draws attention to possible windows of opportunity: political agendas are highly volatile, and opportunities for discussing and deciding upon adaptation are often short-lived. Making use of these windows of opportunity requires political skills and quick action.

Urgency and Timing

Climate change was once seen as a future problem that governments could put on the back burner while focusing on more immediate concerns. This perception is changing as the impacts of climate change are now being felt more acutely (IPCC, 2023), making adaptation more urgent than ever. Urgency is, therefore, a critical factor in the decision-making process when it comes to prioritising adaptation measures. Even for impacts that are expected to occur in the long term, it may be necessary to prioritise adaptation measures in the short term. For example, adopting an adaptive approach to the prioritisation of measures can avoid making disinvestments and creating lock-in situations. Such an adaptive approach requires an iterative process of updating adaptation strategies when new information becomes available. The DAPP approach mentioned in Stage 1 can provide insights into the urgency and timing of these measures.

Evaluation of Adaptation Measures

To develop an effective adaptation strategy, it is crucial to carefully evaluate and select the most promising potential measures. This involves assessing factors such as their effectiveness, efficiency, legitimacy, and sustainability. It may be helpful to consult with relevant stakeholders and experts to identify potential measures and agree on criteria for evaluation. The screening process is an ongoing process that ultimately results in a set of promising measures.

It is important to evaluate the technical and implementation feasibility, as well as the hydrological, social, economic, and environmental impacts of potential measures. Various tools are available to facilitate this screening process. A cost-effectiveness analysis (CEA) is an economic analysis that compares the outcomes of a measure with its relative costs. Social and environmental impact assessments (SEIA) can be used to assess potential social impacts, such as job generation in the area. A social cost-benefit analysis (SCBA) can be applied to determine whether a measure's social benefits outweigh its costs. Finally, a multi-criteria analysis (MCA) is an overarching systematic approach to screen measures and is often used to inform complex decisions when multiple conflicting criteria are involved.

A particular category of promising measures are "no-regret measures". These measures create a maximum positive impact on the objective with minimal negative effects on other aspects. An important criterion for no-regret measures is that there must be a consensus among decision-makers and stakeholders that these measures should be implemented as soon as possible. Identifying no-regret measures early in the planning process is beneficial, as they can be implemented before other extensive studies have been completed.

3.2.2 Investment planning

Types of Adaptation Projects

Defining and prioritising projects, as set out above, is an important step in operationalising an adaptation strategy, as defined in Stage 1. A necessary next step towards investment planning is further categorising and refining the projects. This can help decision-makers to identify relevant stakeholders and clarify responsibilities for further investment planning.

Adaptation projects can be classified into two types: "Type 1 projects" and "Type 2 projects". Type 1 projects refer to investments that have climate adaptation *features*. These projects include those who's proper functioning is inhibited by climate risks. These projects require additional adaptive measures that increase their overall costs. Examples of Type 1 projects include roads, hospitals, or manufacturing facilities. On the other hand, Type 2 projects are those that are primarily aimed at increasing the resilience of their immediate surroundings against climate risks. Examples of Type 2 projects are dikes, flood plains, or water reservoirs. Depending on the type of project, the project ownership and therefore investment responsibility may lie with different (not solely governmental) organisations.

Although the focus of the global dialogue on adaptation is often on Type 2 projects, both Type 1 and Type 2 projects are important in making a country or region more climate resilient. In an ideal scenario, every (infrastructure) investment that is pursued should be climate resilient.

Involvement of the Private Sector

It is important to consider the role of the private sector in investment planning for different types of projects. This can range from minimal involvement to full responsibility for funding, designing, constructing, and maintaining a project. The level of private sector involvement will depend on factors such as the type of project, the country's priorities and capabilities, and the overall strategy. Four categories of public sector involvement are provided below:

- **Public**
  The public sector is the owner and funder of the project and is responsible for financing and implementing the works of the adaptation project, including the operational and maintenance period. An example of this would be upgrading an urban drainage system.
- **Mostly public**
  The public sector is the project owner and is responsible for the funding and financing. The private sector supports the design and construction through contracts. The public sector will operate and maintain the project. For example: an expansion of a public water treatment plant with the help of private contractors.
- **Public-Private**
  In a public-private partnership, the private sector is responsible for the design, construction, and maintenance as well as temporary financing of the full infrastructure, while the public sector is the project owner and pays the private sector for services through availability payments. An example of this would be a coastal protection scheme.
- **Private**
  In some cases, adaptation projects can be fully private. An example is a company that protects its private property with mobile flood barriers.

Overall, defining the role of the private sector in the realisation and operation of adaptation projects is important for a holistic, integrated adaptation strategy and investment planning.

3.3 Stage 3: Implementation and Financing

Once adaptation plans have been decided upon, the focus shifts to the agencies and stakeholders who are entrusted to implement the consolidated adaptation strategies. A well-designed adaptation plan includes an implementation strategy, consisting of a time schedule or road map, identification of responsibilities, as well as a monitoring and evaluation system. Even when such a strategy exists, the actual implementation may still encounter problems, challenges and delays. To identify and address these potential issues, it is essential to take stock of the enabling and inhibiting factors. The upcoming section provides an overview of such enablers and barriers. Financing is often a significant challenge and is discussed more comprehensively in section 3.3.2.

3.3.1 Enablers and Barriers to Implementation

Availability of Knowledge and Data

Making informed decisions requires access to comprehensive, reliable, and up-to-date information that is relevant to the task. This is particularly critical when assessing risk and vulnerabilities across different sectors and stakeholder groups. Standardised, timely, and relevant data can help identify and analyse different options for addressing climate and other threats. It can also help to monitor the impact of implemented measures on different sectors, regions, and groups. Making knowledge accessible and sharing best practices can foster innovation and empower communities and policymakers alike.

The success of adaptation planning largely depends on the knowledge and data that inform the models and toolboxes used in Stage 1. While many of these tools are readily available, their effectiveness can be severely limited by inadequate or imprecise data at the appropriate scale. Ultimately, the applicability of a model depends on the accuracy and quality of its input data and the fit-for-purpose of the model's set-up.

Climate adaptation often involves implementing solutions that are specific to a particular region and are based on validated local and indigenous knowledge. This requires collecting and reviewing local data and practices, and applying scientific methods to assess potential solutions against critical local information. Engaging and empowering citizens in the data collection process may enhance the success of adaptation measures.

Suitability of Governance

Governance refers to the process of decision-making and implementation within a particular society. It encompasses the roles played by various institutions, as well as the relationships between organisations and social groups involved in decision-making process. The OECD Principles on Water Governance (OECD, 2015) provide a useful framework for evaluation of the functioning of the governance arrangements. The framework encompasses three dimensions: Effectiveness, Efficiency, and Trust & Engagement. Each dimension is further divided into four sub-categories, as shown in Figure 7.

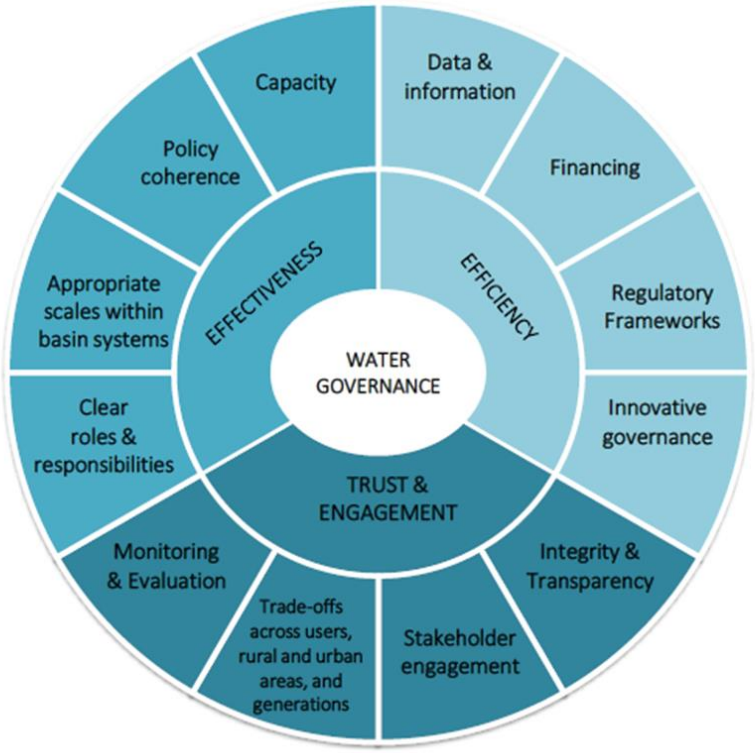

Figure 7. Schematic overview of the OECD Principles on Water Governance (OECD, 2015).

Adaptation efforts require a collaborative and multisectoral approach. In situations where there are unclear or overlapping mandates within existing administrative structures, it may be necessary to reorganise the policy-making system to streamline the planning and implementation processes. Such a reorganisation can take many forms and may involve the creation of new administrative bodies or the consolidation of existing ones (Dolšak & Prakash, 2018).

Adaptation planning is usually carried out at the national level, but the actual implementation of adaptation efforts typically occurs at the regional or local level. A lack of clear coordination can lead to confusion or tension between the national, regional and local levels. For example, it may be unclear whether regional plans are derived from the national agenda or if regional plans shape national planning (Dolšak & Prakash, 2018). In cases where regions are exposed to unique climate risks, regional-level planning may be more suitable than national-level planning.

Multilevel governance is an approach that aims to break silos between sectors, as well as between different levels of government. It is particularly useful in addressing climate adaptation in an integrative and sustainable manner. This approach recognises the diversity of stakeholders involved, ranging from local to national governments, and highlights the importance of collaborative efforts and dialogue across policy-making levels to tackle issues effectively. This Whole of Government and Whole of Society approach fosters a multi-level stakeholder governance process that enables the pooling of resources, expertise, and decision-making powers, facilitating the implementation of comprehensive adaptation strategies. Ultimately, multilevel governance not only enhances the effectiveness of climate adaptation efforts but also fosters inclusivity, transparency, and accountability in the decision-making process, laying the foundation for more resilient communities.

Capabilities and Skills

Adaptive water management requires institutional capacity in three key areas: 1) water management at the appropriate scale, 2) integration of climate risk considerations in spatial planning, and 3) capacity to identify and respond to risks and unexpected events. Upstream-downstream approaches and international cooperation are necessary for properly managing river basins. Specific types of interventions, such as integrating nature-based solutions into urban planning may require additional institutional capacities.

Individual capacities and capabilities are essential to effectively navigate societal adaptation and transformational processes. The introduction of new adaptation measures often necessitates training and capacity strengthening, which can be achieved through collaborations between educational institutions and actors with mutually agreed-upon targets. Leadership skills are crucial for individuals, particularly the ability to form collaborative partnerships and joint agreements to support collective governance. Successful climate adaptation demands the coordinated effort of all actors at all scales, emphasising the importance of genuine collaboration and partnerships.

Exchanging knowledge, learning, and strengthening capacities across countries at an institutional level are important enabling conditions for accelerating adaptation efforts (Johannessen et al., 2019). This is especially critical in places with limited institutional, organisational, and individual capacities. This is common for small islands and is often compounded by a brain drain of young people seeking higher education elsewhere. The traditional approach to capacity building relies on training individuals. These targeted trainings are important to strengthen capacities related to, for example, developing adaptation project proposals, or to more specific topics such as introducing nature-based solutions into engineering practices. However, it is essential also to take an institutional approach to capacity strengthening, which often involves multiple levels of actors (Alaerts & Kaspersma, 2022).

IPDC aims to facilitate the strengthening of institutional capacities, knowledge exchanging, and mutual learning by connecting countries that face similar challenges. Through its consultations, conferences, and publications, the IPDC aims to foster an ongoing dialogue and collaboration among its members.

Behavioural and Institutional Change

The successful implementation of adaptation measures often requires a change in the behaviour of individuals and institutions. This is especially true when implementing innovative solutions or making transformative changes. Sometimes, this requires a paradigm shift or a change in the mindset of those who are used to a traditional engineering approach. However, this may not be enough if official regulations and guidelines are not modified accordingly. If laws and regulations are not adequately adjusted, the risks may become too high for those responsible, who may be held liable if anything goes wrong.

Interventions that involve behavioural change at individual or local level, such as conserving water at the household level, can be challenging and require careful design, considering local customs, traditions and stakeholder support.

The Water as Leverage (WaL) methodology signifies a paradigm shift in planning, transforming water from a challenge into an opportunity and a unifying force. WaL is a methodology for developing comprehensive and sustainable project proposals, focused on readily implementable solutions that embrace inclusion and connectivity through design. WaL programs are carried out in Asia, Latin America, north-west Europe and Africa.

3.3.2 Funding and Financing Projects

A strong financing plan is crucial for the successful implementation of any project. To create such a plan, a comprehensive business case must be developed, which outlines the costs and revenue streams or funding sources for each stage of the project- from its development to implementation and finally to its operational phase.

Project Costs and Funding Needs

Different sources of *funding* are necessary for different types of adaptation projects in their different *phases* and for corresponding *cost elements*:

- Funding for the preparation period
  - Cost elements: (detailed) feasibility study, design, procurement
  - Often referred to as project development costs
- Funding for the implementation period
  - Cost elements: planning and permitting, construction, supervision, risk reservations
  - Often referred to as "Capex": capital expenditures
- Funding for the operational period
  - Cost elements: maintenance, operations, major repairs
  - Often referred to as "Opex": operational expenditures

Funding refers to the provision of financial resources without an obligation for repayment. Some examples of funding include government budgets, project-owned revenues (such as user payments or tariffs), or grants (see Figure 8).

Financing involves providing capital to a project with the expectation of repayment along with a return. Financing is required when there is a gap between available funds and actual expenditures. Loans (regular or concessional) are frequently used as a form of financing. It is important to note that eventually, funds may be required to pay back these loans, also during the operational phase.

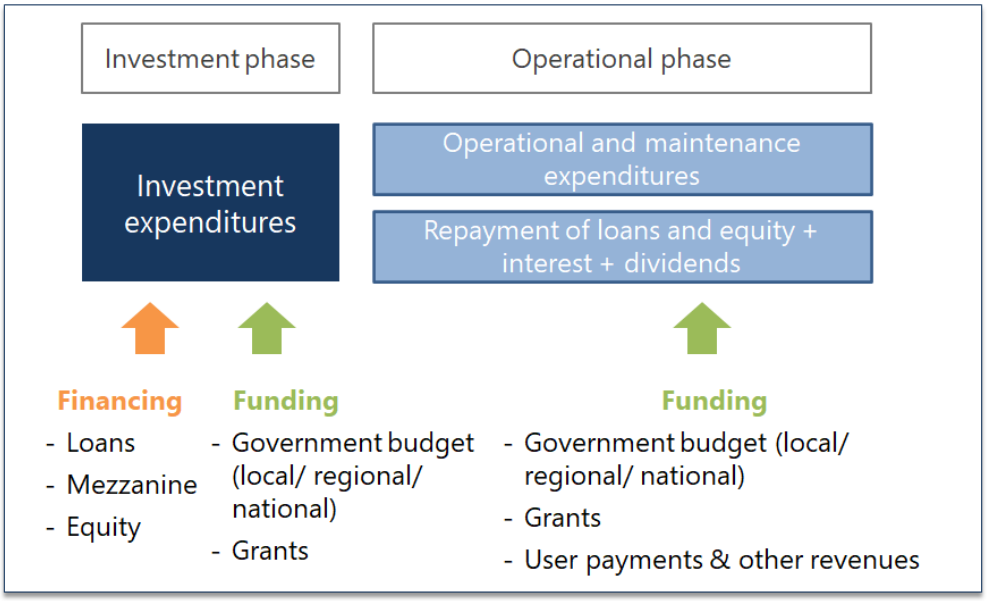

Figure 8. Uses and sources of funding and financing of adaptation projects during the investment and operational phase (Figure by Rebel).

Domestic Sources of Funding

It is important to identify any available domestic sources of funding. Depending on the ownership of the project (e.g. public or private, national or sub-national, etc.), and on the economic situation of the country, the available budgets might differ. Typical domestic sources include *national budgets* (annual or multi-annual), *sub-national budgets* (provincial, municipal, local taxes, etc.) and *local private sector sources*.

For public projects with direct and distinct private beneficiaries (e.g. home owners or businesses), *value capture instruments* could be used by the local government to build up funding. Examples of value capture include:

- Earmarking or increasing taxes for home owners, businesses, citizens in general, or specific citizen groups, such as tourists
- Establishing business improvement districts for specific business areas that will receive protection
- Direct contributions from large individual beneficiaries

An alternative approach to achieving adaptation goals using private resources is through *regulations*. Such regulations may include establishing adequate zoning plans, updating building codes, or conditional permitting. In particular, land reclamation and real estate developments can be subject to adaptation requirements that do not only benefit new assets, but also protect existing assets.

Domestic sources of funding form the foundation for a project's overall funding because international financial support typically requires a certain level of local co-funding. Additionally, international funds consider the long-term sustainability and functionality of a project. Consequently, the receiving country must often secure maintenance and operational budgets from domestic sources.

International Sources of Funding and Financing

Many countries struggle secure funding for adaptation plans, which is not surprising considering the huge challenges that lie ahead. The financing required to fund the implementation of these plans is lagging behind (Ligtvoet et al., 2023; UNEP, 2023). The most recent report on the state of climate adaptation finance (GCA, 2024) confirms this. While global climate finance (for mitigation and adaptation together) doubled between 2021/22 compared to 2019/20, the share of global adaptation finance decreased from 7% to 5% in the same period. In absolute terms, adaptation finance has increased by 28% to USD 63 billion in 2021/22. At the same time, the current need for adaptation finance by developing countries is estimated at USD 212 billion per year up to 2030. In 2021/22, only about a quarter of this need has been met (GCA, 2024).

The primary form of financing provided by international sources for climate adaptation is market debt at the project level, accounting for 60% of the total adaptation finance. This is followed by low-cost (or "concessional") debt for projects, accounting for 22%. Grants only make up 17% of the climate adaptation finance (GCA, 2024).

In 2021, 59 Least Developed Countries and Small Island Developing States received USD 20 billion in climate finance, but spent USD 33 billion on servicing public debt (IIED, 2023). The high proportion of debt instruments in the climate adaptation finance portfolio is not ideal, particularly given the increasing interest rates.

The following multilateral funds offer adaptation finance:

- Adaptation Fund
- Global Climate Change Alliance (GCCA)
- Global Environment Facility (GEF),
    - Least Developed Countries Fund (LDCF)
    - Special Climate Change fund (SCCF)
- Green Climate Fund (GCF)
- Pilot Program for Climate Resilience (part of the Climate Investment Funds)

Bilateral funds and financial support through multilateral development banks also contribute substantially to adaptation finance. The climate adaptation instruments and requirements (region, sector, ticket size, etc.) differ per fund and financial institution. Therefore, adequate options need to be evaluated on a project-by-project basis. The NDC Partnership Climate Funds Explorer may help to identify appropriate institutions and funds.

Overall, the adaptation finance landscape is fragmented and adaptation finance not easy to access. Therefore, it is advisable to carefully familiarise oneself with the procedures and requirements of each financial institution or fund in advance, and to utilise the support provided. For instance, in addition to project implementation funding, the GCF offers a Project Preparation Facility that can be accessed to develop a full project proposal.

4 Adaptation Context in the IPDC Member Countries

In its mission to accelerate climate adaptation efforts, IPDC embraces members needs and priorities via a demand-driven approach to pinpoint gaps in the climate adaptation implementation process. Each member partakes in a consultation process, which commences with an inventory and status assessment to identify primary adaptation implementation gaps. Subsequently, a scoping to make recommendation for priority activities is conducted, followed by identification of priorities and subsequent execution of activities (Figure 9). In that, IPDC stimulates integrated approach to climate adaptation that takes into consideration holistic spatial planning principles, stimulates the utilisation of nature-based solutions while allowing for rigorous assessment of their feasibility, and incorporates uncertainties of climate change in the planning processes. The integrated and holistic approach ensures that IPDC members are equipped with the necessary tools and knowledge to effectively respond to climate change.

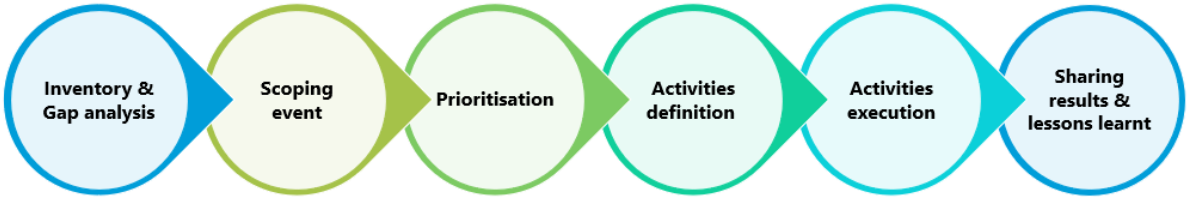

Figure 9. The steps of the IPDC consultation process.

The country Sections included in this Chapter serve as an initial step towards conducting a more comprehensive country status assessment. The dissemination of these contributions embodies one of IPDC's key pillars: facilitating knowledge exchange among its members and the broader international community. IPDC members actively contribute by sharing insights from their national adaptation journey, aligning with the stages of the IPDC Guidance Framework. This collaborative effort involves sharing insights on national adaptation strategies, planning and investment procedures, and the primary enablers and barriers to adaptation planning and implementation. In the future, IPDC will work closely with its members to develop and share more comprehensive country reports.

