Global Water Partnership Caribbean

Caribbean Community Climate Change Centre

Achieving Development Resilient to Climate Change:

A SOURCEBOOK FOR THE CARIBBEAN WATER SECTOR

About the Global Water Partnership-Caribbean

The Global Water Partnership-Caribbean (GWP-C) is one of thirteen Regional Water Partnerships of the Global Water Partnership (GWP) Organisation. GWP-C works with its partners to promote and strengthen interaction and co-operation at all levels and across different sectors to sustain Integrated Water Resources Management (IWRM) in the Caribbean region. IWRM is a process that promotes the coordinated development and management of water, land and related resources in order to maximise economic and social welfare in an equitable manner, without compromising the sustainability of vital ecosystems and the environment. The vision of the GWP-C is for a water secure Caribbean. For more information on GWP-C please visit ***www.gwp-caribbean.org***

About the Caribbean Community Climate Change Centre

The Caribbean Community Climate Change Centre (CCCCC) coordinates the Caribbean region's response to climate change, working on effective adaptation and mitigation solutions through programmes and projects to combat the impacts of climate change, global warming and extreme weather events. It provides climate change-related policy advice and guidelines to the Caribbean Community (CARICOM) Member States and to the UK Caribbean Overseas Territories. The Centre maintains the Caribbean's most extensive repository of information and data on climate change specific to the region. For more information on CCCCC please visit ***www.caribbeanclimate.bz***

About the Climate and Development Knowledge Network

The Climate and Development Knowledge Network (CDKN) supports decision makers to design and deliver climate compatible development. It does this by combining research, advisory services and knowledge management to support locally owned and managed policy processes. CDKN works in partnership with decision makers in the public, private and non-governmental sectors nationally, regionally and globally. CDKN operates in Africa, Latin America and Asia. For more information on CDKN please visit ***www.cdkn.org***

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Foreword

by the Secretary-General of the Caribbean Community

The Caribbean Community (CARICOM) welcomes the publication "Achieving Development Resilient to Climate Change: A Sourcebook for the Caribbean Water Sector". We are pleased with the results of the partnership between the Caribbean Community Climate Change Centre (CCCCC)and the Global Water Partnership-Caribbean (GWP-C) to execute the Water, Climate and Development Programme for the Caribbean, under which this Sourcebook has been developed. This Sourcebook provides a guide towards building climate resilience in the Caribbean water sector. It seeks to increase understanding of the risks posed by the current climate variability and future climate change. In this context, it outlines the critical issues and concerns and provides tools, methods and solutions for addressing these.

The Community is conscious of the consequences of the impacts of climate change and climate variability on our Region's water resources. This fact compels us to drive our individual and collective responsibilities towards building resilience to the current and anticipated changes. The path to building resilience is clearly articulated in the Regional Framework for Achieving Development Resilient to Climate Change and its accompanying Implementation Plan, a platform that was approved and adopted by the Thirtieth Regular Meeting of the Conference of Heads of Government, Belize, 12-13 March 2009 and the Twenty-Third Inter-Sessional Meeting of the Conference, Suriname, 8-9 March 2012, respectively.

Our Community is also very much aware of the critical contribution of freshwater resource management to the health and well-being of its people, to the Region's economic growth potential, and to sustainable development in general. It is for these reasons that the Consortium of CARICOM Institutions on Water, the body tasked with the responsibility for developing a Common Water Framework for the Community was established.

Even as I commend this valuable and timely resource and urge its use, particularly by policy makers and practitioners, I reiterate, on behalf of the Community, our commitment to the proper management of our Region's water resources, to the promotion of water security and to the sustainable development of our Region and look forward to future collaborative initiatives in support of this goal.

Irwin Laroque
Secretary-General of the Caribbean Community

Message

by the Executive Director of the Caribbean Community Climate Change Centre

I am particularly pleased to observe the evolution of the ***Caribbean Climate Online Risk and Adaptation tooL (CCORAL)*** into a rapidly changing and functional tool that is applicable across the region's critical sectors. The inclusion of information related to the sustainable management