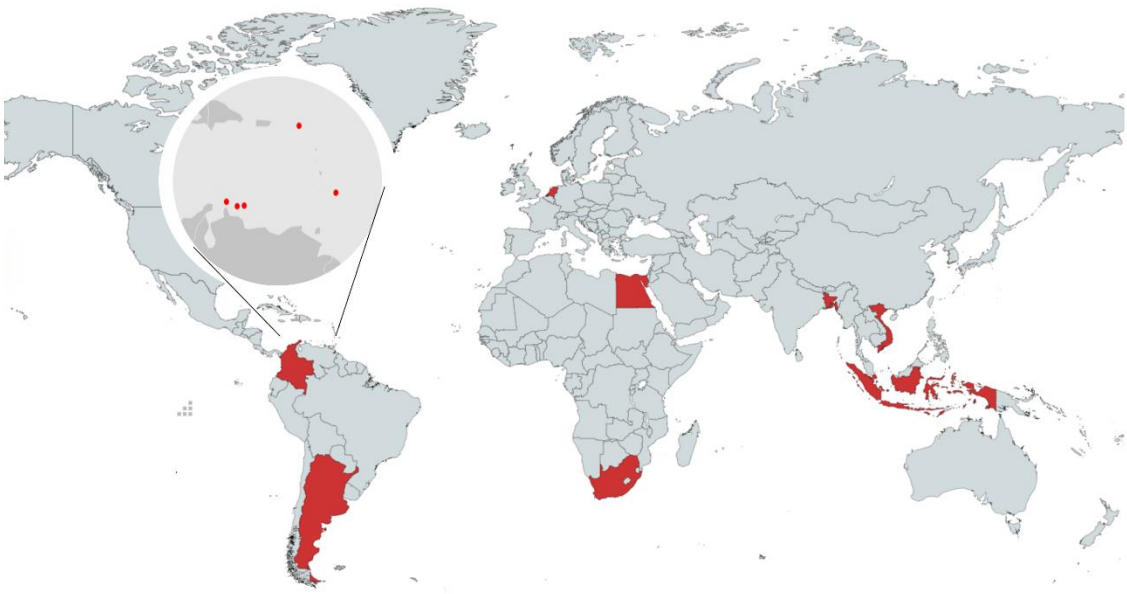

Figure 10. Map of the IPDC member countries.

4.1 Argentina

Introduction

Argentina is a bicontinental oceanic country, with its territory including parts of South America and Antarctica[†]. It has a total area of 3,761,274 km^2, of which 2,791,810 km^2 correspond to the South American continent, 965,597 km^2 to Antarctica, and 3,867 km^2 to the islands in the South Atlantic Ocean. Argentina has over 5,000 km of coast, of which 392 km correspond to the La Plata River Estuary. By 2022, the Argentina's population had reached almost 46 million inhabitants. Approximately 44% of the population is concentrated in the central region of the country, along the Paraná River Delta and Atlantic coast. This population experiences high levels of poverty and inequity.

Argentina is highly vulnerable to climate change impacts. Its economy's high dependence on natural resources further stresses this vulnerability. Concerns about wildfires and water availability are consistent across all regions of the country due to the increase in average temperature. Other expected, and already observed impacts and risks, vary by region and are indicated in Figure 11.

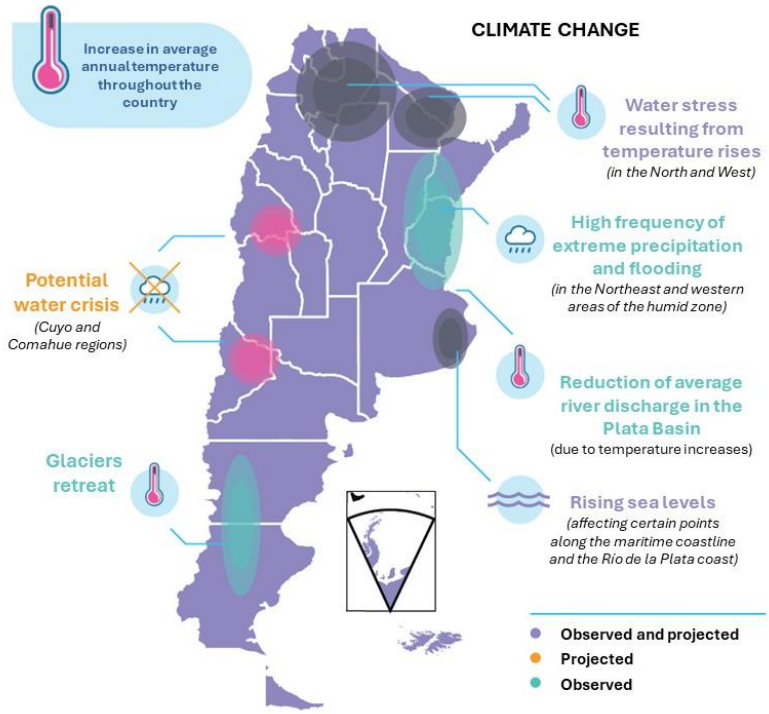

Figure 11. Impacts and risks of climate change in Argentina. Inset map refers to the Argentina section of Antarctica. Adapted from TNC (2015) and MAyDS (2022).

In the Paraná Delta and La Plata River Estuary, climate impacts include temperature increases affecting the hydrological cycle, variations in river flows due to droughts and heavy rainfall, and changes in storm surge frequency and intensity. Along the maritime coast, stresses include sea level rise, shifts in storm wave frequency and intensity, alterations in wind patterns, changes in seawater conditions, accelerated ocean acidification, and coastal erosion (MAyDS, 2022; MINCyT, 2023). The Paraná Delta, the La Plata River estuary and the centre-Atlantic coastal area are the most vulnerable regions, particularly in densely populated areas such as riverine and coastal cities like Rosario (Santa Fe), the City of Buenos Aires, Mar del Plata (Buenos Aires), Bahía Blanca (Buenos Aires), and Comodoro Rivadavia (Chubut).

[†] The territory in Antarctica is part of Argentina's territorial claim.

Climate Adaptation Strategies and Plans

National Adaptation Plan

Argentina has developed a National Plan for Adaptation and Mitigation to Climate Change – NPAMCC (MAyDS, 2022). With a planning horizon to 2030, the NPAMCC is structured around four cross-cutting approaches: (i) Gender and diversity; (ii) Comprehensive risk management; (iii) Health; and (iv) Just labour transition. These are instrumentalised in four action lines: (a) Action for climate empowerment; (b) Financing for transition; (c) Institutional strengthening; and (d) Research, Development and innovation. Furthermore, the NPAMCC identifies six strategic goals and lines for action: (1) Conservation of biodiversity and common goods; (2) Sustainable management of food systems and forests; (3) Sustainable mobility; (4) Sustainable and resilient territories; (5) Energy transition; and (6) Productive transition. More than 250 measures have been identified to advance in these approaches.

Concerning the adaptation of deltas and coastal areas, the NPAMCC presents only two specific measures:

- Strengthen Integrated Coastal Management (Action line: Adaptive ecosystem management).
- Promotion of the Regional Plan for Adaptation to Climate Change of the Paraná River Delta (Action line: Environmental land use planning).

Additionally, more general measures are described, such as the management of protected coastal areas or the strengthening of warning systems, which contribute to climate resilience of these areas. Among the notable aspects, the plan includes a monitoring system for its measures, enabling the visibility of ongoing actions and facilitating monitoring for learning and improved management. Additionally, it provides an estimate of implementation costs. However, the NPAMCC lacks dedicated funding for its implementation, hindering its long-term sustainability.

National Policy

The Law 27.520/2019 on Minimum Standards for Adaptation and Mitigation of Global Climate Change is a fundamental basis for inclusive action, instruments, and strategies for national climate change mitigation and adaptation. Furthermore, the Law institutionalised the *GNCC*, enabled the development of the NPAMCC, and requires the National Public Administration to include the necessary budgetary credit to fulfil the laws 'objectives on a yearly basis (Art. 29).

Over the last 10 years, national water and infrastructure plans have been developed by the national government. The National Water Plan (2017) includes adaptation to climate extremes as one of the four pillars in addition to cross-cutting priorities such as (i) the preservation of water resources, (ii) capacity building, (iii) innovation, and (iv) stakeholder inclusion. The National Plan of Public Works for Development (2023) incorporates adaptation issues in two key areas: (i) integrated water resources management; and (ii) urban infrastructure. The Coastal Marine Program (2023, Resolution 315/2023) consolidates the main objectives of the national environmental authority regarding water and coastal and marine ecosystem management. Focused on promoting conservation and sustainable use, its primary goal is to maintain the ecosystem services they provide and to enhance the quality of life for the population. This program builds on Law 27167/2015 which established the National Program for Research and Productive Innovation in Argentine Maritime Areas.

Regional and Local Policy

Regional and provincial efforts to address climate change adaptation have also taken place. The Comprehensive Strategic Plan for Conservation and Sustainable Use in the Paraná Delta (PIECAS-DP) is an interjurisdictional agreement, signed in 2008 between the provinces of Buenos Aires, Entre Ríos, and

Santa Fe, and the national government for the comprehensive management of the wetlands of the Parana Delta. The UN-Climate Technology Centre and Network (CTCN) Technical Assistance Technologies for coastal Management of the province of Buenos Aires provides support for updating tools to study coastal morphology and monitor the effects of climate change.

Buenos Aires City and Rosario (Santa Fé) have also developed local climate actions plans: the 2050 Climate Action Plan and the 2020 Local Climate Action Plan, respectively (Godfrid et al., 2022). Other local climate action plans of coastal municipalities were developed within the framework of the Argentine Network of Municipalities against Climate Change. These include cities like Mar del Plata (Buenos Aires), Viedma (Chubut), Puerto Madryn (Chubut), and Comodoro Rivadavia (Chubut).

Policy Process, Knowledge Management and Key Stakeholders

Argentina is constitutionally organised as a federal republic, consisting of 23 provinces and the Autonomous City of Buenos Aires. Both the national government and each provincial government have institutional frameworks in place for the management of natural and water resources. As mandated by the National Constitution, provinces are the guardians of the natural resources within their boundaries, and consequently responsible for policy development and implementation. The national government is responsible for providing general regulatory frameworks and national strategies. As a result, institutions which govern climate, water and environment portfolios can be recognised across the multiple government levels (national, provincial and local).

At the national level, the Under-secretariat of the Environment is responsible for implementing environmental policy, promoting sustainable development, ensuring the rational use of natural resources, and directing efforts to mitigate and adapt to climate change. The Under-secretariat of Water Resources is mandated to implement water resources management policies at a national level. These actions are guided by the Water Policy Principles, and by international water agenda, like the Sustainable Development Goals. The Environmental Federal Council (*COFEMA*, for its Spanish acronym) and the Water Resources Federal Council (*COHIFE*, for its Spanish acronym) serve as platforms for the coordination of environmental and water-related policies between the national and subnational governments, supporting a multilevel approach to policymaking.

Given the intersectoral dimensions of climate change, Argentina has made efforts to establish an interministerial council, aiming to break silos. Two significant cross-cutting initiatives can be highlighted:

- The National Climate Change Cabinet (GNCC) is a high-level platform for the multilevel (national and provincial) and multisectoral (interministerial) coordination of climate policy. The GNCC is mandated to elaborate the National Determined Contributions (NDC) and National Adaptation Plan (NAP). The GNCC aims to design the national climate policy with technical expertise through institutional and inter-agency agreements. It coordinates its efforts through thematic sectorial meetings, including topics such as energy, agriculture, forestry, waste management, transport, and industry; and cross-cutting meetings on topics like education, adaptation and finance. Additionally, it includes a formal participation mechanism for provinces through COFEMA, as well as NGOs, professional associations, private entities, academic and scientific sectors, and local governments.
- The Blue Pampa Initiative is a national interministerial effort that supports scientific research, technological development, and innovation to drive sustainable progress in marine and coastal regions. IPA has an Interministerial Coordinating Committee, including ministries for areas such as Science and Technology, Foreign Affairs, Environment, Agriculture and Fisheries, Tourism, Defence, and Security. Additionally, it includes two advisory bodies: a scientific council and a technological council, both consisting of members from scientific organisations, universities, and the private sector.

Even though all provinces have institutional environmental and water resources management frameworks, they tend to have limited capacity, resources and personnel, and lack specific coastal management competencies, which constrains their lines of action. An exception is the Maritime Coast Department of the province of Buenos Aires, focused on coastal infrastructure.

Argentina has a consolidated yet dispersed scientific community supporting climate adaptation efforts. At a national level climate monitoring, forecasting and response activities are primarily conducted by the National Meteorological Service (*SMN*, for its Spanish acronym), the National Water Institute (*INA,* for its Spanish acronym) which provides hydrological services, the Naval Hydrographic Service (*SHN,* for its Spanish acronym) responsible for maritime monitoring and forecasting, and the National Comprehensive Risk Management System *(SINAGIR,* for its Spanish acronym) which is a scientific agency focused on disaster risk reduction, response and recovery. Other organisations such as the National Scientific and Technical Research Council (*CONICET,* for its Spanish acronym), and universities are also actively involved in research concerning climate adaptation, deltas, and coastal areas. Provinces and local governments' contributions to the scientific component is limited, with certain exceptions, like the Scientific Research Commission of the province of Buenos Aires.

Recent developments in coastal and delta management resulted in the establishment of interinstitutional research centres: Mar del Plata Interinstitutional Centre for Marine Research (*CIIMAR*, for its Spanish acronym), and Interinstitutional Centre for Interdisciplinary Research for the Sustainable Development of the Delta and Islands of the Paraná (I-Delta.Ar). These aim to include many of previously mentioned stakeholders and promote multidisciplinary scientific collaboration.

Finally, it is important to highlight that given the transboundary nature of Argentina's delta and La Plata River basin, further transnational institutional frameworks are in place. The Intergovernmental Coordinating Committee of the Countries of the La Plata Basin (*CIC-Plata*, for its Spanish acronym) is the permanent management authority for transboundary water management, resulting from the La Pata River Basin Treaty (1969), signed between Bolivia, Paraguay, Brazil, Uruguay and Argentina. CIC Plata facilitates multinational efforts focused on promoting the comprehensive development of the basin. Secondly, the Administrative Commission of the La Plata River (*CARP*, for its Spanish acronym) is the binational organisation that provides the legal framework and guides the dialogue between Argentina and Uruguay for the shared management of the Río de la Plata estuary, as a result of the La Plata River Treaty (1973) signed between Uruguay and Argentina.

Prioritisation and Investment Planning

Prioritisation Process

Based on the previously presented assessment, Table 1 shows the prioritised areas, based on their risk exposure and vulnerability. A thorough prioritisation in consultation with policy officers and stakeholders is recommended to have a comprehensive approach to a prioritisation and investment planning. This preliminary selection serves the purpose of informing further discussions with decision makers.

Table 1. Prioritised areas, threats and corresponding impacts.

Area	Threat	Impact
Parana River Delta front and coastline of the La Plata River	Sea level rise, changes in river discharges, changes in storm surges, changes in wave patterns	Floods, droughts, coastal erosion, changes in sediment transport
Central and Northern Buenos Aires maritime coast (Necochea, Mar del Plata, Villa Gesell, Pinamar, and Partido de la Costa).	Sea level rise, changes in storm surges	Floods, coastal erosion
Surroundings of the cities of the San Jorge and North Patagonian gulfs (Comodoro Rivadavia, Rawson, Puerto Madryn	Sea level rise, changes in storm surges	Floods, coastal erosion
Bahía Blanca Estuary and Anegada Bay.	Sea level rise, changes in storm surges, changes in wave patterns	Floods, coastal erosion, changes in sediment transport

Implementation and Financing

The primary challenges for developing adaptation actions to climate change concern limited multi-level policy coordination, such as the integration of local challenges in provincial or national planning strategies; lack of comprehensive or multisectoral approaches, such as integrating a system approach for Water Climate Adaptation in infrastructure development; and access to sustainable funding for adaptation measures. The following sections discuss the main challenges, implementation barriers as well as enables that could accelerate policy implementation.

Implementation Barriers

In Argentina, the main challenge hindering climate adaptation is transitioning from policy development to implementation. Many programs, strategies or initiatives are launched but not formalised or lack funding and capacity for their long-term sustainability. Capacity disparities between national and subnational organisations are notable. Subnational governments generally present limited capacity in comprehensive risk management and demonstrate a limited focus on climate change adaptation in policy planning, development of initiatives, and infrastructure. Contributing to the multi-level governance challenges, policies' sustainability and continuity is threatened by changes in the administrations across government levels. Furthermore, within the complex framework of managing water resources and coastal areas, the interjurisdictional nature of governing coasts and deltas further delays and occasionally obstructs consensus required for program implementation.

Access to water and climate adaptation funding is also a challenge. In a context where the adaptation finance gap is widening in developing countries compared to international adaptation finance flows (United Nations Environment Programme, 2022), the opportunities for countries like Argentina are scarce. Constrained access to funding, both local and from international sources, has also hindered the implementation of adaptation measures. Despite the existence of legislation requiring minimum budgets, these are insufficient to tackle the challenges ahead, and budgets are allocated to the maintenance of organisations or existing infrastructure. Though Argentina has benefitted from loans from multilateral development banks, these funds tend to be allocated to basic – and much needed – infrastructural development. Hence transitioning from grey to blue-green infrastructure, or implementing nature-based solutions are in the early stages or remain at pilot scales.

Data accessibility and specific knowledge on coastal and delta dynamics, local climate scenarios, and connected impacts is limited. This is partly attributed to the lack of scientific personnel, adequate budget allocated for knowledge development, and linking science to policy. The existence of isolated or sectoral funding, focusing on specific aspects of the challenges or system also compromise the development of a comprehensive and systemic approach to climate adaptation.

Enabling Conditions

Argentina has already taken several steps in building a strong institutional framework to the development of proactive policies addressing climate change. For instance, minimum budgets are guaranteed to facilitate action in this direction. Furthermore, Argentina has an active participation in international agenda, including adherence to international treaties and engagement in forums related to climate change adaptation and water resources management.

Moreover, the country has a strong scientific community, actively engaged in knowledge development in the field of climate change. Additionally, for the cases of the Paraná Delta and the estuarine and marine coasts, community engagement through participatory processes and citizen science has been part of the scientific community for decades. Lastly, it is important to highlight that the increased visibility of impacts, like coastal erosion, have helped policymakers recognise the urgency of the situation, emphasising the need for immediate action.

Financing and Funding

Funding mechanisms for climate adaptation and water policy development in Argentina rely on the loans or grants from international financial institutions, such as the Development Bank of Latin America (*CAF*, for its Spanish acronym), the Inter-American Development Bank (IADB), and the World Bank (WB). Funding through national budgets is constrained and negotiated in the Congress yearly. Furthermore, funding for climate change adaptation efforts addressing threats in deltas and coastal areas concerning water dynamics is limited. Subnational governments, though responsible for the implementation of measures, have limited access to financial mechanisms. Limited access to information, challenges in interjurisdictional dialogue, and technical obstacles are some of the factors that impede the effectiveness in fund allocation and execution (Amanquez and Piana, 2019).

Financing mechanisms for adaptation in deltas and coastal areas of the country are scarce. A mechanism with direct funds for coastal maritime issues resulted in the technical assistance requested by the CTCN (UN Climate Technology Center and Network) for the development of technologies for coastal management in the province of Buenos Aires (USD 180,000, 2018-2020).

Furthermore, there are other mechanisms not directly centred on climate change adaptation in deltas and coastal areas, but still relevant to IPDC's purpose. Examples of these include initiatives (some of them in their final phases), such as the Climate Change adaptation in vulnerable coastal cities and ecosystems of the Uruguay River by the Adaptation Fund which began in 2019; the SABIA-Mar satellite mission—a contribution to the health, fishing, tourism, and production sectors linked to the sea in Argentina and its coastal areas by CAF.

4.2 Bangladesh

Introduction

Bangladesh, with an area of 147,570 km^2, is very densely populated, with a growing population of 174 million[‡]. The country is often referred to as *the land of rivers*, with over 500 small and large rivers with some 24,000 km (Rahman et al., 1990), crisscrossing the country from North to South. Bangladesh is one of the largest active deltas in the world (Wilson & Goodbred, 2015), built by the three mighty rivers, the Ganges, the Brahmaputra, and the Meghna (GBM), together shaping approximately 88% of the delta. The GBM rivers shape the country's physical features, land types, elevation, and, ultimately, livelihoods. Of the 500+ rivers, 57 are transboundary, of which the GBM and their tributaries dominate, creating mostly flat floodplains. Only a few areas are hilly, primarily in the north-western and north-eastern parts of the country. The combined total area of the three river basins is 1.75 million km^2, of which 93% of the catchment is outside the geographic boundary of Bangladesh. The catchment generates some 1.2 million m^3 of runoff annually, of which 10% is generated within Bangladesh. About one-fourth to one-third of the country is inundated by overflowing rivers during the yearly monsoon season (Islam et al., 2010).

Bangladesh and its people are known for their *resilience*; their ability to recover from cyclones, disastrous floods and droughts, deal with *climate variability* and develop a highly productive agriculture, food and industrial sector. With an average GDP growth of 6% or more, the last 10 years (World Bank, 2022[§]), Bangladesh is one of the fastest growing economies in Asia. The country has crossed the Lower Middle Income Country status in 2015 and fulfilled all the criteria of the United Nations to graduate from the Least Developed Countries. Bangladesh has now set the vision of becoming a developed country by 2041 after eliminating extreme poverty by 2031. To achieve this vision, Bangladesh is moving forward with effective adaptation strategies, elaborated in key national planning documents such as the Bangladesh Delta Plan 2100 (BDP 2100) and the National Adaptation Plan (NAP).

Climate Adaptation Strategies and Plans

The Ministry of Environment, Forests and Climate Change (MOEF&CC) formulated the Bangladesh Climate Change Strategy and Action Plan (BCCSAP) in 2009 to address the perils of climate change. In BCCSAP, 44 programs are identified under 6 (six) thematic areas; five on adaptation and the sixth on mitigation. The thematic areas are food security, social protection and health; comprehensive disaster management; Infrastructure; Research and knowledge management; mitigation and low carbon development capacity building, and institutional strengthening. The Government has established the Bangladesh Climate Change Trust Fund (BCCTF) with its resources to institutionalise a homegrown approach to addressing climate Change. BCCTF has undertaken more than 800 projects with a sole focus on effective climate adaptation and mitigation. MOEF&CC, Ministry of Water Resources (MOWR), Ministry of Disaster Management and Relief (MODM&R), Ministry of Agriculture (MOA), and other related ministries and divisions of the government implement projects under BCCSAP 2009 to address climate change issues and tackle the impacts of natural disasters.

National Adaptation Plan (NAP), 2023-2050

The NAP primarily encompasses eight distinct sectors: water resources; disaster, social safety, and security; agriculture; fisheries, aquaculture, and livestock; urban areas; ecosystems, wetlands, and biodiversity; policies and institutions; and capacity development, research and innovation, which are also the priority areas of BDP 2100. The Risk and Vulnerability analysis of NAP captured the risk and vulnerability of water resources, agriculture, ecosystems, biodiversity, cities, Chattogram Hill Tracts, communities and livelihoods. The NAP considered 11 climate stress areas, devising 113 interventions

[‡] https://worldpopulationreview.com/countries/bangladesh-population
[§] https://data.worldbank.org/indicator/NY.GDP.MKTP.KD.ZG?end=2022&locations=BD&start=1961

based on developed adaptation pathways and sectoral adaptation requirements. The NAP implementation process will follow an optimistic adaptation pathway, adjusting dynamically and synchronising with the BDP 2100 and the SDGs to fulfil the development vision by 2030, 2041, and beyond.

The NAP offers an inclusive, multilevel structure based on the existing institutional framework. The National Council on Environment and Climate Change will be responsible for overseeing the strategy, policy-level progress, and the outcome of implementation. The Interministerial Steering Committee on Climate Change will guide implementation and a separate National Technical Advisory Committee has been proposed for coordinating the NAP implementation and addressing gaps and challenges to ensure smooth implementation. MOEF&CC, MoWR, MOA, Ministry of Fisheries and Livestock, (MOF&L), Local Government Division, and other relevant government ministries/divisions and their corresponding agencies, Private sector bodies, NGOs, etc. will be involved in the implementation of the NAP.

The institutional arrangement for NAP will ensure the mainstreaming of this plan into the development planning cycle of Bangladesh in alignment with the BCCSAP, BDP 2100, Mujib Climate Prosperity Plan 2030, Perspective Plan, SDGs, and other development agendas. Obligatory climate impact assessments as part of feasibility studies have been proposed to complement the Development Project Proforma (DPP) approval process and climate-resilient development. Required policy and institutional reforms to support the functionality of the proposed institutional arrangement are given a high priority.

Other plans and strategies relevant to climate adaptation include the Mujib Climate Prosperity Plan 2022-2041 (MCPP) and the Bangladesh Delta Plan 2100. The Mujib Climate Prosperity Plan (MCPP) counteracts climate-induced damage and losses by equipping vulnerable communities, industry, and the government with the Mujib vision supported by optimised financing tools and models that will be key to embracing a new risk management paradigm that would bring about resilience and stability. The MCPP shifts Bangladesh's trajectory from one of vulnerability to resilience to prosperity (VRP). The implementation of the MCPP would facilitate diversified capital sources, including the private sector, blended finance, enhanced economic cooperation, and improved market access. The MCPP leverages the financing of the Eighth Five Year Plan 2021-2025 of Bangladesh, Vision 2041, and Bangladesh Delta Plan 2100 with synergies with the Bangladesh Climate Change Strategy and Action Plan, National Adaptation Plan, and NDCs submitted in 2020, to unlock a pathway for a fast-tracked delivery of the SDGs by 2030. The activities under the MCPP will be implemented by the concerned ministries/divisions and government agencies.

In 2018, in collaboration with the Government of the Netherlands, the Government of Bangladesh adopted the 'Bangladesh Delta Plan 2100'. The BDP 2100 is a 'long-term, holistic, hydro-centric and integrated plan', aimed at achieving long-term food and water security, economic growth, and environmental sustainability, whilst reducing vulnerability to natural disasters, climate change, and delta-related other challenges through adaptive and integrated strategies (Government of the People's Republic of Bangladesh, 2018). The sustainable use of water resources and prevention of water-related natural disasters provides the backbone of the BDP 2100. The strategies for managing water resources in wet and dry seasons that have been formulated, are flexible and adaptive in the sense of periodic review and updating in the Five Year Planning cycle based on situation and development needs. These are 'no-regret' measures in terms of effectiveness and maximum benefits and offer integrated implementation with innovation, advanced information technology, and strengthened institutional capacity.

Adaptive Delta Management (ADM) is the core approach of the BDP 2100 and its Investment Plan. ADM requires flexible and adaptive plans in response to emerging situations to enable robust, flexible, and pursue no-regrets investments first. ADM, as applied in the BDP 2100, aims to support holistic water governance, planning, and implementation in the Bangladesh delta under uncertainty, by anticipating short-term and long-term challenges and opportunities resulting e.g., from climatological, transboundary water flow, and socio-economical change scenarios. In Bangladesh, the application of

ADM focuses on development goals and thus aims to answer the question "How can we enable socio-economic development under uncertain changing conditions, especially regarding climate change and (transboundary) water resources? The BDP2100 scenarios are concentrated around two key drivers: 1) future water conditions based on transboundary developments and climate change; and 2) national and internal socio-economic development and related land use changes. It follows the IPCC climate analysis approach, is both simple and effective, and allows other key drivers to be included using a consistent approach.

Implementation and Financing

In the BDP2100, several implementation challenges were identified: 1) weak capacity of water and water-related institutions; 2) absence of water management organisations throughout the country; and 3) lack of integration of water issues with climate change, environment, land management and other delta-related challenges owing to inadequate institutional coordination. The monitoring and evaluation of policies is also weak. Therefore, "a substantial overhaul of the Delta governance and the institutional arrangements is needed to implement the Delta Plan." (Executive Summary BDP 2100).

Investment Gaps

Historical tendencies towards unrealistic investment assessments have led to poor implementation outcomes. The BDP 2100 aims for a systematic increase in resource allocation to reach 2.5% of GDP by 2025, but currently suffers from a public sector investment gap. The BDP 2100 investment program includes 32 projects dedicated to climate change adaptation. These projects are slated to begin by 2030, although the scale and programmatic nature of some investments may extend the timeline of implementation.

The main challenge in implementing the Delta Plan is the significant gap between current investment and the required funds, exacerbated by the pandemic and a tax GDP ratio of around 10%. Effective resource utilisation and prioritisation of delta investment projects are crucial for the plan's success. While public financing is a potential source for BDP 2100 implementation, Bangladesh must also explore external sources of funding, both bilateral and multilateral and specialised funds like the Green Climate Fund (GCF), Adaptation Fund, Global Environment Facility, REDD+, and the Land Degradation Neutrality Fund. Enhanced and coordinated efforts would also be needed to mobilise funds needed for investment in the implementation of these plans.

The Delta Appraisal Framework

The BDP 2100 represents a significant shift in Bangladesh's development strategy by incorporating the Adaptive Delta Management (ADM) approach into its planning and decision-making framework. This integration aims to reform the country's project planning system. Despite the strategic importance of ADM, current guidelines for developing, selecting, and appraising projects do not align well with ADM principles, leading to its inadequate implementation in project preparation and approval. To address this misalignment, the General Economics Division (GED) is developing the Delta Appraisal Framework (DAF) with World Bank support. The DAF is designed to thoroughly embed ADM principles thoroughly into the planning, assessment, and approval processes of BDP 2100-related projects, ensuring they align with the overarching goals and strategies of the plan.

Institutional Capacities

The implementation of BDP 2100 largely depends on the ability to develop bankable projects to tackle challenges and seize opportunities, a capability that is constrained in many implementing agencies. The design stage of the BDP 2100 projects is more critical than any other project, as it includes the development of different alternatives to deal with a changing climate and socio-economic conditions. In addition, ADM requires strong monitoring and evaluation of the dynamic delta environment; its river courses, floodplains, marine environment, sea level rise and climate change pattern (BDP 2100, 2018).

Additionally, the success of project implementation largely depends on proper coordination, cooperation, and collaboration among all executing agencies, which is currently deficient.

Developing and designing integration and adaptation strategies and projects for the BDP2100 requires making choices and trade-offs among various interests and temporal scales in a complex environment. This process necessarily involves uncertainties regarding future climate change impacts, numbers of stakeholders involved, conflicting interests, and the intricacy of a massive Delta that is characterised by diverse and sometimes hostile environments. Therefore, individuals that are highly specialised in skill and expertise are crucial for designing integrated adaptation projects.

Project Readiness

The public sector project preparation and approval process in Bangladesh follows a structured but extensive pathway. This multi-layered approval process is designed to ensure thorough evaluation and alignment with strategic goals, though it extends the timeline for project commencement. To optimise project readiness, implementing agencies allocated funds for preliminary activities like feasibility studies. However, the complexity of this funding arrangement can mirror the intricacy of the approval process itself. Implementing agencies often rely on internal resources for project preparation, occasionally taking shortcuts such as using in-house consultants, which may not always meet the required quality standards for feasibility studies. This can lead to studies that inadequately reflect true project costs and benefits, impacting the project's viability and attractiveness to potential financiers.

For BDP 2100 projects, ensuring high-quality project preparation is crucial. Among the projects included in the 8th and 9th Five-Year Plans, many are yet to have comprehensive development proposals or completed feasibility studies. These studies are fundamental for accurately assessing project scope, environmental, social, and institutional risks, and overall cost-benefit analyses, which are critical for making informed implementation judgments calls.

Legal-Institutional Framework

Although the current structure is functional, the legal frameworks and institutional arrangements need strengthening. The government is working on enacting the Bangladesh Delta Act, with the General Economics Division (GED) drafting the legislation in collaboration with the World Bank.

A key component of the governance structure for BDP 2100 is the Delta Governance Council (DGC), which serves as a high-level body to ensure political support and decision-making alignment for the Delta Plan's objectives. The GED has also established a 'Delta Wing', tasked with the coordination, implementation, monitoring, and periodic updating of the plan.

An interministerial Project/Programme Selection Committee (PPSC), led by a GED member, selects delta-related projects. A network of Focal Points from relevant ministries enhances coordination across government layers, ensuring strategic alignment and efficient execution of the Delta Plan. Additionally, a policy brief on the Delta Fund has been adopted to allocate resources incrementally to support BDP 2100 implementation.

Operation and Maintenance

The importance for effective operation and maintenance (O&M) of infrastructure cannot be understated in managing water resources in Bangladesh, not just the development of infrastructure itself. The Bangladesh Delta Plan 2100 (BDP 2100) addresses the need for adequate O&M, recognising that consistent maintenance can prevent the costly issues associated with deferred maintenance, which escalates over time and can ultimately compromise infrastructure functionality. Despite the importance of O&M, it has been somewhat neglected, with insufficient funding, a lack of skilled personnel, and low beneficiary participation noted as persistent challenges.

The BDP 2100 proposes to allocate about 0.50% of GDP for proper maintenance of existing water sector infrastructure. However, actual spending on O&M has often been less than 0.10% of GDP, with the Bangladesh Water Development Board (BWDB) generally receiving only 10-12% of the necessary funding for O&M from its revenue budget. This underfunding highlights a critical need for a shift from focusing solely on resource development to enhancing resource management, ensuring that infrastructure can continue to function effectively without incurring untenable costs.

Integrated Assessment of Investments

Developing and designing adaptation measures and investment projects for the BDP2100 entails navigating through a complex landscape of choices and trade-offs. This complexity stems from uncertainties regarding future climate change impacts, conflicting interests among various sectors and stakeholders, and the intricate nature of the Delta itself, characterised by numerous interconnections and uncertainties. To effectively address these challenges, an integrated assessment framework is necessary.

This framework should comprise a comprehensive set of indicators to guide decision-making and a rapid assessment tool facilitating an interactive process, enabling joint assessments. Additionally, a more advanced tool, the Bangladesh Metamodel (BMM), could be integrated offering a more nuanced and comprehensive approach. Employing the methodology of a Multi-criteria Decision Analysis (MCDA), with a rapid assessment tool could streamline the decision-making process.

However, the entire process necessitates extensive knowledge and in-depth analysis of future climate change scenarios. Moreover, it requires identifying suitable holistic investment options that promote the sustainable development of the Bangladesh delta while ensuring the responsible utilisation of natural resources.

4.3 Colombia

Introduction

Colombia, officially known as the Republic of Colombia, is a diverse country located in South America. It is one of the world's most biodiverse countries and has a variety of unique ecosystems, including rainforests, Andean mountains, vast plains, and pristine beaches. Colombia's coastline stretches over almost 7000 km, divided between the Caribbean coastline (2253 km) and the Pacific coastline (4709 km). Territorially, the country's coastal zone is made up of 10 Coastal Environmental Units covering 12 departments and 60 municipalities, which as of 2016 have a total population of approximately 3,715,662 inhabitants (Caribbean: 84%; Pacific: 14%; Insular Caribbean[**]: 2%) representing 12% of the country's population.

Colombia and its coastal zones are highly vulnerable to the impacts of climate change. Sea level rise threatens between 2 and 13% of the population living in the coastal zones. The impact is expected the be greater on the Pacific coast than on the Caribbean coast. Additionally, sea level rise and other climatic pressures are expected to impact the country's biodiversity, food security, infrastructure, and tourism sector (IDEAM et al., 2017).

Other pressures affecting the functioning of the Colombian coastal zone include:

- Interventions in the water system such as the construction of dams and deforestation which generate changes in coastal dynamics, in the availability of water resources, alterations in deltaic sedimentary processes, changes in mangrove cover, loss of coral ecosystems and deterioration of environmental quality.
- The development of hydraulic works on the coastline has generated blockage of the river mouths, causing flooding in the surrounding communities and erosion processes in other places.
- Population growth and increased infrastructure have led to the loss of mangroves in the delta.
- Deforestation of the mangrove forest due to timber extraction.
- The massive extraction of gold, which generates contamination in the delta by chromium, copper, cadmium and arsenic.
- Other sources of pollution such as nutrient pollution, heavy metals, toxic substances, plastics, wastewater discharges that affect water quality.
- The break-up and segmentation of barrier islands as a result of the combined action of a reduction in sand transport along the coast, earthquakes, and sea level rise.

Adaptation Strategies and Plans

With the National Development Plan 2022-2026, the process of Territorial Planning around water has begun. It focuses on ecosystem protection and restoration. The Territorial Planning will encompass updates of existing plans related to ecosystem conservation, integrated coastal zone management plans, and erosion. It will also include plans for implementing at least six climate change adaptation risk management initiatives, incorporating ecosystem-based adaptation in Marine Protected Areas (MPAs) and declaring at least 30% of seas as protected areas.

[**] The insular Caribbean coast of the ocean is made up of the archipelago of San Andrés, Providencia, Santa Catalina and their associated islets and cays.

For its implementation, the ministry has developed several guides, such as:

- Guide for the implementation of Ecosystem-based Disaster Risk Reduction Measures Emphasis on marine-coastal ecosystems (Ministry of Environment and Sustainable Development, 2023)
- Guide to ecosystem-based adaptation to climate change in Colombia (Ministry of Environment and Sustainable Development, 2018)
- Technical Guide for the Integrated Planning and Management of the Coastal Zone (Ministry of Environment and Sustainable Development, 2017)

Planning Process

Colombia launched its climate change adaptation strategy, called the National Plan for Adaptation to Climate Change – PNACC, in 2012. In 2016, the PNACC was updated. The PNACC has a very close relationship with the Colombian Low Carbon Development Strategy and the National Strategy for the Reduction of Emissions from Deforestation and Forest Degradation, because the implementation of any of the country's climate change strategies can contribute to the achievement of PNACC objectives. The specific objectives that contribute to the adaptation process in the country are:

- Manage knowledge about climate change and its potential consequences on communities, biodiversity, ecosystem services, and the country's economy.
- Incorporate adaptation to climate change into territorial and sectoral development planning.
- Promote the transformation of development for adaptation to climate change with criteria of competitiveness, sustainability and equity.

The legal basis for planning consists of several pieces of legislation. Law 1523 of 2012 adopts the national disaster risk management policy and establishes the National Disaster Risk Management System. Additionally, the National Council for Economic and Social Policy (CONPES) developed several strategies to adapt to and mitigate the effects of climate change.

Prioritisation and Investment Planning

For more than two decades, several actions have been identified, characterised and established in Colombia through different scientific initiatives to counteract marine-coastal risks. As part of our commitments as a country to adapt to climate change and the constant concerns of the territorial authorities (governors and mayors' offices), research, orientations, guidelines and guides have been promoted and developed to prioritise the places subject to the greatest coastal erosion processes and the areas with the greatest vulnerability to sea level rise. In terms of coastal erosion, 81 sites have been identified, of which 20 were prioritised in 2017 to develop some type of measure.

Between 2020 and 2023, Nature-based Solutions were implemented in four coastal departments, Guajira, Magdalena, Córdoba and Antioquia, to counteract the problem of coastal erosion. This approach has also made it possible to develop indicators to facilitate decision-making.

However, although there is experience, legal instruments and a set of lessons learned, guides and guidelines, it is also important to point out that there is no clearly identified roadmap to face all threats (extreme events, salinisation, windstorms, landslides and/or avalanches, storm swells, earthquakes, hurricanes, tsunamis, droughts, acidification, SST increase, etc.). GHG, among others). Therefore, it is necessary to develop a comprehensive roadmap to identify sources and priorities for intervention that guarantee the implementation and monitoring of measures and/or solutions for adaptability to the current and future changing climate.

Implementation and Financing

Barriers to implementing adaptation efforts were found to be related to the governance processes, capacity and knowledge, staff training, lack of continuity in the development of the processes due to high staff turnover, lack of standardised and integrated information systems that facilitate the exchange of open data, sources of financing for the development and continuity of the projects, as well as the lack of long-term monitoring systems with associated status and impact indicators to evaluate the effectiveness of solutions. Additionally, there is a need to need to establish models for strengthening resilience in territories in response to climate change. An overview of the main gaps is provided below:

- Sectoral and independent work
  - Work by sector rather than in an integrated manner
  - Weak inter-agency coordination, leading to suboptimal use of funds
- Lack of capacities and knowledge of local governments
  - To formulate projects by local governments
  - There is a lack of knowledge in the territory about the technical tools, protocols and legal frameworks for the development of projects and implementation of actions
- Lack of knowledge and limited capacities to address marine-coastal threats and risks
  - Training of high-level technical staff
  - Missing data in specific locations
  - Limited information system, not integrated, and no open data sharing
  - Expertise on Nature-based solutions (corals, seagrasses) is lacking
- Financing
  - Budgets exist during the development of certain plans and programs or during the term of the government, but once it is finished, many actions remain undeveloped
  - Annual budgets that do not provide continuity
  - With the changes in administration, the objectives change, so it is necessary to project medium and long-term actions with continuity of future validity
  - It is necessary to know and manage resources and access mechanisms at the international level
  - At the national level, there are sources such as the Fund for Life, but information is required on how to access it
- Completed and ongoing projects
  - Long-term monitoring and control systems are required (projects end after the project ends)
  - Long-term operation and maintenance of the works
  - Strengthening aspects related to the resilience of communities in the territories
  - Maintaining staff continuity for several years
- Executors are international and must better connect with the national government
  - Understanding local needs
  - Social and cultural aspects
  - Applicability of knowledge

4.4 Egypt[††]

Introduction

Egypt, the Arab Republic is geographically positioned in the north-eastern quadrant of the African continent. Egypt's terrestrial expanse exceeds 995,000 km^2, and it boasts a coastline extending over 3,500 km in length (WBG, 2021). The inhabited land, however, constitutes a mere 6.76% of Egypt's total land area. According to data from 2023, the country's demography includes a population of approximately 104 million inhabitants (CAPMAS, 2023). Demographic distribution indicates a predominance of rural residency over urban, with rural inhabitants comprising 57.16% of the population, contrasted against an urban composition of 42.84% (IDSC, 2021).

Egypt's total renewable water resources are quantified at approximately 56.8 billion m^3/y. The irrigation system in Egypt exhibits an overall efficiency exceeding 88%, which ranks among the highest globally. Treated wastewater undergoes multiple reuses, amounting to roughly 21 billion m^3/y. The current agricultural water requirements in Egypt are estimated to be about 61 billion m3/y. The dependency ratio on external water resources critically exceeds 97.7%, highlighting a significant reliance on transboundary water bodies for meeting the nation's water demands (MWRI, 2017).

The Nile Delta (Figure 12) - the area where the Nile River spreads out and flows into the Mediterranean Sea - is one of the largest in the world, with a coastline along the Mediterranean of about 240 km. It stretches approximately 160 km from north to south, starting near Cairo in the south and extending to the Mediterranean coast in the north. Characterised by its exceptionally fertile lands, the delta has sustained intensive agricultural practices for at least five millennia, accounting for the consumption of over 80% of Egypt's total water resources (WBG, 2021). Predominant agricultural outputs from this region include beans, cotton, wheat, and flax, underscoring the delta's vital role in Egypt's agrarian economy (WBG, 2021). Groundwater resources, notably in areas of recent agricultural reclamation at the desert margins of the Nile Delta, are indispensable for the region's water supply (Mahmoud, 2017). The demographic significance of the Nile Delta is also noteworthy, with approximately 50% of Egypt's populace, equating to around 40 million individuals, domiciled within this area. Industrially, the Delta is a central locus, housing about 40% of all Egyptian industrial activities. Consequently, the region is a substantial contributor to Egypt's economy, driving over half of the national economic output through a confluence of agriculture, industry, and fisheries (Negm et al., 2016).

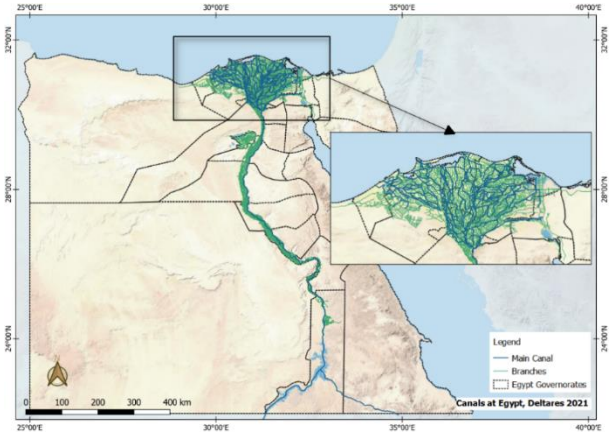

Figure 12. Irrigation and drainage system in Egypt.

The climatological conditions of Egypt are primarily defined by a hot and arid climate, exhibiting significant thermal variability throughout its geographical expanse. Precipitation levels across Egypt are markedly low. The highest precipitation occurs along the Mediterranean coast, with annual averages exceeding 200 mm. However, as one progresses inland away from the coastal areas, precipitation rates precipitously decline, with the vast majority of the Egyptian territory receiving approximately 2 mm of precipitation annually (CAPMAS, 2004-2022).

[††] The Report is based on the compilation, review of secondary data available from the target institutions and in the public domain, third parties and analysis applied to the data provided.

Climate change is anticipated to magnify existing vulnerabilities in Egypt, potentially intensifying entrenched disparities in human development and regional inequalities. The phenomenon contributes to heightened uncertainty regarding the availability of water resources, augments the frequency and intensity of heatwaves, accelerates desertification, and thereby adversely affects biodiversity (WBG, 2022). Moreover, it poses significant risks to food security. Projections indicate that by the year 2060, the aggregate negative economic impact of climate change could amount to between 2% and 6% of Egypt's GDP (Smith et al., 2014).

Climate Adaptation Strategies and Plans

In 2011, Egypt established its inaugural National Strategy for Climate Change Adaptation and Disaster Risk Reduction. This was followed by the development of a Low Emission Development Strategy (LEDS) in 2018, aligned with the Sustainable Development Strategy (SDS) - Egypt Vision 2030. Despite these efforts, there remained a notable deficiency in consolidating all climate change-related aspects into a singular document that would serve as a foundational reference and facilitate the integration of the climate change dimension into the general planning across various sectors. To address this, the National Council for Climate Change (NCCC) formulated the first comprehensive National Climate Change Strategy for Egypt extending to 2050 (Min. Env., 2023). The strategy emphasises the necessity for cross-sectoral collaboration, extending beyond governmental bodies to include non-governmental organisations (NGOs) and civil society. The revised Egypt Vision 2030 highlights the critical role of NGOs in enhancing public awareness about significant issues, thus underscoring their potential to significantly contribute to the strategy's goals through advocacy and promotion of volunteerism in climate action.

In 2017, the Ministry of Water Resources and Irrigation in Egypt introduced a new National Water Resources Plan (NWRP2037) designed to address the challenges posed by population growth, economic development, increased upstream activities, and climate change (EU, 2017). These factors collectively threaten to diminish both the quantity and quality of water available to Egypt's society, economy, and ecosystems. The plan spans a 20-year period, aligning with common practices in water resource planning. Notably, it sets intermediate milestones for 2030, coinciding with the timeline of Egypt's Sustainable Development Strategy.

NWRP2037 incorporates considerations of climate change, including measures for coastal protection and the resilience of infrastructure. It incorporates the projected average effects of climate change on water balance, although it acknowledges that actual impacts may vary. The strategy is predicated on the assumption that Egypt can manage the effects of climate change through a blend of coping mechanisms and adaptation strategies. However, it also recognises the potential necessity for substantial revisions in water management practices should climate change impacts exceed current projections. Despite this, NWRP 2037 does not currently account for a fundamental transformation in water management strategy (Min. Env., 2023).

In 2022, the World Bank Group released the Country Climate and Development Report (CCDR) for Egypt (WBG, 2022). The report highlights that climate change is likely to intensify Egypt's existing vulnerabilities, potentially exacerbating disparities in human development and geographical inequities. Key issues include increasing unpredictability in water resource availability, more frequent heatwaves, advancing desertification impacting biodiversity, and heightened threats to food security.

The report also notes that Egypt's growing urban population, projected to reach 41.4 million by 2050, will likely exacerbate the strain on services in urban areas and increase the exposure of both assets and populations to climate-related risks. Vulnerable groups are expected to bear a disproportionate share of these risks. Furthermore, the CCDR outlines a series of priority actions, categorised into short-term (within the next 1 to 3 years) and medium-term initiatives (beyond 3 years). These actions are designed as part of a roadmap to bolster Egypt's resilience and adaptation strategies while advancing its transition towards a low-carbon development trajectory. The report provides detailed steps for these actions and includes estimates of the investment required for selected priority measures.

In 2021, the Environmental and Climate Changes Research Institute (ECRI) in Egypt released a report titled "Climate Change Social Risk Management and Adaptation for the Nile Delta." (ECRI, 2021). This publication aims to assess the social impacts of climate change specific to the Nile Delta and to devise an adaptation strategy informed by these social implications. The proposed adaptation strategy is structured around five primary categories: planning, regulatory, land use modification or restriction, structural, and soft strategies.

The strategic recommendations include the revision and update of existing policies, maintenance of coastal defence structures, restoration of shoreline sand dunes, preservation of existing wetlands, and implementation of regulations to restrict development in high-risk areas. Additional suggestions involve altering land use patterns, relocating infrastructure to less vulnerable locations, establishing a comprehensive environmental monitoring framework, and creating a commission for compensation. It advises conducting an environmental and social impact assessment (ESIA) study including an environmental and social management plan (ESMP) for each individual shoreline conservation or expansion project to ensure their sustainability and social acceptability. It underscores the necessity of feasibility studies including economic and values engineering design to demonstrate the net benefits of proposed adaptation strategies. Furthermore, it calls for an analysis of the setback line which was delineated by the Shore Protection Authority along the Mediterranean coast of the Nile Delta, to evaluate the economic value of each component distinctly, ensuring informed decision-making in shoreline conservation and development projects.

Implementation and Financing

In 2018, Egypt launched the "Enhancing Climate Change Adaptation in the North Coast of Egypt" project, which is dedicated to safeguarding the densely populated, low-lying areas of the Nile Delta, at pilots' scale. This region, home to 25 percent of Egypt's population, is particularly susceptible to sea-level rise induced by climate change. Administered by the Ministry of Water Resources and Irrigation, the project is funded with a total budget of US$ 31.4 million and spans seven years (2018- 2025). Funded by the Green Climate Fund, the project implemented a low-cost dike system to prevent flooding from sea surges during extreme weather events. Additionally, it supported the development of an Integrated Coastal Zone Management Plan (ICZM) for the North Coast. This plan integrates shoreline protection measures with national coastal zone development strategies. The ICZM also includes the creation of a systematic observation system to monitor changes in oceanographic parameters and evaluate the impacts of various shoreline protection measures on coastal erosion and stability. The project relies on nature-based solutions to enhance shore protection in selected areas.

In 2023, the National Council for Climate Change (NCCC) prioritised enhancing adaptive capacity and resilience to the negative impacts of climate change as a central objective. This comprehensive strategy encompasses multiple sectors with a focus on public health readiness and infrastructure resilience.

To measure the efficacy of these initiatives, performance indicators are established at two levels: general indicators for overarching success across all sectors, and specific sectoral indicators for detailed tracking. Sector-specific metrics focus on enhancements in water management systems, sewage coverage, and agricultural efficiency. Additionally, the framework emphasises gender- sensitive policies, aiming to increase women's participation in climate change decision-making, access to financial resources, and satisfaction with technological solutions in climate initiatives.

Several financial mechanisms are available to support the objectives of NCCS. The Ministry of International Cooperation has secured development financing totalling $260 million for the environmental sector, earmarked for four major projects. These projects focus on solid waste management and the control of industrial pollutants, with contributions from several development partners, including the World Bank, the European Investment Bank, the French Development Agency, the European Union, and Italy.

Additionally, the Ministry of International Cooperation has allocated $365 million towards a development plan specifically aimed at achieving Sustainable Development Goal 13, which focuses on climate action. Despite these investments, the NCCS identifies a substantial funding shortfall, estimating a gap of approximately $94.7 billion required for the adaptation projects necessary to mitigate climate change impacts. This highlights the ongoing need for substantial financial resources to effectively address the challenges posed by climate change within the region.

Enhancing sector-specific capacity to address climate change at both national and local levels is essential for fostering robust interagency cooperation. This enhancement requires the formulation of a national strategy coupled with coordinated efforts to develop human capital proficient in climate change mitigation and adaptation. Currently, institutional capacity related to climate change is primarily centralised within a few key entities. Notably, these include the Climate Change Central Department at the Ministry of Environment, the Climate Change and Energy Efficiency Units at the Ministry of Electricity and Renewable Energy, and the Energy Efficiency Unit at the Ministry of Petroleum.

The dissemination of knowledge and data pertinent to climate change within the Arab Republic of Egypt is facilitated through both governmental and international entities. The World Bank's Climate Change Knowledge Portal serves as a comprehensive resource, offering an overview of historical and projected climatic data, sector-specific impacts, principal vulnerabilities, and ongoing adaptation efforts[##]. Additionally, United Nations Children's Fund (UNICEF) sheds light on the ramifications of climate change on the well-being and developmental prospects of children within Egypt, underscoring the country's heightened susceptibility to climate-induced alterations[§§]. Such changes are anticipated to manifest through increased frequencies of heatwaves, dust storms, Mediterranean coastal storms, and other extreme weather phenomena. Moreover, in alignment with its commitment to mitigating vulnerability and poverty while pursuing sustainable economic growth, Egypt submitted its Nationally Determined Contribution (NDC) and Third National Communication (NC3) to the UNFCCC in 2016. These submissions further elucidate Egypt's engagement in climate action.

Various governmental bodies within Egypt, including the National Water Research Center, Agriculture Research Center, Ministry of Higher Education & Scientific Research, Ministry of Environment, Ministry of Petroleum and Mineral Resources, Ministry of Electricity and Renewable Energy, Egyptian Meteorological Authority, and the Central Agency for Public Mobilization and Statistics, contribute to the collation and dissemination of climate change-related data and insights. Most of this information is encapsulated within annual reports, with a notable portion not being readily accessible via online platforms. As of 2023, the Egyptian Meteorological Authority has been designated as the official body authorised to release climate-related data to the public.

At COP27 in Egypt, significant progress was made in addressing climate justice through the establishment of the Loss and Damage Fund, aimed at supporting vulnerable countries affected by climate disasters. Egypt also launched various climate initiatives, particularly benefiting African nations, and integrated sustainable practices domestically, such as the Green Sharm initiative for environmental transformation and the substantial solar energy investments through the Egypt-PV program.

[##] https://climateknowledgeportal.worldbank.org/country/egypt
[§§] https://www.unicef.org/egypt/climate-change

4.5 Indonesia

Introduction

Indonesia, an archipelago nation located in Southeast Asia, comprising more than 17,000 islands, including the largest: Sumatra, Java, Borneo (Kalimantan), Sulawesi, and Papua. The country spans a vast area of approximately 1.9 million km^2, making it the largest archipelagic state in the world. It is situated between the Indian and Pacific Oceans, with maritime borders with Malaysia, Singapore, the Philippines, Australia, and Papua New Guinea. Indonesia's landscape is diverse, featuring many tropical rainforests, volcanic mountains, fertile plains, coastal areas, and coral reefs.

Indonesia is the world's fourth-most populous country, with a population exceeding over 270 million people. The population is highly diverse, comprising various ethnic groups, with Javanese being the largest ethnic group, followed by Sundanese, Batak, and Malay. The country is also culturally diverse, with more than 700 languages spoken across its islands. The capital city, Jakarta, is the largest urban centre, serving as the political, economic, and cultural hub of the country. Currently, Indonesia has a massive task in moving its capital city to Nusantara, situated in Kalimantan, close to the city of Balikpapan.

Indonesia has a tropical climate characterised by high temperatures, humidity, and rainfall throughout the year. The country experiences two main seasons: the wet season (October to April) and the dry season (May to September). Temperatures are relatively consistent year-round due to its proximity to the equator, with average temperatures ranging from 24°C to 30°C. The climate varies slightly across different regions, with coastal areas experiencing more moderate temperatures compared to inland areas.

Indonesia is one of the world's most biodiverse countries, hosting a wide range of plant and animal species, many of which are endemic to the region. The country's rainforests are among the most extensive in the world, but they face threats from deforestation, illegal logging, and agricultural expansion. Indonesia's marine ecosystems, including its coral reefs, are part of the Coral Triangle and support a rich diversity of marine life. However, they are vulnerable to overfishing, pollution, and climate change. Natural hazards such as earthquakes, volcanic eruptions, tsunamis, and floods are common due to Indonesia's location along the Pacific Ring of Fire. Environmental conservation efforts are underway to protect Indonesia's natural resources and biodiversity, including initiatives to combat deforestation, promote sustainable agriculture, and preserve marine habitats.

Temperature rise, extreme weather events and rising sea levels due to climate change will affect the country in a variety of ways. Indonesia’s extensive coastline and low-lying areas are highly vulnerable to sea level rise, leading to increased flooding, coastal erosion, and saltwater intrusion into freshwater sources. Climate change is expected to intensify extreme weather events such as cyclones, storms, and heavy rainfall, leading to more frequent and severe flooding, landslides, and infrastructure damage. Increasing temperatures can have various impacts, including heat stress on human health, loss of biodiversity, changes in agricultural productivity, and shifts in ecosystems.

Climate Adaptation Strategies and Plans

National Adaptation Strategy (2019)

Indonesia's National Adaptation Strategy (NAS) outlines the country's approach to addressing the impacts of climate change and enhancing resilience at the national, regional, and local levels while promoting sustainable development in line with national development priorities and international climate agreements. Its primary objective is to mainstream climate change adaptation into national development planning and decision-making processes to minimise risks and enhance adaptive capacity across sectors and regions. The strategy identifies priority sectors and areas for adaptation action, including agriculture, water resources management, coastal zone management, infrastructure, health,

and disaster risk reduction. It emphasises the importance of ecosystem-based adaptation approaches to preserve biodiversity, ecosystem services, and natural resources resilience.

The NAS also integrates cross-cutting themes such as gender equality, social inclusion, indigenous knowledge, and community participation to ensure adaptation measures are inclusive, equitable, and context-specific. It emphasises the role of science, technology, and innovation in enhancing climate resilience, data collection, monitoring, and early warning systems for climate-related risks.

The strategy outlines institutional arrangements, coordination mechanisms, and capacity-building initiatives to strengthen national, regional, and local governance structures for effective climate change adaptation. It emphasises the importance of multi-stakeholder collaboration, partnerships, and cooperation with international organisations, donors, and the private sector to mobilise resources and expertise for adaptation efforts.

The NAS includes mechanisms for mainstreaming adaptation considerations into sectoral policies, plans, and budgets, integrating climate risk assessments into development projects, and promoting knowledge-sharing and learning among stakeholders. It emphasises the need for adaptive management, iterative planning, and flexible approaches to respond to changing climate risks and uncertainties.

National Medium-Term Development Plan 2020-2024

Indonesia's RPJMN (Rencana Pembangunan Jangka Menengah Nasional), or National Medium-Term Development Plan, for the period of 2020-2024 outlines the country's development priorities, strategies, and targets to achieve sustainable and inclusive growth, taking into account external factors such as among others climate change and urbanisation.

The plan identifies priority sectors and strategies for development, including infrastructure development with a focus on transportation, energy, water resources, telecommunications, and digital infrastructure to support economic growth and connectivity. In addition, the RPJMN also addresses economic transformation, environmental sustainability and regional development.

With much more focus set on integrated planning taking into account water and soil, the RPJMN (currently being developed for the period of 2025 – 2029) is an important cornerstone of the future developments of Indonesia.

Legal and Regulatory Framework

In Indonesia, various stakeholders are involved in addressing water management and climate-related issues. At national level several ministries play an important role in this, such as Ministry of Environment and Forestry, Ministry of Public Works and Housing, Ministry of Energy and Mineral Resources, Ministry of National Development Planning and the Coordinating Ministry for Maritime and Investment Affairs. The National Disaster Management Agency coordinates disaster response, preparedness, and risk reduction efforts, including those related to climate-related hazards such as floods and landslides. The Ministry of National Development Planning (BAPPENAS) is responsible for short, medium and long-term planning, and can be seen as an important integrator of various sectors.

Local Governments, i.e. the Provincial and district/city governments (Bappeda's, BWS's, etc.), are responsible for implementing water management, land use planning, and disaster risk reduction measures at the local level, often in collaboration with central government agencies.

Universities and research institutes conduct research, data analysis, and innovation in areas such as hydrology, climate science, water resources management, and adaptation strategies. Currently, the Indonesian Government has set up Badan Riset dan Inovasi Nasional (BRIN) as the national research agency.

Environmental NGOs and Humanitarian organisations are also active in the field of climate change adaptation, implementing community-based projects to address local water and climate issues, and providing relief and assistance during climate-related disasters, respectively.

The Private Sector, such as Water Utilities and infrastructure companies, often works in partnership with government agencies or through public-private partnerships (PPPs). Industry associations represent the interests of businesses in sectors affected by water scarcity, climate change, and environmental regulations, and may engage in corporate social responsibility (CSR) initiatives related to water stewardship.

Local communities are often directly impacted by water-related challenges such as access to clean water, flooding, and drought, and may engage in grassroots initiatives for water conservation, community-based adaptation, and disaster preparedness. Indigenous groups in Indonesia are custodians of traditional knowledge and practices related to water management, conservation, and adaptation, and may advocate for their rights and interests in natural resource governance.

Besides these stakeholders, also international organisations and donors are active in Indonesia. United Nations agencies provide technical assistance, capacity building, and funding support for water and climate-related projects, as well as coordination and policy guidance at the national and regional levels. Multilateral development banks finance infrastructure projects, capacity building, and policy reforms related to water resources management, climate resilience, and sustainable development in Indonesia. These include the World Bank, Asian Development Bank, Invest International, Asian Infrastructure Investment Bank (AIIB), Islamic Development Bank, etc.

Implementation and Financing

Several policy challenges persist in Indonesia when addressing water and climate issues, and they involve various stakeholders. Limited coordination and integration among government agencies responsible for water management is leading to fragmented policies, conflicting objectives, and inefficient resource allocation. Insufficient institutional capacity leads to weak enforcement of water-related regulations, inadequate monitoring and compliance mechanisms. Transboundary Water Management is struggling with complexities in managing shared water resources across borders, conflicting interests among neighbouring countries, and the need for effective cooperation mechanisms for transboundary water governance.

Adaptation efforts are challenged by limited mainstreaming of climate change adaptation into water management policies and practices, inadequate funding for adaptation measures, and insufficient awareness and capacity among stakeholders. Limited involvement of local communities and indigenous peoples in decision-making processes hampers community engagement and empowerment. Traditional knowledge and practices in water management are often not recognised, while support for community-based initiatives is insufficient.

Water infrastructure development is struggling with inadequate funding for water infrastructure projects, limited private sector involvement in water sector investments, and challenges in accessing financing for climate-resilient infrastructure.

4.6 The Netherlands

Introduction

The Netherlands, with its 17,6 million inhabitants spread over 41,526 km^2, is the 16th most densely populated country in the world. Much of the country has a strong deltaic character, exemplified by the fact that 40% of the land is below sea level at high tide, and around 10 million people are vulnerable to flooding from either the sea or river. Additionally, a major part of its economy (70%) is located in the lowest parts. At the same time, the Netherlands has a long-standing history of coping and adapting to address these risks, including developing relevant policy and governance structures, committing financial resources, and developing specialised expert knowledge in both the public and private sectors.

The Dutch delta is under pressure at multiple fronts due to climate change and sea level rise, with implications in terms of water safety and water availability, the potential failure of vital and vulnerable functions, damage to agriculture and the economy, biodiversity loss and health effects. The situation is exacerbated by the fact that the climate is changing faster than anticipated in long-term planning, making this a more pressing issue. Certain developments, such as long periods of drought or heavy precipitation, are already being experienced today, while others will manifest themselves in the longer term.

Flood defences, such as dikes, dams and storm surge barriers, remain the most important measures in the Dutch flood safety system, providing high safety standards varying between 1/100 to 1/100,000 per year, depending on the region. Current practice for dike maintenance and strengthening already includes a margin for relative sea level rise in the coming decades, and technically the flood control system could be further expanded to give protection against substantial additional sea level rise. But even with two meter sea level rise, some of the present barriers would have to be continuously closed, seriously hampering the discharge of river water into the sea and navigation. Even today, this problem does occasionally occur due to a combination of high river discharge and storms at sea (as happened during the winter of 2023/2024). Other consequences include the demand for more space to raise dikes, a substantial increase in the need for sand (to supply beaches and dunes), increased pumping capacities and increased salinity intrusion.

Climate change will impact freshwater availability in several ways. Reduced future average summer river discharge (10-30%) combined with rising sea levels and increased evapotranspiration will increase salt intrusion and droughts. Because the Dutch water system is highly complex, consisting of rivers, lakes, aquifers, canals, wetlands and small water bodies connected to each other by inlets, sluices, dams, weirs and pumps, the adaptation strategy consists of a large number of measures and controls. They vary between alternative management decisions (smart real-time management), increased freshwater buffers, reduction of saltwater intrusion in sluices, groundwater recharge and water-saving measures in agriculture and other sectors.

Climate Adaptation Strategies and Plans

The Netherlands has developed a sophisticated framework for climate adaptation, which is summarised in Figure 13. At the national level, there is the National Climate Risk Assessment (NCRA) and National Adaptation Strategy (NAS). Based on international guidelines for climate risk analysis, the NCRA aims to develop and apply a standard methodology to gain insight into the current state of affairs and ensure a climate-proof and water-robust Netherlands in 2050 and beyond regarding people, culture, nature, environment, and economy.

The National Adaptation Strategy constitutes the Dutch response to the European Commission's appeal to all the member states to draw up a climate adaptation strategy. It was delivered in 2016 and may be revised based on the NCRA 2022-2026. NAS provides an integrated policy framework for climate adaptation in the Netherlands. It includes adaptation strategies for urban planning, agriculture and

nature, as well as for spatial planning, freshwater availability and safety against flooding – the three themes that are part of the Delta Programme.

The Delta Programme was established in 2010 and has been supported by a Delta Law since 2012. Every year, the independent Delta Commissioner reports on the status of Delta Plans carried out and proposes new actions and measures within the framework of the Delta Programme. In addition, the Delta Commissioner enhances and stimulates cooperation between governmental bodies, private companies and civil society organisations, in order to arrive at preferential strategies and delta decisions that then will be included in the National Water Programme (NWP).

Important parts of the NWP are the river basin management plans, the flood risk management plans and the North Sea Programme 2022-2027, which are included as legal appendices. Local authorities and civic parties are involved in the development of the NWP from an early stage through a broad participation process.

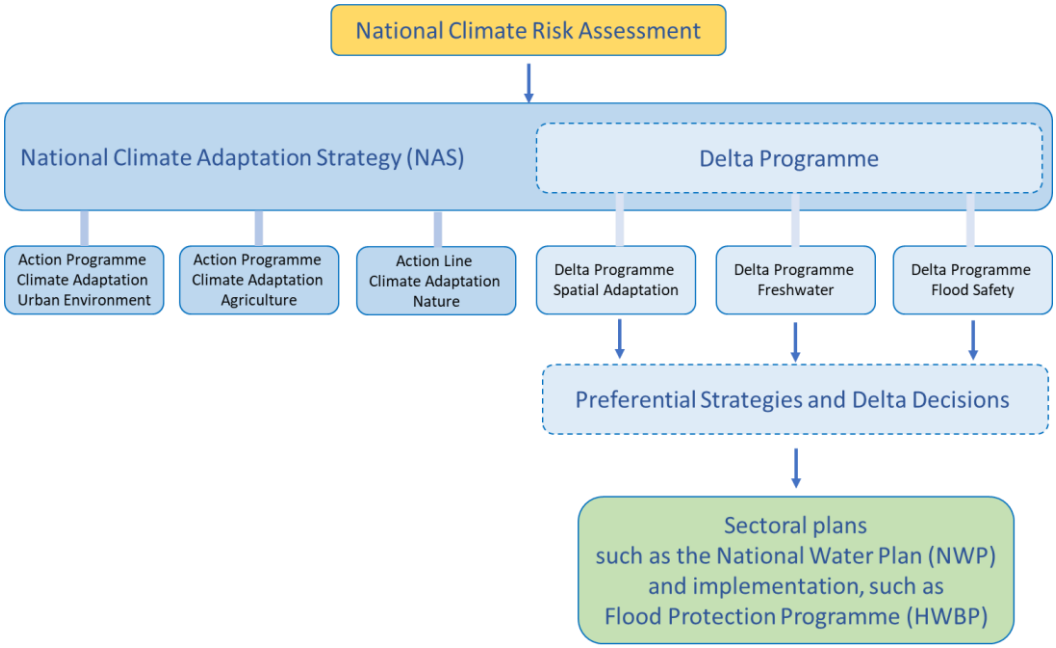

Figure 13. Overview of the NAS and its relation with sectoral plans.

The water dimension is inherently present in all adaptation plans since water management lies at the core of historic and future Dutch land-use development, including its political, institutional and legislative organisation. More specifically, the Delta Programme has already identified three key risks for the Netherlands:

- Increased flood risk
- Endangered freshwater supply
- Extreme events in temperature and precipitation

Planning Process

Generally speaking, water management is well institutionalised at national, regional and local level, with agencies as Rijkswaterstaat and the Water Boards having centuries of experience. This is less so for spatial planning, which is intricately connected with water management. There is an increasing need for national coordination, especially since spatial planning is delegated to the provinces and implemented at municipal level.

The policy for the national water system is to maintain the existing water infrastructure for as long as possible through its optimisation. The regional water systems also follow this policy, but add specific measures to become (more) self-sufficient in their water demand.

In recent years, the Dutch approach to river management somewhat shifted from 'controlling rivers' to 'giving rivers space'. An example is the implementation of the Room for the River programme, aimed at increasing safety against river floods. It adopts a robust approach that works in harmony with nature and promotes multi-functional land use. It acknowledges the uncertainties associated with natural variability and climate change, as well as the capacity to recover from flood events.

Without measures, extremely high temperatures and heavy downpours can cause damages in the urban environments up to 50 billion euro in the period to 2050. As it is expected that heavy downpours (e.g. more than 100 mm in one day) will increase in frequency, the Delta Programme has proposed many measures to reduce the potential impact of such extreme events. Typically, these measures are location-dependent but can be classified into improved infiltration, temporary storage or delayed discharge. Additionally, there are measures to reduce exposure or vulnerability, such as making houses more flood-proof, growing flood-resistant crops, etc. The government approved the Delta Plan Spatial Adaptation in 2018 and aims to make the country climate-proof in 2050.

Planning Tools - Dealing with Uncertainties

There is great uncertainty about the magnitude and timing of an acceleration in sea level rise. The possibility of a high and accelerated sea-level rise later this century due to ice sheet instability and retreat in Antarctica may result in a sea level in 2100 that is up to two meters higher than present and up to five meters in 2150. Therefore, adjustments to the existing strategies of the Delta Program may be required from 2050. To deal with such uncertainty, adaptation pathways have been developed that show under which circumstances the flood protection strategy should be changed and which measures are needed in the coming years to keep future options open. An illustration of such adaptation pathways is provided in Figure 14.

The alternative strategies for flood safety also influence freshwater availability. For instance, keeping the rivers in open connection with the sea will cause more salinity intrusion, whereas a closed variant would mitigate this. Increasing salinisation of the soil due to seepage will become a problem for all solutions unless a fresh coastal lake is created.

Therefore, strategic choices must be made regarding the permanent closure of estuaries, the pumping or periodic storage of high river discharges, agriculture in an increasingly saline coastal area, and the maintenance of the coastline by beach nourishments. These strategic choices must be complemented by no-regret measures such as spatial reservations for future sand extraction (for beach nourishments) and future expansion of flood defences, water discharge, and water storage.

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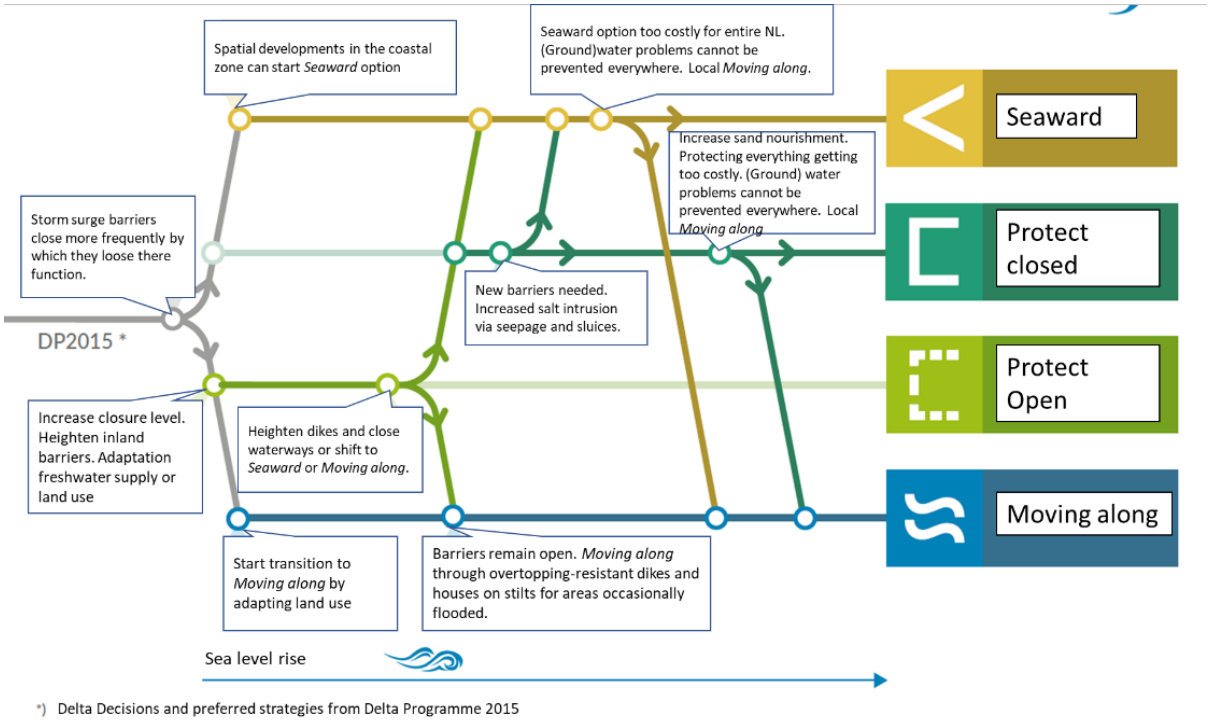

Figure 14. Adaptation pathways for sea level rise in the Netherlands.

Prioritisation and Investment Planning

The Delta Programme introduced a stepwise planning process for the selection and prioritisation of the so-called "Delta Decisions": key decisions for adaptation to a changing climate. This process took about 4 years, starting in 2010 and each step took roughly 1 year. The results of each step were submitted to the National Parliament for inclusion in its annual planning.

From 2010 till mid-2011, an inventory was made of which water challenges were relevant. Until mid-2012, possible strategies were explored to deal with these challenges in an adaptive way. To enable decision-makers to make well-informed decisions, promising strategies were developed until mid-2013. Not only technical and financial feasibility was substantiated, but also attention was given to side effects. In the final phase, linkage opportunities and administrative commitment were determined, which resulted in a proposal from the Delta Commissioner to the cabinet in mid-2014.

A combination of modelling, impact analysis, cost-benefit analysis and multi-criteria analysis was used to enable a transparent decision process through a stepwise reduction of uncertainties and making normative aspects explicit (Broekhans et al., 2014).

The investment planning follows the Delta law of 2012 in which a Delta fund has been foreseen. This fund is mainly intended to be used for safety against flooding and freshwater supply, although a small amount is available for extra ambitions e.g. for nature, spatial quality and environment. Note that besides the Delta fund at national level, there are also funds available at regional and waterboard level.

Implementation and Financing

Current Implementation Challenges

In the Netherlands, water management is intricately connected to spatial developments, and therefore, spatial planning could be an important tool for increasing climate robustness. However, the Delta Act and the Delta Fund are constrained to flood protection and fresh water supply and are not available for other spatial objectives, even if effects on water management would be substantial. Pressure on the spatial domain from increasing housing demands (over 1 million new houses before 2040) has

intensified the debate on urban development in (potentially) highly vulnerable locations, like deep polders (which may be 4 to 7 meters below sea level). The Delta Program explicitly identified this as a situation that potentially cannot be maintained in the future. Present national regulations do not exclude such areas from urban development, keeping the responsibilities with the local municipalities.

Recently (2022), the Dutch Government adopted a policy principle called "Water and Soil guiding" ("Water en Bodem Sturend"). It implies that water and soil systems should have a critical role in spatial planning, thus making the nation more climate resilient, relieving the pressure on biodiversity and promoting a healthy and robust economy, society and living environment. The policy, which should prevent investments in locations with high climate risk, will be implemented in the upcoming years through existing regulations, regional and local planning processes as well as national decisions.

Availability of Knowledge and Data

There is a large body of knowledge regarding water, coasts and climate change in the Netherlands, dating back several centuries. Currently, the Delta Programme monitors changes in climate, sea level, hydrology and land use using indicators that relate to the past and the future. Each year, the Delta Programme evaluates the available knowledge needed for its programme and policy decisions and identifies areas where more knowledge or information is needed. Of course, one of the biggest uncertainties in knowledge is the direction and rate at which climate change is developing. This uncertainty is being captured in national climate scenarios, which are updated every few years.

Suitability of Governance, Engagement and Collaboration

Although Duch water governance is in line with good generic governance principles, in practice, several multi-level governance gaps persist that can hinder water policy in the future. One is the relation between spatial planning and water management (see above). An important traditional vehicle for stakeholder engagement is and has been the Water Boards, the management of which is determined through elections by the inhabitants, although general interest and knowledge about the Water Boards with the citizens is rather low. Dutch citizens tend to take water security for granted. Therefore, they often show a lack of interest in discussions related to water policy, unless any action or intervention is directly affecting them. The outcomes of stakeholder participation are not persistent, and its success primarily relies on building mutual trust between all parties involved and engaging stakeholders at an early stage.

Behavioural Change and Attitude to Embrace Innovations

The Dutch have shaped the Netherlands, featuring the centuries-old tradition of building dikes, reclaiming land from the water and draining swamps to create fertile land. This history explains the Dutch' focus on sophisticated water engineering to control floods, make rivers navigable and reclaim new land. Now that climate change is imminent, the big question is if such attitude is sustainable, or that other development options are needed. History has shown that one is indeed capable of making a paradigm shift, notably in the 1970s (the Eastern Scheldt Barrier) and the early 2000s (Room for the River program). Notwithstanding these examples, Dutch society currently is not very risk aware (OECD, 2014). Most people take flood safety and fresh water for granted. The value of water is not acknowledged as a vital condition for economic development and activities, health, ecosystems and biodiversity. It is already more than 70 years ago that the last major flood occurred, which means that it is starting to fade in memory.

Availability of Finances

For the period 2023-2036, a total of €21 billion is available from the Delta Fund (i.e. an annual budget of approx. €1.5 billion), of which water safety measures tend to take the bigger share (€6.9 billion) compared to investments in freshwater supply (approx. €370 million). However, besides the Delta Fund, provinces, water boards and municipalities contribute significantly to the maintenance and adaptation

of the Dutch water infrastructure. The government, water boards, municipalities, provinces and drinking water companies all have a role in protecting the country against flooding and/or ensuring sufficient and clean drinking water. Together, these organisations spent €7.8 billion on this in 2021, which equals less than 1% of the Gross Domestic Product (GDP).

4.7 Singapore

Introduction

Singapore is a small island-state with a total land area of about 734 km^2. Much of the country is flat and relatively low-lying. As of 2023, Singapore's total population, including foreigners working in Singapore, is estimated at 5.92 million. Singapore's population density of about 7,688 persons per km^2 is one of the highest in the world.

As a low-lying, densely populated country, with about 30 per cent of the main island less than 5m above mean sea level, Singapore is vulnerable to the impacts of climate change: longer dry spells, extreme rainfall and rising sea levels.

In January 2024, the Centre for Climate Research Singapore (CCRS)[***] released the findings of Singapore's Third National Climate Change Study, or V3. V3 downscales global climate models from the Intergovernmental Panel on Climate Change (IPCC) 6th Assessment Report (AR6) to higher resolutions of 8km over Southeast Asia and 2km over Singapore. V3 projects higher temperatures, more wet and dry extremes, and accelerating increase in mean sea levels for Singapore and Southeast Asia by the end of the century, in line with global findings from IPCC AR6. V3 projections for Singapore showed that:

- Dry spells could be more frequent and last longer;
- Extreme daily rainfall is projected to increase across all seasons;
- Mean sea level is projected to rise by up to 1.15m by 2100, and up to around 2m by 2150; and
- Very hot days and warm nights will be the new normal, with between 41 and 351 days per year on average experiencing a daily maximum temperature exceeding 35°C (an increase from around 21 days in the last 40 years).

Singapore has started making early preparations to adapt to the impacts of climate change and ensure that Singapore remains resilient.

Climate Adaptation Strategies and Plans

Organisation of Singapore's Efforts

Climate change has many dimensions that cut across the responsibilities of several ministries. The Inter-Ministerial Committee on Climate Change (IMCCC) oversees the whole-of-government coordination on climate change policies. The National Climate Change Secretariat (NCCS) is a dedicated unit under the Prime Minister's Office (PMO) Strategy Group that serves as the secretariat to the IMCCC.

To coordinate efforts in climate adaptation, a multi-agency Resilience Working Group (RWG), led by the Ministry of Sustainability and the Environment (MSE) and the Ministry of National Development (MND), was set up under the IMCCC. The RWG assesses Singapore's physical vulnerabilities to climate change based on a Resilience Framework (Figure 15), which guides the formulation of adaptation plans up to 2100. This inter-agency effort ensures that adaptation plans are coordinated across the Government.

[***] In 2013, Singapore established the Centre for Climate Research Singapore (CCRS) to advance our scientific understanding of tropical climates and how associated weather systems affect Singapore and the Southeast Asia region.

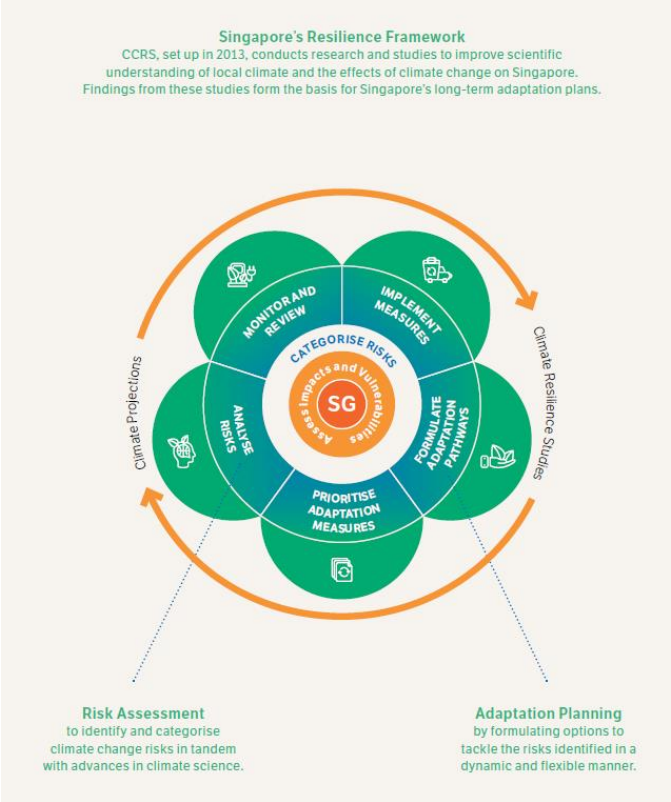

Figure 15. Singapore's Resilience Framework.

In 2021, Singapore launched the Green Plan 2030, a whole of nation movement to advance Singapore's national agenda on sustainable development. It charts ambitious and concrete targets over the next decade, strengthening Singapore's commitments under the Paris Agreement, and the UN's 2030 Sustainable Development Agenda. The Green Plan comprises 5 pillars that influence how we live, work and play. Under the "Resilient Future" pillar, we have identified specific targets and initiatives to adapt to sea level rise and strengthen flood resilience.

Adapting to Sea Level Rise

Singapore has been extensively studying and implementing adaptation measures against the impact of sea level rise and building flood resilience. In April 2020, PUB (Public Utilities Board) was appointed the national coastal protection agency to address inland and coastal flooding holistically. PUB is progressively conducting site-specific studies across Singapore's varied coastlines to examine various coastal adaptation solutions. Where feasible, they will be co-located with amenities or recreational spaces for the community to enhance the living environment. PUB will also explore hybrid solutions that combine nature-based elements with hard engineering measures.

Land reclamation is a viable measure to protect our coasts, while creating more land for housing and other needs. To mitigate the impact of sea level rise, the minimum reclamation levels for new developments have been raised from 3 m to at least 4 m above the mean sea level since 2011. New critical infrastructure such as Tuas Mega Port and Changi Airport Terminal 5 will be built at least 5m or more above the mean sea level. In November 2023, Singapore announced plans to start technical studies for the 'Long Island', which could involve reclaiming around 800 hectares of land and protecting the low-lying East Coast of Singapore from rising sea levels. This will integrate coastal protection with future land use needs, create a new freshwater reservoir to enhance long-term water resilience and create new possibilities for parks and recreational activities.

Singapore is also investing in research and development to support the long-term endeavour of coastal protection. To holistically assess the combined effects of extreme coastal sea levels and intense rainfall, PUB is developing a Coastal-Inland Flood Model. This model will help in evaluating the effectiveness of adaptation measures and provide advance warning to facilitate emergency response. In September 2023, Singapore launched the Coastal Protection and Flood Resilience Institute (CFI), our first Centre of Excellence dedicated to strengthening local capabilities and expertise in coastal protection and flood management research and solutioning. This is a key pillar under the S$125million (US$92 million) Coastal Protection and Flood Management Research Programme.

Building Flood Resilience

To enhance inland flood resilience, PUB adopts a "Source-Pathway-Receptor" approach, which looks at catchment-wide solutions to build in flexibility and adaptability to cope with higher intensity storms. This comprehensive approach covers the entire drainage system, addressing not just the pathway over which the stormwater travels (i.e. "Pathway"), but also in areas generating stormwater run-off (i.e. "Source") and the areas where floods may occur (i.e. "Receptor").

PUB raised the drainage design standards in 2011 and 2017 so that our drains can handle higher rainfall intensities (i.e. "Pathway"). All new developments and re-developments of 0.2 hectares or more are required to implement measures to slow down surface run-off and reduce the peak flow of stormwater into the public drainage system, by implementing on-site detention measures (i.e. "Source") since 2014. Developments are also required to adhere to the minimum platform and crest levels or install flood barriers to prevent floodwaters from entering buildings (i.e. "Receptor"), with the latest revision of the Code of Practice on Surface Water Drainage issued in October 2023. These structural measures are complemented using technology such as X-band radars and an extensive network of water level sensors and CCTVs installed island-wide, to better predict and respond to floods. Public alerts can also be issued in a timely fashion, enabling residents in areas at risk of flash floods to take preventive measures such as deploying portable flood barriers.

Water Sustainability

Singapore has a robust and diversified water supply from four sources, which we call our "Four National Taps". This comprises water from local catchment, imported water, NEWater, and desalinated water. In particular, long-term planning and investment in weather-resilient water sources like NEWater and desalination are crucial in strengthening our water security. There are currently five desalination plants and five NEWater factories.

In Singapore, water is priced to recover the full cost of its supply and production, and to reflect the cost of producing the next drop of water. This right pricing of water allows for continual investments in critical water infrastructure and encourages water conservation by households and industries.

Water demand management is also a key prong of Singapore's water sustainability. For instance, in 2024, Singapore has introduced mandatory water recycling requirements for new projects in water-intensive industries. Singapore has also enhanced the Water Efficiency Fund in 2023, to provide greater support for businesses to implement water-efficient practices and embark on water recycling projects. For households, Singapore has the goal of lowering the amount of water used by households to 130 litres per capita per day.

Implementation and Financing

Prioritisation and Resourcing

Climate adaptation is a long-term endeavour to ensure that Singapore remains resilient to the impacts of climate change. A high-level estimate is that coastal protection will cost more than S$100 billion (US$74 billion) over 100 years and will add to our medium- to long-term spending needs. Singapore will finance climate adaptation measures in a way that is fiscally sustainable and equitable across

generations. The Coastal and Flood Protection Fund (CFPF) was set up in 2020 with an initial injection of S$5 billion (US$3.7 billion).

To ensure the judicious use of resources, Singapore has adopted a phased approach to the implementation of climate adaptation measures. Coastal protection measures are being implemented progressively, beginning in areas that are more vulnerable to flooding, to prevent bunching of resources. Furthermore, pilot projects and test beds are used to test the efficiency of solutions prior to large scale implementation, such as nature-based enhancements to coastal protection solutions.

Strengthening Community Resilience

The Government alone cannot achieve climate resilience, and will need to galvanise collective action by corporations, communities, households, and individuals. For instance, PUB engages building owners and residents in low-lying areas on the loan and deployment of flood protection devices in case of flash floods caused by heavy rainfall. Members of the public can also stay updated on the flood situation through PUB's telegram channel, PUB's X (formerly known as "Twitter") page, "myENV" mobile app, radio broadcasts, news media, as well as Land Transport Authority's Expressway Monitoring Advisory System.

To raise awareness among Singapore's population on the threat of sea level rise, PUB has been organising a series of community dialogue sessions ("Our Coastal Conversation"). These seek to gather early public sentiments relating to sea level rise and inland flooding, aspirations for coastal areas, and discuss trade-offs of potential solutions. PUB also organised an ideas competition ("Living with the Rising Seas") to seek proposals for innovative coastal protection ideas from tertiary students. These ideas will be considered by PUB in its formulation of coastal protection measures.

Under the Green Plan, the Government is committed to working with Singaporeans and partners to co-deliver and co-create solutions for a greener Singapore. It established the Green Action for Communities to enable and empower community action in environmental sustainability. The S$50 million (US$37 million) SG Eco Fund was also set up in 2020 to support projects that advance environmental sustainability and involve the community. Projects included the creation of a living seawall for coastal defence and biodiversity enhancement, and establishment of an Eco-Pond as a nature-based solution to improve drainage capacities and reduce run-offs. In addition, the Government has also organised Citizen Engagement workshops and launched a nationwide month-long campaign Go Green SG to allow members of public to appreciate Singapore's sustainability efforts first-hand. PUB engages in community outreach efforts, such as an annual water conservation campaign, to raise awareness of water conservation.

Capability Support and Regional Contributions

Singapore is committed to supporting fellow developing countries in their efforts to address climate change through capacity-building assistance. The sharing of best practices and expertise can have a meaningful, multiplier effect in addressing the challenges of climate change. Countries would also be able to adapt these best practices to suit their unique national circumstances. Under the Singapore Cooperation Programme (SCP), our flagship technical assistance programme, the Sustainability Action Package (SAP) was launched in 2022 to focus on sustainability themes, including green project management, low carbon development and carbon markets. The SAP succeeds the Climate Action Package which, since its launch in 2018, had run 60 courses in climate adaptation, mitigation, disaster risk management and green finance for over 1,500 participants from over 130 countries, territories, and intergovernmental organisations. Climate adaptation, including coastal protection and flood resilience, will be one of the key themes at the 2024 Singapore International Water Week (SIWW) to galvanise climate action amongst municipal and industrial stakeholders. The inaugural Coastal and Flood Resilience Cities Roundtable and Leaders' Summit would be held during SIWW for city authorities and

industry leaders to share experiences and showcase successful case studies in building climate-resilient cities.

Singapore is working with regional counterparts to strengthen the region's disaster risk financing capabilities through the Southeast Asia Disaster Risk Insurance Facility (SEADRIF). SEADRIF, established as an ASEAN+3 initiative in partnership with the World Bank, provides disaster and climate resilience solutions to ASEAN Member States. Singapore contributes to SEADRIF through financial support and bringing together the public and private sector to provide technical capacity building, insurance solutions structuring and risk modelling support.

Singapore will share data and findings from V3 with the region via a dedicated data portal, which is expected to be launched in 2025. Singapore will also contribute V3 data to the Coordinated Regional Downscaling Experiment for the Southeast Asia Region (CORDEX-Southeast Asia), a World Climate Research Programme (WCRP) framework to evaluate regional climate model performance through a set of experiments. Singapore will also be collaborating with the Food and Agriculture Organization of the UN (FAO)'s Regional Office for Asia and the Pacific to incorporate V3 data into the FAO's climate risk assessment tools to allow for more detailed assessment of the impact of climate change on regional agrifood systems and food production. With these tools, regional partners can be empowered to implement timely and effective adaptation efforts in the agri-food space.

Conclusion

Singapore takes a proactive, long-term approach towards climate change adaptation – our adaptation efforts help us fulfil our obligations under the Paris Agreement and achieve the goals of the 2030 Agenda for Sustainable Development. Singapore will build on current efforts and review and adjust our policies and plans as new knowledge and information on the effects of climate change become available.

Climate change resilience goes beyond physical adaptation and must involve the entire community. The private sector will need to review their business continuity plans to cater for short-term disruptions caused by extreme weather events, while Singaporeans need to be mentally prepared for a changing environment. Making early adjustments will make this transition easier.

Through our participation in IPDC, Singapore hopes to contribute to the IPDC agenda and at the same time, draw inspiration from related efforts in deltas, coastal areas and islands all around the world. We look forward to collaborating closely with IPDC partners and building a resilient future for generations to come.

4.8 Vietnam

Introduction

Vietnam (land area approx. 331,230 km^2) is among the world's most vulnerable countries to climate change, with sea level rise[†††], changing rainfall patterns and rise in extreme heat among the most prominent risks. Especially the low-lying coastal and river delta regions are considered highly vulnerable, both from a physical perspective and because most of the 100 million people live and work here[‡‡‡]. Strategic economic sectors such as fisheries, aquaculture and agriculture are located along the coast and are specifically prone to damages due to climate change. But also the industrial, tourism and energy sectors are likely to suffer.

Vietnam is also a disaster-prone country. Every year, the northern and central provinces experience heavy rainfall, storm surges and high winds due to typhoons, often leading to floods and landslides. Recurrent droughts cause saline waters to intrude far inland through the rivers, causing damage to crops. Approximately one third of the coastline is suffering from coastal erosion, due to natural processes, lack of sediments from rivers upstream and sea level rise. It is likely that climate change will exacerbate many of these hazards.

Geographically, one can divide Vietnam into several regions (see Figure 16), of which the following are most relevant in the context of IPDC: Mekong Delta / Red River Delta / North Central and South-Central Coast / Islands.

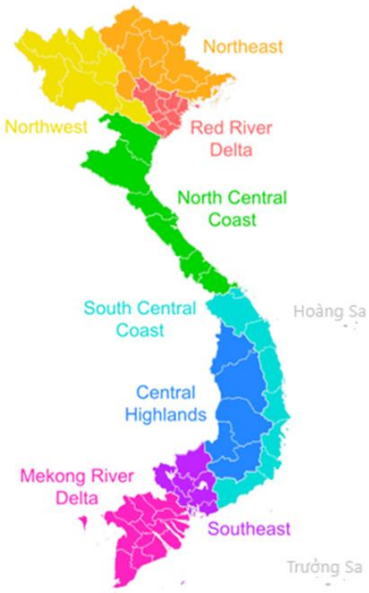

Figure 16. Map of Vietnam.

The Mekong Delta is shared by Vietnam and Cambodia, with the largest part (approx. 40,000 km^2) within Vietnamese territory. It was formed by the Mekong River over a period of 3,000 years. Alongside the two main river branches, the Bassac and Mekong, large floodplains exist which are yearly inundated up to a depth of 3 m. These are the 'Plain of Reeds' and Long Xuyen Quadrangle, which only fairly recently have been reclaimed. The average elevation is less than one meter above sea level (Minderhoud et al., 2019), which makes the delta especially vulnerable to sea level rise. According to the climate change scenario (MONRE, 2020), the average sea level rise in 2050 is 23 cm for the RCP4.5 scenario (medium emission concentration scenario) and 28 cm for the RCP8.5 scenario (mid-high emissions scenario). By the end of the century, sea level is likely to increase by 55 cm for the RCP4.5 scenario and 77 cm for the RCP8.5.

The problem of flooding due to rising sea levels will become even more serious due to the combination with land subsidence in the area. During the period 2014 - 2019, the rate of land subsidence in the region ranged from about 3 - 5 cm/year, about 10 times higher than the average annual sea level rise rate (INDRA-GISAT, 2019). Along with the increasing level of flooding, the level of salinity intrusion is also becoming increasingly serious. Monitoring data shows that in Mekong Delta, in recent years, the level of salinity intrusion in the dry season tends to be higher than the preceding (wet) season. It is projected that in the future, as sea levels rise, the extent of the influence of saltwater intrusion will become larger.

[†††] Vietnam's low-lying coastal and river delta regions have very high vulnerability to sea-level rise. Without effective adaptation measures, 6 to 12 million people could be affected by coastal flooding by 2070–2100, depending on the global emissions pathway (WB, 2022).

[‡‡‡] Vietnam is among the top four countries in the world having the highest population in the lower-elevation coastal zone (below 10 m mean sea level) (Neumann et al., 2015).

Compared to the Mekong Delta, the Red River Delta (15,000 km^2) is considerably smaller than the Mekong delta and is well protected by river dikes. Hence, flooding is not common, although the coast has a high flood hazard due to the regular typhoons.

In between the two large deltas, the coast of Vietnam consists of an alternation of rocky outcrops, dunes, beaches and smaller estuaries and deltas. The coastal plain is usually relatively narrow, as the hinterland along most parts consists of the Annamite Mountain range. In recent times, many parts of Vietnam's coastline are subject to erosion. From 1986 – 2021, about 28% of the length of the coastline has an erosional trend (Lappe et al. 2022). In the context of rapid sea level rise, the rate of coastal erosion will become more severe with a possible increase of 60% when adding estimates of sea level rise (Deltares, 2017). It is projected that, in the future, rising sea levels due to climate change and coastal erosion will greatly affect people's lives and the socio-economic development of coastal areas.

Vietnam has several islands close to the coast, such as Phu Quoc and Con Dao in the South and the Ha Long Bay archipelago in the North, as well as further offshore islands (Hoang Sa and Truong Sa).

Climate Adaptation Strategies and Plans

The "*National Adaptation Plan for Vietnam for the period 2021-2030, with a vision to 2050*" was ratified by Prime Minister in July 2020 (MONRE, 2022a). The overall objective of the Plan is "Mitigate vulnerability and risks from the negative impacts of CC by strengthening the resilience and adaptive capacity of the natural, economic and social systems; minimise losses and damages caused by increasing natural disasters and climate extremes and sea level rise due to climate change; promote the integration of climate change adaptation into the strategies and master plans." It has 3 specific objectives:

- Objective 1. Strengthen the resilience and adaptive capacity of natural, economic and social systems through investing in adaptation actions, science and technology, capacity building and awareness raising to be ready to adapt to climate change.
- Objective 2. Reduce natural disaster risks and minimise damages, be readily prepared to respond to increasing climate change-induced natural disasters and climate extremes.
- Objective 3. Improve the effectiveness of climate change adaptation by intensifying the State management of climate change response and promoting the integration of climate change adaptation into the strategy and planning systems.

For each of these objectives, many tasks are proposed. The Plan also formulated tasks and solutions for 6 regions in Vietnam, 4 of which (Red River Delta, North Central and Central Coast, Southeast and Mekong Delta) are of relevance for IPDC. The measures that focus on Water Climate Adaptation can be identified as follows:

- Development and upgrade of water infrastructure (irrigation systems, flood control works, reservoir operation and safety, salinity intrusion control works, freshwater supply storage, drainage)
- Riverbank and coastal erosion prevention measures, including nature-based solutions (e.g. mangrove and dune restoration)
- Improve disaster management (flood-proofing, relocation from high-risk areas, storm sheltering anchorages, etc.)
- For the Mekong Delta: adapt economic activities to ecological conditions (actively "live with floods, droughts and saline intrusion"), control groundwater extraction and land subsidence, water storage.

It can be observed that many tasks focus on rather general economic development goals, such as developing infrastructure and traffic systems, blue economy, industrial zones etc. Because Vietnam is still a developing country with relatively low average income levels, and poverty and under-

development are key factors in climate vulnerability, it is therefore not surprising that many adaptation measures do not differ much from general economic development interventions.

The National Adaptation Plan (NAP) fully aligns with the National Strategy on Climate Change to 2050 and NDC (MONRE, 2022b) which were approved in 2022. The NAP was drafted based on the guiding documents of the United Nations Framework Convention on Climate Change (UNFCCC). Drafting steps include: 1) collection of information and data; 2) analysis and assessment of climate change impacts, identification of challenges and gaps in climate change adaptation and - based on that - proposing tasks and solutions to adapt to CC; 3) develop the NAP.

The development of the NAP actively involved various ministries, sectors, provinces, experts, research agencies, non-governmental organisations (NGOs), businesses and development partners through many concentrated working sessions and consultation workshops at all levels. Besides the NAP, also ministries, sectors, provinces and cities have issued several sectoral and provincial climate change-related policies and plans. The NAP summarises the scientific consensus on the impacts of climate change based on future climate scenarios on society, its economy, people and natural resources. For the implementation of adaptation measures, it distinguishes three phases: 2021-2025; 2026-2030 and Vision to 2050 but does so in quite general terms.

Implementation and Financing

Current achievements mentioned in NAP include improved weather forecasting and early warning; proactive disaster response measures and systems, including strengthening community-based disaster risk management; upgrade of sea & river dikes and irrigation systems. In general, the developments and implementation of climate change adaptation action plans have resulted in reducing the climate change and natural disaster incurred loss and damages. However, there were still heavy loss and damages caused by natural disasters in some areas.

Vietnam's four river basins: the Red River - Thai Binh, Mekong, Dong Nai and Southeast river basins, which contribute 80% of GDP by 2030, all face water resource stress in the dry season. In particular, the Southeast River Basin is expected to face serious water resource stress, not even reaching 28% of dry season water demand by 2030. Besides, Ho Chi Minh city and the Mekong Delta region is facing the problem of land subsidence causing a series of serious harms and economic losses, specifically land surface subsidence causing instability of construction infrastructure, increasing the risk of flooding.

Resolute and implementable actions must be taken for the sustainable development of Vietnam with priority should be given to management and construction solutions, no-regret measures in key economic regions (Red River Delta, Mekong Delta, Southeast) to prevent the upcoming water crisis including water resource stress, local surface water pollution in river sections.

The research and application of advanced technologies in the sustainable use and management of water resources are still limited; there are not sufficient standards and regulations on water-saving products, equipment and technologies. There is a shortage of human resources for water management, especially at the local level. The plan on afforestation of coastal mangroves, protection forests and special-use forests faces a lot of difficulties due to lack of financial capital and land funding.

Gender equality has been integrated into climate change adaption projects and activities in different sectors. Notably, measures to ensure social security and gender equity were identified and proposed in the National Strategy on Climate Changes until 2050 (approved by the Prime Minister Decision 896/QD-TTg dated 26 July 2022). However, studies and assessments on the impacts of climate change on social security and gender equity, and difficulties and challenges faced by women in the climate change context are still limited.

Many legal documents mention climate adaptation and there are guidelines and policies for the integration of adaptation into master plans, for integration of gender into climate change actions as well as studies for climate change related information database development. Human resources in

climate adaptation in various fields need to be developed in both quantity and quality, e.g. through specialised trainings. Many adaptation plans use construction solutions whereas the promotion of solutions such as changing lifestyles, energy production and consumption practices up till now receive less attention.

Resources for the NAP implementation are mobilised from various channels, in compliance with the relevant law and include the State budget, international assistance (GEF, GCF, bilateral and multilateral donors etc.) as well as (potential) resources of businesses and public contributions. According to the 2020 updated Nationally Determined Contributions (NDC), State resources were only enough to meet 30% of adaptation needs.

The program on "*Science and technology to serve the national target program to respond to climate change*" and the program on "*Science and technology to respond to climate change, manage natural resources and environment in the period 2016-2020*" have made great contributions to determining the scientific basis for nationwide climate change responses. However, there remains a large gap in important knowledge related to the prioritised research on proactive responses to climate change.

Integration of adaptation contents into socio-economic development plans at all levels is a challenge. Coordination among and between ministries, sectors and local authorities in climate change adaptation needs attention. Also the participation of social organisations and NGOs could be enhanced through improved access to official (government) data sources, better coordination and information sharing with government agencies.

4.9 Aruba

Introduction

Aruba is geographically located in the Southern Caribbean Sea and as part of the Dutch Caribbean; it is a sub-national island jurisdiction (SNIJ) within the Kingdom of the Netherlands. With a population of an estimated 107,000 and a total surface area of 180 km^2, the official average population density comes to 598 persons/km^2. Yet, density levels vary considerably across the island, with some highly urbanised and tourism districts ranging well over 1,500 persons/km^2.

Geologically, the South-West coast of Aruba is largely built from Quaternary Late Pleistocene limestone terraces, reefs, calcareous dune sand limestone, and alluvial sandstone, which are the remaining evidence of coral reef deposits and sedimentations (CBS, 2016). In general, limestone is highly permeable and sensitive to ocean acidity and seawater temperatures. Its relative alkaline and absorptive capacity are conducive to coastal erosion – over time and especially during storm surges and swells – as witnessed by the formation of coastal inlets (so-called "boca's" in the national language of Papiamento) surrounding Aruba's coasts. The birth of the Aruban tourism industry dates to 1934 when the first guest house was opened in Oranjestad, the capital of Aruba. Since the 1960s, the island's tourism policy has been geared at attracting large hotels and soliciting international investments for tourism resort constructions and infrastructure expansions; a tourism policy that still holds today. In 2023, the island received more than 2 million visitors, with an estimated total contribution to GDP of at least 80%.

As a small island with an open economy, Aruba is highly exposed and vulnerable to several external shocks, including but not limited to, financial-economic and geo-political shocks, as well as environmental and climate shocks. In terms of the exposure to and vulnerability from climate change, Aruba is exposed to both climate shocks, as well as climate slow burns. Climate volatility and extreme weather patterns have increased over the past century (Peterson, 2019). Over the past five decades, the time interval between major hurricanes has shortened from 80 to an estimated 6 to 8 years. Extreme weather events over the past 20 years coincide with major hurricanes and tropical storms in the Caribbean, including e.g., Joan (1988), Bret (1993), Lenny (1999), Ivan (2004), Felix (2007), Omar (2008), and Matthew (2016). Whereas Aruba was not in the direct path of these hurricanes, the subsequent precipitation and storm surges caused significant flooding with average rainfalls of 795 mm; almost three times the annual average of 274 mm in Aruba. Conversely, studies also indicate several periods of drought after the turn of the century.

Furthermore, national census records (CBS, 2016) indicate that over the past two decades, incidents of residential and commercial flooding have increased substantially (+82 percent). Spatial data analysis shows that an estimated 46 percent of all households are located in coastal residential areas with density levels well over 1,000 residents per km^2, as well as at least 10,000 tourists per km^2. These densely populated coastal zones are prone to storm surges and floods. The amalgam of climate pressures ranges from rising temperatures (on land and sea surface) to extreme weather events, storm surges, inland flooding due to rain and sea level rise, the impact thereof is compounded by non-climatic factors such as the loss of biodiversity, environmental degradation, ocean acidification, coral bleaching and decay, waste pollution, and water contamination.

Although initial regional and coastal zoning and marine protected areas were adopted in 2019, Aruba's natural habitats and marine environment have remained largely unprotected and overexploited for well over 100 years since the exploitation of the phosphate, gold, and oil refining industry during the 1920's. Environmental archives indicate that much of Aruba's endemic flora and fauna, including wildlife, has gone extinct or is in imminent threat of extinction. In combination with the structural deforestation and dredging of marine and coastal ecosystems since the late 1940's, the slow and consistent rise in seawater temperature is partially responsible for the loss of marine life and marine biodiversity. Moreover, although no significant historical data is readily available, the growing stress on the local marine

ecosystem is also likely due to the incessant acidification of marine waters – resulting from past oil spills and leakages, polluted water runoff, and the non-treated coastal disposal of waste – as well as the growing population density and surging coastal urbanisation (Vermeij et al., 2019).

Climate Adaptation Strategies and Plans

Whereas in the past several sectoral plans have been developed on specific aspects of climate change, including renewable energy production, an integrated national plan for climate adaptation and climate resilience does not exist. The National Climate Resilience Council of Aruba (NCRC), formally launched on April 22, 2024 (Earth Day), is tasked with developing the NAP for Aruba (#OceanAction47440). Two other important initiatives were also announced at the same day to be coordinated by the NCRC: a Climate & Ocean Risk & Vulnerability Index Assessment by the Stimson Institute, as well as the Climate Impact Atlas for Aruba (version 1.0), to be conducted by Climate Adaptation Services.

Water-related climate adaptation is addressed in, e.g., the expansion and integration of Aruba's protected wetlands under the RAMSAR convention as well as restoring the Western Wetlands, connected to the Bubali Wastewater Treatment Plant, as a first defence to sea level rise (SLR) and flooding from heavy rainfall (#SDGAction51176). Additionally, the Government of Aruba is busy with developing a water memorandum and ordinance (#SDGAction51171) to regulate and optimise Aruba's water system in an integrated way (to include both mitigation and adaptation aspects, pollution prevention and rainwater harvesting). Aruba's current marine park will also be expanded to surround the entire island (#OceanAction47437).

There are several links between water, climate adaptation, and other plans. For instance, the "Build with Nature Policy" could be reviewed and strengthened with water-related climate adaptation strategies for zoning, urbanisation, and nature conservation purposes (Directie Natuur en Milieu, 2019). Furthermore, Aruba has begun with the formulation of a National Safety Strategy in which the intensification of climate mitigation and adaptation under the Crisis Management Office is being addressed.

The National Strategic Plan (NSP; Nos Plan, Nos Futuro, 2020) is a national plan coordinated by the Department of Economic Affairs, Commers and Industry. In this NSP, the chapter on Natural Resource Management addresses, among other topics, climate adaptation actions, and the chapter Sustainable Energy addresses, among other topics, climate mitigation actions. Likewise, Aruba's master plan "Repositioning Our Sails" (Government of Aruba, 2021) presents Aruba's mission-driven model and roadmap for economic resilience, including the transition toward a climate-resilient economy, outlining the necessary actions to, e.g., establish a national agenda for climate action and resilience (including a national policy and risk measurement), conserve and restore environmental resources and (marine) ecologies, as well as, to establish and enforce climate-resilient building codes and infrastructure directives. The establishment of the NCRC is a direct result from the master plan "Repositioning Our Sails".

Nonetheless, from a climate finance and investment perspective, both the NSP as well as the Masterplan lack clear and explicit inclusion, definition, and measurement of Environment-Social-Governance (ESG) and Principles of Responsible Investment (PRI) criteria and indicators. Consequently, programs and projects are not evaluated and rated in terms of their climate risks and impacts, nor in terms of their contribution to climate resilience and adaptation, as recommended by the World Bank. Likewise, contrary to for instance the Principal Adverse Impact (PAI) statements that are required in the EU, or the climate disclosures by the European Central Bank (ECB) and the Task Force on climate-related risks and impacts (TCDF), currently in Aruba, there is no legal framework nor requirement to explicitly include, present, and disclose climate impacts and climate-related risks, in addition to climate-related financial disclosures.

In terms of legal and regulatory frameworks, three laws are (partially) relevant, i.e. on Disasters (Calamiteitenverordening,1992), Spatial Planning (Landsverordening Ruimtelijke Ontwikkeling, 2006) and Nature Conservation (Natuurbeschermingsverordening, 1992). Furthermore, a Rights of Nature clause is included in the new Aruba's Constitution of 2024 (pending final draft amendment, public consultation process completed April 21, 2024).

Planning Process

The general goal of the NCRC is to contribute to the strengthening of Aruba's climate resilience and adaptive capacity[§§§]. Thereto several legal, financial, institutional, organisational, community, and educational measures have been identified, and will gradually be implemented in the coming years.

There are multiple stakeholder and sectors engaged with climate adaptation at different levels. However, stakeholders are largely 'siloed' across sectoral and thematic lines. Hence the need for, and importance of an 'inclusive and just' platform (c.q., NCRC) for collaboratively and proactively strengthening Aruba's climate resilience and adaptive capacity. Therefore, NCRC introduced the 'Climate Quintet' model, in which the (i) public and (ii) private sector, (iii) NGO's, (iv) academia & science, as well as (v) regional & international institutions play a strategic role to foster and strengthen new inter-institutional relationships and capacity to advance a climate resilient Aruba.

There is a strong focus on structured and linear planning, without sufficient consideration of volatile, uncertain, complex, and ambiguous (VUCA) environments, although some exceptions do exist (CBA, 2021). The traditional 'blueprint' design and planning excludes foresight and leading from the future, underestimates the importance and influence of stakeholder diversity, and is usually driven by past ambitions or emerging (urgent) problems. Hence, the use of scenarios is sporadic, and adaptive pathways have been, and remain insufficiently solidified and robust. The use of models and deeper analysis is hampered by limited and fragmented data.

Prioritisation and Investment Planning

The National Strategic Plan (NSP) mentioned earlier, is a national plan coordinated by the Department of Economic Affairs, Commers and Industry (DEACI). In this NSP, the chapter "Natural Resource Management" addresses, among others, the climate adaptation actions. Yet, as previously indicated, there is a structural gap in terms of the inclusion and measurement of ESG and PRI criteria and indicators, as well as PAI and climate-related financial and non-financial disclosures.

Implementation and Financing

Knowledge and data

Despite a few 'deep pockets' of knowledge and data, there is an overall lack of structured (scientific), accessible, reliable, and valid data on climate and climate related developments. Likewise, climate literacy remains limited.

Governance

Pre-existing governance structures are largely inefficient and ineffective for addressing and advancing climate resilience from a holistic 'whole-of-nation' perspective. This legacy results mainly from traditional (inter- and intra-governmental) 'siloes', as well as disjoint private-sector developments, in addition to a lack of enforced 'ecological-based' legislation, regulation, policies, and programs. The platform design of the NCRC accounts and aims to correct previous efforts to safeguard an inclusive and responsible transition toward climate resilience.

[§§§] www.ncrc-aruba.org

Capacities and Skills

Notwithstanding several specialised capacities and skills, the general breadth and depth of the stock and flow of relevant capacities and skills remains largely insufficient, and more importantly, fragmented across institutional and sectoral lines. Hence, not only does Aruba lack the requisite capacities and skills (as well as other resources), the current (existing) climate resilience capabilities remain disintegrated. The NCRC will address this dual challenge of fostering and developing climate resilience capabilities in an inclusive and integrated manner.

Financing and Funding Sources

Domestic sources of financing and funding are largely based on the government budgets, including that of SOE's (State-Owned Enterprises). International financing and funding are largely inaccessible (due to special position of Aruba as a high-income country within the Kingdom of the Netherlands, and the absence of any climate resilience funding from within the Kingdom of the Netherlands). The latter is a matter of high policy importance and (national security) urgency to be further discussed within the Kingdom of the Netherlands, especially considering the exposure to climate change disasters and hazards, the existential threat of climate change to lives and livelihoods in Aruba (as well as other sub-national island jurisdictions in the Kingdom of the Netherlands), in addition to the limited (financial and human) capacity in addressing and strengthening the climate resilience of Aruba to the benefit of inter- and intra-generational wellbeing of society and nature.

4.10 Bonaire

Introduction

Bonaire (a special Dutch municipality) is a small island with a growing population and a tourism-based economy. Its population has almost doubled since 2000 (from 13.000 to the current 24.000), fuelled by net immigration from other islands in the Dutch Caribbean, South America, and the European Netherlands. Its population density is 60 people per km^2. The demand for Bonaire as a tourist destination has tripled over the last two decades. While in 1995 Bonaire received 59.000 non-resident air arrivals, this was 170.000 in 2022.

Bonaire faces several challenges. (1) Climate change leads to the exacerbation of existing issues related to increased stormwater runoff and associated erosion, and the consequences for people and the environment. This became clear in November 2022 when heavy rainfall caused flooding and sediment washout over the coral off the coast. (2) The population growth and the growth of tourism in Bonaire are significant, putting pressure on available space, infrastructure, amenities, nature, and the environment (waste, wastewater, etc.). (3) Sea level rise and high sea levels and waves during hurricanes make stormwater runoff increasingly problematic, necessitating more measures (sea barriers) to be implemented.

Climate Adaptation Strategies and Plans

There is no national adaptation plan (NAP). But nature-based water-related climate adaptation is included in the Nature and Environmental Policy Plan (NEPP) 2020-2030 for the Caribbean Netherlands. Several projects in this plan are focused on improved water management. In the last years, this includes, for example, researching and (action)planning of urban area water management improvement options and restoration of dams and waterways in different areas.

There is a strong policy connection between nature restoration and water management improvement because combating erosion, run-off and flooding events demand investment in the removal of free roaming grazers and the restoration of vegetation and coral ecosystems.

The detailing of the NEPP strategic framework (Figure 17) is ongoing, mainly through the design of specific area-based action plans for nature and water management. The Bonaire local government and national ministries work together in priority-setting, preparing policy or project plans, and financing. Lastly it is important to note that the NEPP is aligned with both local (Bonaire) nature and environmental planning as well as with international nature and biodiversity agendas and frameworks.

Strategic goal 1 Reverse coral coral reef degradation to enhance wellbeing in the CN	Strategic goal 2 Restore and conserve the unique habitats and species in the CN	Strategic goal 3 Sustainable use of land and water for the development of the local economy
1.1 Control erosion and runoff	2.1 Conservation and restoration of key habitats	3.1 Sustainable fisheries
1.2 Effective waste and wastewater management	2.2 Conservation of keystone and flagship species	3.2 Tourism industry in balance with nature conservation
1.3 Coral reef restoration	2.3 Prevent new and control established invasive species	3.3 Invest in sustainable local food production

Strategic goal 4 Create the local conditions to ensure sustainable results of nature policy in the CN		
4.1 Create awareness through education and training	4.2 Create employment through investments in nature	4.3 Develop a structural research agenda

Figure 17. Strategic Goals Framework of the NEPP.

Several laws and decrees form the legal and regulatory framework, both national and local. Most important are those that concern nature management, waste management, and spatial planning. Key stakeholders are the local and national governments, government-owned companies (e.g., utilities and waste), and an array of commercial companies and NGOs involved in implementing projects and interventions.

Prioritisation and Investment Planning

While the NEPP offers a strategic goals framework, the steering group for Land and Water (a recurrent meeting with representatives of Bonaire's local government and ministries) is tasked to lead the way in terms of prioritisation, financing, and monitoring. All projects are monitored in alignment with achieving strategic goals and milestones. For the years 2020-2024, an additional national budget (35 million euros for the Caribbean Netherlands as a whole) was reserved for the implementation of the NEPP. A mid-evaluation of the overall implementation will take place in 2024; whereafter it must be seen if and how much additional national budget is available for the upcoming years.

Implementation and Financing

The main implementation barrier is limited available capacity and expertise. In terms of quantity in both the public and private sectors, but also in terms of quality, e.g. environmental legal experts, engineering experts, sustainability specialists, and public-private-partnership brokers. For large and complex interventions, data is often lacking. Sources of funding are mainly public, so there is much to win with enhancing private sector resource mobilisation for both nature-based and infrastructural adaptation.

4.11 Curaçao

Introduction

Curaçao is an island in the southern Caribbean Sea, with an area of 444 km2. It includes the main island of Curaçao and a much smaller and uninhabited island of Klein Curaçao ("Little Curaçao"). Curaçao has a population of 148.925 inhabitants with a male-to-female ratio of 83:100 (CBS Curaçao, 2023). Curaçao's cultural richness is a result of its history as a melting pot, with migration playing a dominant role. Migrants mainly originate from the Netherlands and more regional countries such as Venezuela, Colombia, the Dominican Republic and Suriname****. Another notable trend is the rapidly ageing of the population (CBS Curaçao, 2015).

Curaçao has always been an island with limited freshwater resources due to its location in the South-Caribbean dry belt and its climate. Contrary to the other islands within the Caribbean, the island experiences periods with limited rainfall, so "natural'' fresh water has always been scarce. The first inhabitants of Curaçao – the indigenous Caquetios tribe – obtained their water from natural springs and shallow trenches during the dry period. After the colonisation by the Dutch, the water demand increased due to additional inhabitants, plantations for food production, and other activities. This led to uncontrolled water extraction and the removal of vegetation, leading to a gradual decrease in the groundwater level and salt intrusion in some of the wells. In 1928, a desalination plant was installed, and since 2011, 98,8% of the island has access to safe drinking water (Census 201, Central Bureau of Statistics Curaçao).

Like other small islands, Curaçao is particularly vulnerable to the impacts of climate change due to its limited land area, exposure to sea level rise, and fragile ecosystems. One of the key challenges faced by Curaçao is the increasing frequency and intensity of storms. Curaçao is located in a region prone to tropical cyclones and hurricanes. More intense storms will put Curacao at risk of destructive winds, storm surges, and heavy rainfall, which could lead to flooding, infrastructure damages, injuries, and loss of life. Sea level rise is projected to increase between 24-28 cm by 2050 and between 47-86 cm by 2100, depending on emission scenarios. The rate of sea level rise is expected to accelerate towards the end of the century. The average temperature in Curaçao has increased by about 0.2 °C every ten years since the first records of temperature recordings back in the 20th century. Historical data also shows an extremely likely (>95%) increase in warm spells and heat waves and in warmer and more frequent hot days and nights (Girigori, 2011).

Climate change is negatively impacting human health in Curaçao, especially for people with underlying health problems. The relationship between climate change and human health on Curaçao is complex and is influenced by factors such as weather events, the population's overall health, healthcare infrastructure, and socio-economic conditions. Financial constraints and socio-economic contexts often make people more vulnerable to these impacts. For instance, people who cannot afford air conditioning struggle with the heat, and low-income citizens may have limited access to healthy food. Climate change will have an impact on health, with pre-existing health conditions, socio-economic status, and life stage playing a critical role in determining the extent of its vulnerability.

Climate Adaptation Strategies and Plans

Curaçao does not have a National Adaptation Plan (NAP). However, a Curaçao Climate Change Platform Curaçao has been set up (National decree of Nov 5th, 2021), following a report on the "Curaçao Climate Change Policy Assessment" (2020). This Platform has developed a "Roadmap Climate Strategy" (2024), outlining the necessary steps to achieve a national adaptation strategy.

**** Latest migration data Centraal Bureau voor de Statistiek, up to 2022.

Other related strategies and plans that Curaçao has developed include the National Development Plan (2015-2030), the roadmap for SDG implementation in Curaçao (Curaçao SDG Roadmap, 2018), Policy plan for integrated water management (2020), National Energy Policy (NEP) for Curaçao 2018, Environmental Policy Plan Curaçao (2016 – 2021), and the Blue Halo Curaçao Coastal zone management Policy Recommendations (2017).

Climate Change Adaptation Governance has been assessed by De Bruijn and Dieperink, (2022). Their first impression is that transparency and inclusiveness are elaborated the best out of the five principles, with Government effectiveness, accountability, and connectivity being poorest in place. The climate adaptation and risk assessment process is coordinated through the Platform, which consists of organisations from diverse sectors, including the public and private sectors, financial institutions, academia, and NGOs.

Implementation and Financing

Curaçao faces several obstacles to implementing climate adaptation measures. High debt to GDP ratio as a result of multiple shocks, an underdeveloped financial infrastructure, a lack of access to funding due to its constitutional status, and support are some of the primary challenges faced by Curaçao. Other barriers include outdated legislation, dispersion of data, inconsistent data collection and data sharing mechanisms, and subsequent analysis for decision-making. There is furthermore a lack of societal awareness, and lack of ownership, a foreign governance system that incorporates several characteristics that are incompatible with the islands limited capacity, and a significant brain drain due to labour market mobility on the island and abroad.

Opportunities that could help to overcome the financial barriers include exploring private sector investments that are often more innovative than governments and bring managerial and technical expertise, as well as developing dedicated funding mechanisms to facilitate easier access to funds. Facilitating a centralised information system, as the Climate Impact Atlas that is being supported by IDPC, may help to overcome knowledge gaps and increase societal awareness. Finally, capacity strengthening programs, research development, leveraging and sharing local knowledge, and the involvement of diaspora could help to structurally improve capacity limitations. That being said, there are many NGOs on Curaçao that are deeply motivated to support sustainable development, such as the Curaçao Doughnut Economy, Bario pa Bario, Stichting Soltuna, Stichting Uniek Curaçao, Stichting Splikami, Reef Renewal Curacao, Branch Coral Foundation, Youth for Climate Curaçao, the Green Phenix social enterprise, Sustainable Community Curaçao, and The Ripple Curaçao.

4.12 Saba

Introduction

The island of Saba is a special municipality within the Kingdom of the Netherlands. It's located in the northeastern part of the Caribbean archipelago and lies within the hurricane belt. It has a land area of 13 km2 with a terrain that is generally mountainous, consisting of steep slopes, deep ravines, valleys and some plateaus. At 887 meters, Mt. Scenery, Saba's dormant volcano, is the highest point in the Kingdom. Saba has several different vegetation and climate types, ranging from a tropical rainforest climate on its upper slopes and a tropical savannah climate in the lower coastal areas. From the island's shoreline extending to a depth of 60 meters is the Saba Marine Park – a protected nature area around the island established to preserve and manage Saba's marine resources. Several kilometres to the south of Saba is the Saba Bank – the largest submarine atoll in the Atlantic Ocean containing some of the richest marine biodiversity in the Caribbean Sea. It covers an area of 2,200 km2 and is the largest protected nature area in the Kingdom. The island has a population of approximately 2,000 residents, which are spread throughout the 4 main villages of Hell's Gate, Windwardside, St. John's and The Bottom – the island's capital.

Saba and its residents face various unique challenges in relation to climate change, which are compounded by the island's small scale and remoteness. In the 2023 climate scenarios report of the Royal Netherlands Meteorological Institute (KNMI, 2023), a decrease in precipitation for the islands of the Dutch Caribbean was forecasted. This will have a significant negative impact for Saba and its residents, who rely heavily on rainwater as a source of fresh water for daily life. Rainwater, which is collected and stored in cisterns under houses, is used for common household activities – such as washing dishes, showering, and laundry – and for agricultural purposes for local food production. In addition to longer dry periods, Saba will also experience shorter, heavier periods of rainfall. This will further contribute to erosion and runoff, which pose various threats to the island's ecosystems – such as its coral reefs – and to the safety of the island's residents.

According to KNMI's climate scenarios report, Saba will also experience warmer temperatures in the future. In a warmer climate, island residents will become increasingly reliant on air-conditioning. This trend has already been observed by the island's electric company. A further reliance on air-conditioning in a warmer climate will have an impact on public health, especially for those residents who work outdoors. Additionally, this will have an economic impact on island inhabitants as their electricity bills increase.

Due to rising ocean temperatures, hurricanes may become stronger and intensify more rapidly in the future (KNMI, 2023). Such hurricanes with higher wind speeds and more rainfall present several risks and challenges for the island. Although houses are already built on Saba with hurricanes in mind, stronger hurricanes increase the risk of fatalities and damages. Other infrastructure could also be damaged by landslides due to increased rainfall. This could weaken the structural integrity of the island's road that connects all 4 villages, the one airport and the harbour. The supply of electricity could also be interrupted, impacting daily life for residents and business operations.

Another consequence from rising ocean temperatures is ocean acidification, leading to coral bleaching. In 2005, a severe coral bleaching event occurred in the Saba Marine Park. The bleaching of coral not only has an obvious environmental impact on marine ecosystems, but it could also result in future economic impacts due to losses from the tourism industry. Saba's coral reefs are one of its main tourist attractions and deterioration of Saba's coral reefs could lead to a drop in tourists. Next to this, local fishermen depend on the health of the coral reefs and overall marine ecosystems for the fish and lobsters they catch on the Saba Bank to earn a living. The strong currents that come with hurricanes cause significant damage to reefs, with branching species being broken off and others completely toppled.

The residents of Saba depend heavily on imports for daily life. Most of the food consumed on Saba is imported through St. Maarten from the US, Latin America and Europe. This means the island is dependent on the continuous operating of global food supply and shipping lines. These lines are easily interrupted during the passing of hurricanes, as has been the case for each of the hurricanes Saba has experienced. It took 3 weeks before fresh produce and household supplies were brought to the island following Hurricanes Irma and Maria in September 2017. Saba's recovery is dependent on St. Maarten's recovery after a hurricane. If St. Maarten's airport and harbour are damaged and therefore not operational, food and other basic supplies do not reach Saba and travel between the islands is halted.

One of the main pillars of Saba's economy is tourism. Visitors come to the island to experience its impressive terrestrial and marine biodiversity through hiking and diving. This economic pillar is vulnerable and dependent on the preserving and sound management of Saba's natural resources. Without healthy coral reefs and tropical forests, the island could see a significant drop in visitors, which could, in turn, jeopardise the continuity of business operations for hotels, restaurants and other local businesses.

Climate Adaptation Efforts

In the last decades, the local government, known as the Public Entity Saba (PES), has taken several steps to improve the island's self-sufficiency and management of its natural resources to ensure long-term sustainability. These steps have coincidentally contributed to the adaptation process against the effects of climate change and in preparing Saba for the future. They will also lay the foundation upon which Saba's climate adaptation plan is developed.

To manage the island's rainwater, special catchments have been strategically built along the island's road to collect runoff in grey water cisterns. This water is used for agricultural purposes. Water conservation is an inherent part of the island's culture and individual mindset. For example, residents use precious resources conservatively by taking short showers and using water-efficient washing machines. There is a reverse osmosis plant at the harbour that supplies residents and businesses with water during periods of drought when cisterns run dry. The PES installed a water grid from the reverse osmosis plant to all villages to make water more accessible. The trucking of this water is subsidised by the local and national government to ensure its kept affordable. In November 2021, the PES developed a water bottling plant to provide the island's residents with quality drinking water, adhering to the legal standard of the (European) Netherlands.

In 2020, the Nature and Environment Policy Plan (NEPP) was developed with as a main goal to ensure the sound management of the natural environment for the responsible and sustainable use of the natural resources on the islands of Bonaire, St. Eustatius and Saba. As part of the NEPP, the PES started a goat control project in 2020 to address the island's widespread erosion and runoff issues through the removal of roaming goats that eat away at the native vegetation, which ultimately impact the health of the coral reefs that surround Saba during periods of heavy rainfall. In 2023, the PES started a reforestation project with the goal of further reducing erosion and runoff through the planting of trees and as a means to help boost the recovery of the island's native vegetation. Another goal of this project is to increase local food production through the development of food forests.

Up to 40 percent of Saba's electricity comes from solar energy. Since 2018, Saba Electric Company (SEC) commissioned two solar parks. Together with a battery storage system, these solar parks allow the island to run on solar energy for 8 – 10 hours a day on days with optimal sunshine. These investments were made to reduce the island's dependency on fossil fuels and to make electricity more affordable. SEC plans to increase its renewable energy share to 89 percent by installing a third solar park. Additionally, SEC is working on safeguarding its energy supply from hurricanes. Currently, 95 percent of the previously aboveground distribution network has been replaced by an underground network.

The PES has also taken steps to increase food security by increasing local food production. In 2022, a hydroponics farm that produces leafy greens and vegetables from vine crops became operational. It uses water more sustainably and will reduce the island's dependency on imports.

To facilitate the restoration of coral reefs, the Saba Conservation Foundation has initiated several coral-nursery and out-planting projects in the past years. Additionally, the Van Hall Larenstein University of Applied Sciences has been doing extensive research on Diadema (sea-urchins) and their importance as reef grazers on Saba. A coral restoration plan, which focuses on expanding the coral out-planting and grazer research, is scheduled to start mid-2024.

Climate Adaptation Plan

A solid foundation has been laid down by the various projects and activities already carried out by the Public Entity Saba and other local institutions on the island. This foundation will be further built upon to develop a Climate Adaptation Plan. The main goal of this plan will be to further improve Saba's self-sufficiency in order to prepare it for the primary and secondary impacts of climate change and for an uncertain future. The plan will be developed in close collaboration with the Ministry of Economic Affairs and Climate Policy, the Ministry of Infrastructure and Water Management, the Ministry of Interior and Kingdom Relations, local stakeholders and knowledge institutions, such as KNMI, Deltares and Climate Adaptation Services (CAS). The plan will be aligned with the goals of the already established Nature and Environment Policy Plan. Under the umbrella of improving self-sufficiency, priority is given to rainwater management, renewable energy, climate resilient infrastructure and spatial planning, the conservation of terrestrial and marine biodiversity, erosion control, food security and sustainable economic diversification.

4.13 St Eustatius

Introduction

Sint Eustatius, often referred to as Statia, is a small Caribbean island located in the northern part of the Leeward Islands chain. The island has a population of about 3200 people (Central Bureau of Statistics, 2022), covers an area of approximately 21 km^2 and is characterised by rugged terrain, volcanic landscapes, and beaches.

In terms of vulnerability to climate change, Sint Eustatius faces several challenges due to its geographical location and topography. As a low-lying island nation, it is particularly susceptible to rising sea levels, which can lead to coastal erosion, inundation of coastal areas, and increased risks of storm surges and flooding during extreme weather events such as hurricanes. The water and powerplant are in this vulnerable area.

Furthermore, climate change can also impact the island's freshwater resources (wells), as changes in precipitation patterns may lead to droughts or changes in the availability of potable water. This can have significant implications for agriculture, and overall socioeconomic stability.

Additionally, climate change threatens the island's biodiversity and ecosystems, potentially impacting coral reefs, marine life, and terrestrial flora and fauna. Rising temperatures and ocean acidification can also threaten the delicate balance of these ecosystems, affecting both local livelihoods and the island's appeal as a tourist destination.

Climate Adaptation Strategies and Plans

Although no NAPs have been developed to specifically address climate adaptation, St Eustatius is implementing adaptation (Nature Environment Policy Program) and mitigation measures such as coastal protection strategies, water management initiatives, and renewable energy sources. Collaboration with international organisations and neighbouring islands may also be crucial for addressing the transboundary nature of climate change impacts in the Caribbean region.

Additionally, Water Climate Adaptation is taken into consideration in an infrastructure development plan. St Eustatius' economic road that connects the harbour to the rest of the island is located along the coastline and is under threat of being eroded. Hence, there is an urgent need to implement erosion measures at the coastline to reduce the wave impact. Therefore, St Eustatius is in the process of renovating its road network. Surface water is redirected away from the sea and into retention and infiltration ponds. The aim is to collect as much rainwater as possible as the island does not have an extensive source of freshwater. Currently, water is supplied by a desalination system. Most buildings are equipped with a cistern that facilitates rainwater harvesting. This is ingrained in the culture of St. Eustatius.

A local climate plan is being drafted and is intended to be finalised by the end of 2024. The development of this plan is guided by the Climate Agenda for the Kingdom of the Netherlands, which identifies eight strategic points that are key to becoming climate resilient. Key stakeholders involved in the planning process include the Government departments with the responsibility for nature, economic and infrastructural development and those responsible for the social domain, as well as the St. Eustatius National Parks Foundation (STENAPA), as well as the Dutch Ministries of Economic Affairs and Climate Policy, Infrastructure and Water Management, and Interior and Kingdom Relations. Regular meetings between these agencies take place.

Implementation and Financing

Besides plans and policies, there are currently no legal and regulatory frameworks that apply to the topic of Water Climate Adaptation. Additionally, there is a lack of staff on the islands to effectively deal with the challenges posed by climate change and other pressures. Moreover, there is insufficient data

and knowledge available on the islands. Therefore, structural human capacity, as well as better knowledge and data, are needed to protect the island from the impacts of climate change.

The primary funding sources are the European Union and The Netherlands. However, Sint Eustatius would like to have access to additional sources.

4.14 St Martin

Introduction

St. Martin is an island in the northeastern Caribbean. The island's first inhabitants, the Amerindians, originally named the island "Soualiga", the land of salt, or "Oualichi", the land of the brave and beautiful women. The name Soualiga was inspired by the island's vast ponds, lagoons and saltpans which are still essential to the identity of the people of St. Martin.

Present day, the island is divided between the French Republic (53 km^2) and the Kingdom of the Netherlands (34 km^2), and respectively known as Saint-Martin and Sint Maarten. This contribution reflects descriptions of, in particular, the Southern part of the island under Dutch jurisdiction. In a future update we hope to provide more information of the Northern side under French jurisdiction. Sint Maarten is an autonomous constituent country within the Kingdom of the Netherlands, whereas Saint-Martin is a semi-autonomous overseas collectivity of France. As such, despite the connection to two European Union Member states, only the French part of the island is part of the EU.

Despite this unique institutional divide between the two halves of the island, the cooperative relationship between both sides is formally established through the Treaty of Concordia, said to be the oldest international treaty which is still being enforced. This treaty was signed on March 23, 1648, between the French and the Dutch. Based on the terms of the agreement, the island of St. Martin was to be divided between the French and the Dutch and the peoples of St. Martin shall coexist in a cooperative manner. With this, the people of St. Martin live their lives freely on both sides of the island and a comprehensive approach to climate adaptation and vulnerability reduction should consider a whole island approach.

Sint Maarten is the more heavily populated half of the island and is the most densely populated country or territory in the Caribbean: with 1,192 inhabitants per km^2 (Statistical Yearbook, 2017). Both sides of the island are hilly with large mountain peaks. The highest hilltop of the islands is the Pic Paradis (424 m) in the centre of a hill chain on the French side. The hilly nature of the island results in a number of valleys where many houses are located. There are no rivers on the island, but there are many dry gullies. Due to the naturally limited resource base of small islands, St. Martin relies greatly on imports, resulting in key/critical infrastructure located on or near the coastline. With an economy heavily reliant on tourism, the coastlines are also important for key touristic infrastructure and attractions.

Under the Köppen climate classification, the island has a tropical savanna climate (Aw) with a dry season from January to April and a rainy season from August to December. Because the island is located within the tropics, it is regularly threatened by Atlantic Hurricane activity in the late summer and early fall. On 6 September 2017, the island was hit by Hurricane Irma (Category 5 at landfall), which caused widespread and significant damage, estimated at $3 billion, to buildings and infrastructure. Some days after the storm had abated, a survey by the Dutch Red Cross estimated that nearly a third of the buildings in Sint Maarten had been destroyed and that over 90 per cent of structures on the island had been damaged.

Climate Adaptation Strategies and Plans

Sint Maarten is not individually a party to the UNFCCC and the Netherlands is categorised as an Annex 1 country (industrialised countries that were members of the OECD in 1992). The same is true for Saint-Martin and France. There is no developed NAP for either half of St. Martin.

Adaptation is considered a "top" priority for the Netherlands, both domestically and internationally. In 2016, the Netherlands adopted its National Adaptation Strategy (NAS), which is slated to be updated soon. The NAS sets clear guidelines for adaptation action in the (European) Netherlands to prepare for a climate-resilient future. However, this NAS does not consider the islands of the Dutch Caribbean but states that separate plans would be needed for the islands:

"Climate-related issues in the Caribbean Netherlands are significantly different to those in Europe and demand a separate plan. During the first half of 2017, the Ministry of Infrastructure and the Environment will hold talks with the 'special municipalities' of Bonaire, Sint Eustatius and Saba, and will offer assistance in producing a climate adaptation strategy. Should they so wish, the autonomous islands of Aruba, Curaçao and Sint Maarten can avail themselves of the same opportunity, subject to the approval of Interparliamentary Council of the Kingdom".

In an analysis of the legal framework of climate justice for the Caribbean part of the Kingdom of The Netherlands, Misiedjan (2022) concluded that there is a need for a long-term climate strategy within the Kingdom along with complementary funding. On April 24 2024, a step was made towards this through the signing of the Kingdom Climate Agenda between the Ministry of Economic Affairs and Climate (EZK) and the Government/governing bodies of the Dutch Caribbean islands.

The importance of Disaster Risk Management (DRM) and climate-change adaptation for Sint Maarten was stated in the National Recovery and Resilience Plan (NRRP) following the devastation of Hurricane Irma. To support the development of climate change adaptation plans in the Dutch Caribbean, the Dutch Caribbean Nature Alliance (DCNA) published the Dutch Caribbean Climate Action Plan 2022. This plan provides recommendations for the islands on both climate adaptation and mitigation strategies to combat climate change effects. The ambition for Sint Maarten to work towards the development of a National Climate Change Strategy, as well as an Ecosystem-based Adaptation (EbA) plan, was iterated in the Nature Policy Plan 2021 – 2025. The Sint Maarten Development Vision 2020 – 2030 (NDV) points to the need to develop resilience measures and address the impacts of climate change, and the importance of an integrated approach by all actors, the government Ministries, NGO's and Private Sector (Goal 19: The impact of Climate Change addressed).

In May 2023, the first Caribbean Climate & Energy Conference (CCEC) took place in Aruba. During this conference, the European Netherlands, Aruba and Sint Maarten agreed to strengthen cooperation in the field of renewable energy and signed a Memorandum of Understanding between the Ministry of EZK of the Netherlands and the Governments of Sint Maarten and Aruba. During this conference, it was agreed to develop the Kingdom Climate Agenda to foster collaboration within the Kingdom to address the impacts of climate change (as previously mentioned). Alongside these positive developments, the IPDC was also officially launched in 2023 at the UN Water Conference whereby Sint Maarten's Minister of Public Housing, Spatial Planning, Environment and Infrastructure (VROMI) reiterated our commitment as a Champion to this important initiative. Through the IPDC, Sint Maarten will start the process of developing a "Climate Impact Atlas".

While a comprehensive national climate change adaptation plan has not yet been developed for Sint Maarten, the conversation has begun, and a number of projects are being developed. Driven by the increasing public awareness of the impact of hurricanes and the devastation of coastal areas, Island(er)s at the Helm (funded by the NWO Caribbean Research programme and implemented by the University of St. Martin) brings together researchers and societal partners to combine technical, traditional, and contemporary knowledge practices to co-create sustainable and inclusive strategies for social adaptation to climatic challenges. Launched in 2021, this research program builds on the principle that local-specific practices and ontologies of Caribbean societies are crucial for promoting sustainable Water, Food, Shelter/WFS-nexus solutions.

In 2023, the Ministry of VROMI launched project CORENA (Coastal REsilience Needs Assessment) through funding from The Caribbean Overseas Countries and Territories (OCTs) Resilience, Sustainable Energy and Marine Biodiversity Programme (RESEMBID) program. This project aims to advance progress towards the sustainable management of the marine and coastal environment of Sint Maarten. Among its activities, this project intends to assess coastal risks and vulnerabilities (including impacts due to climate change) to draft sustainable management and adaptation plans.

Through funding from the Green Overseas (GO) Program, the Ministry of VROMI further intends to launch a call for proposals in 2024 to develop a Climate Change Report for Sint Maarten. This Climate Change Report will detail the current global science regarding climate change, the projected localised impacts/effects for Sint Maarten, provide an assessment of vulnerabilities to climate-related risks, and present possible adaptation strategies, policy recommendations and an overview of international commitments and partnerships for addressing climate change on Sint Maarten. By acquiring this total picture of the effects of climate change for Sint Maarten, it is the goal to create a baseline of understanding across Government and society to facilitate the integration/mainstreaming of climate change (adaptation) into new and existing policies, programmes, and activities, in particular development planning processes and strategies, within all relevant sectors and at different levels.

Water Climate Adaptation in Other Policies and Plans

While a comprehensive (water-related) climate adaptation plan has not been established for Sint Maarten and climate change adaptation considerations are not yet mainstreamed into policy and planning, water-related climate adaptation considerations can be found in several policies and plans. These include the National Development Vision 2020 – 2030, Nature Policy and Nature Plan (2021-2025), National Building Decree (2021), Spatial Development Strategy (2030), Storm Water Management Strategy (2016), Draft Country Sewage Masterplan 2030, Sint Maarten National Recovery and Resilience Plan (2018), Draft Zoning plans (2014), Beach Policy (1994), Hillside Policy (1998).

Legal and Regulatory Frameworks

Laws and regulations containing consideration relevant to water-related climate adaptation relate to spatial development planning, building construction, wastewater, management of the maritime areas and disaster relief. The latter regulation contains the legal basis to establish a National Disaster Management Plan, which however has not been established yet.

Planning Process

To date, a comprehensive assessment of the key stakeholders to be involved specifically in the development of (water) climate adaptation plans has not yet been undertaken. Initial key stakeholders identified for Saint-Martin, the Reserve Naturelle, and Sint Maarten are the Government, University of St. Martin and the Nature Foundation. The Nature Foundation conducts research of the natural environment which can be used to analyse the impacts of climate change on the natural environment of Sint Maarten (i.e. coral reef health). The Ministry of VROMI has a Service Level Agreement with the Nature Foundation which provides the foundation with limited financial resources to conduct this research and other activities related the conservation of the natural environment.

Planning Tools

On Saint-Martin, the Environmental Code dictates that states of France are mandated to develop and implement plans for the prevention of foreseeable natural risks such as floods, landslides, avalanches, forest fires, earthquakes, volcanic eruptions, storms or cyclones. Following the coastal devastation observed after the passing of Hurricane Irma in 2017, the Natural Risk Prevention Plans (PPRN) that dated back to 2011 was revised. The main objective of the PPRN is to reduce exposure to risks as well as the vulnerability of property and people.

On Sint Maarten, a stormwater modelling study was finalised by UNESCO in 2006 and 2008. This study was the first step towards the development of a comprehensive stormwater plan. However, beyond the Storm Water Management Strategy of 2016, a comprehensive plan has not been developed yet. A comprehensive Storm Water and Drainage strategy is still in development. At present, there have not been comprehensive climate scenarios and/or adaptive pathways developed for St. Martin as an island.

With the intention of developing a national climate change report and working towards a national climate change strategy, the Ministry of VROMI hosted interns from the Vrije Universiteit of Amsterdam in 2020 that created scenarios of the future climate change impacts for Sint Maarten using a novel method (Super-Fast Inundation of CoastS (SFINCS)) to model coastal and pluvial flood hazard and to combine this with the selection and testing of adaptation measures supported by the local stakeholders. Additionally, this research was used to conduct a multi-hazard risk analysis of the built environment on Sint Maarten based on the different climate scenarios.

Implementation and Financing

Sint Maarten faces some obstacles when it comes to implementing climate change adaptation planning and strategies due to insufficient funding, compounded by the government's capacity constraints (e.g. in proposal writing and project management). Sint Maarten is part of the Kingdom of the Netherlands, however, as the Kingdom of the Netherlands is classified as a high-income, developed country, accessing international funding tailored for developing countries is not possible for Sint Maarten. Some funds, like the Groeifonds and SDE++ may open up to Sint Maarten in 2024/2025. However, with limited capacity, accessibility to these funds will remain a challenge. That said, Sint Maarten is in need of more knowledge, capacity and information on alternative external funding sources to tackle climate change issues, and more resources invested by the Dutch state.

5 Conclusions and Way Forward

5.1 General

This the first edition of the IPDC Report. It aims to present a unified approach to discuss climate adaptation and serves as the starting point for the discussion between IPDC member countries. The report collects and shares best practices, as well as common enablers and barriers to implementing climate adaptation. IPDC countries and the wider community interested in climate adaptation are invited to reflect on the content of this report and suggest modifications and additions for future editions. This report should be viewed as a living document that continuously improves though contributions from IPDC members. Ultimately, the report aims to facilitate interaction between the member countries to collectively shape the way forward.

IPDC aims to bring the discussion on climate adaptation financing closer to the planning process. Traditionally, climate adaptation responsibilities are divided among different agencies within a country. Starting the discussion on climate adaptation financing early in the planning process bridges an important gap and contributes to a more effective policy dialogue on integration and prioritisation between different sectors. Since the financial needs for adaptation are expected to rise significantly in the coming decades, the need for a rigorous prioritisation approach and deeper understanding of the climate financing mechanisms will only grow. In that regard, this report aims to create common ground for the discussion on climate adaptation, and a healthier relationship between funding agencies and donors on the one hand, and recipient countries on the other.

During the March 2024 IPDC Conference in Rotterdam, the outline of this report and in particular, the Guidance Framework were discussed in a dedicated session. The immediate feedback from the IPDC members indicated that the Guidance Framework is well-recognised and is aligned with their planning process. It offers a common ground for discussion though the unification of terminologies and tries to mainstream the processes from planning to implementation. The feedback yielded useful suggestions and ideas; part of which are already embedded in the report. Additional recommendations are discussed in the next sections.

5.2 On the Guidance Framework

The Guidance Framework, as outlined in Chapter 3, serves as a comprehensive repository of best practices for a unified approach and terminology in the domain of climate adaptation. Its primary objective is to streamline communication and standardise the climate adaptation process, right from the initial stages of planning and strategy formulation to the final stages of implementation. This includes taking into account key factors, such as prioritisation and financing. The framework offers a universal structure that aligns well with traditional policy planning and implementation cycles. This dual advantage not only provides a harmonised approach and a shared language, but also helps in identifying common challenges and tracking progress in climate adaptation.

While the framework provides a structured approach, it is not meant to be a rigid blueprint for planning processes related to climate adaptation. These processes are largely influenced by the specific conditions and circumstances of each country. Nevertheless, the framework's structure can be instrumental in guiding the development of implementation plans for Water Climate Adaptation and their respective financing strategies.

A crucial component not yet incorporated into the Framework, but recommended by the IPDC members, is the integration of Monitoring, Evaluation, and Learning (MEL). This includes concrete indicators for

monitoring and evaluating the implementation of adaptation strategies within a country. MEL, often overlooked, is a vital part of the planning process. It plays a central role in evaluation, reflection, and strategy adaptation, leading to the ongoing enhancement of the climate adaptation process. This closes the loop from implementation back to plan adjustments. MEL fosters a process of learning and iteration, emphasising that adaptation is not a one-time, linear activity, but rather a cyclical process. Although the creation of a monitoring and evaluation (M&E) system specifically for climate adaptation is yet to be scoped for IPDC, the topic has begun to be addressed in scientific literature and in the development of guidance documents within the context of the UNFCCC Global Goal on Adaptation. As such, we plan to evaluate, in collaboration with IPDC members, whether the inclusion of MEL recommendations would add value to future editions of the IPDC Report.

5.3 On the Country Contributions

Country contributions serve as a platform for sharing knowledge and lessons learned in the planning and implementation of Water Climate Adaptation. The aim is to inspire, promote communication, and enhance learning through shared experiences and practices. IPDC members have underscored the need for, and importance of, learning across countries. This report compiles summary contributions from various countries in Chapter 4. In the future, IPDC will work closely with its members to develop and share more comprehensive country reports.

It is evident from the country contributions that climate adaptation is a complex process requiring an integrated approach. It necessitates long-term commitment and sufficient capacity for the development and implementation of climate adaptation strategies. These strategies should be based on existing and newly developed policies, institutional frameworks, financing instruments, and stakeholder involvement at both national and local levels. Each country adopts its own approach to planning and implementing climate adaptation, influenced by its unique cultural, physical, and socio-economic characteristics. However, some commonalities can be observed, particularly in the identification of enablers and challenges for adaptation and solutions to address these. These shared challenges will serve as a foundation for further exploration, study, and interactions, a process that IPDC is eager to facilitate.

5.4 On the Way Forward

Recognising that IPDC is committed to supporting its members based on their unique needs and requirements, we invite all members to actively participate in shaping the future IPDC agenda. This report serves as a crucial instrument for our upcoming discussions. To stimulate this discussion, we propose the following key recommendations:

- **Knowledge Exchange**
  There is unanimous agreement on the necessity and value of continuous information and knowledge exchange on climate adaptation. This includes sharing practical experiences encountered during the planning, prioritisation, implementation, and financing of adaptation strategies and measures. IPDC will work together with its network on establishing a discussion platform, regularly sharing experiences and best practices, showcasing new technologies, and discussing valuable funding propositions. The report, with its Guidance Framework and country contributions, serves as a valuable reference for these activities.

- **Support in Designing Adaptation Strategies and Solutions**
  IPDC aims to provide technical and strategic support to its members in the development and implementation of climate adaptation strategies and solutions. Our focus is on the comprehensive perspective and intricate challenges that impede climate adaptation. For instance, we would like to explore how to incorporate integrated spatial planning approaches

to climate adaptation, support the utilisation of nature-based solutions and assess their feasibility, and incorporate the uncertainties of climate change in the planning processes. This holistic approach ensures that our members are equipped with the necessary tools and knowledge to effectively respond to climate change.

- **Considerations for the Economics and Finance of Climate Adaptation**
  Many IPDC members have expressed concerns about the complexity of the current financing tools available for climate adaptation. The report outlines an array of potential financial sources. However, there is a clear need for practical expertise to access these sources effectively; a domain that IPDC would explore with its members. In all cases, it is important to integrate finance early on in the process, work with economic and financial indicators, and build a strong business case for climate adaptation. Furthermore, it's beneficial to connect these efforts with national budgets and incorporate the role of donors and finance agencies in funding climate adaptation initiatives.

- **Raise Awareness**
  Despite the unequivocal need for climate adaptation, its practical implementation often faces various barriers and may benefit from some enablers. This report, along with other IPDC activities, can contribute to making these conditions explicit, particularly during the planning stage. Besides raising awareness, this could empower national governments and support partnerships with international financial organisations, thereby encouraging better conditions for implementation.

- **Aligning with International Programmes**
  There are several programmes and initiatives at global, regional, and national levels that focus on climate adaptation. These include policy frameworks, research collaborations, knowledge sharing, capacity building, and funding mechanisms. IPDC strives to align its activities with relevant initiatives and programmes. By doing so, IPDC aims to ensure that its efforts towards climate adaptation are not only consistent with international best practices, but are also synergistic, leveraging the collective knowledge and resources of the global community.

- **Capacity Building and Training**
  IPDC is committed to investing in capacity building, training, and knowledge sharing initiatives. These initiatives, though developed in partnership with IPDC members, will be made accessible to everyone. IPDC has already begun with such activities. For instance, a training to support countries in accessing climate finance from the Green Climate Fund (GCF) was executed, as well as a guidance for the program 'Water as Leverage'. In the near future, IPDC intends to introduce more of such initiatives.

We believe these recommendations will significantly contribute to the effectiveness and impact of IPDC's work towards accelerating climate adaptation. We look forward to further improvements via the active contributions from the IPDC network.

Finally, this report is the first of numerous publications to come from IPDC. It serves multiple purposes: it acts as a parcel for stocktaking, provides guidance for discussing priority areas of IPDC activities, bridge some of the climate adaptation knowledge gaps, and facilitates the dissemination and sharing of knowledge. Future IPDC products and publications will serve similar purposes. Dissemination and sharing will be conducted through various channels such as webinars, social media, and the IPDC website: www.ipdc-climate-action.org.

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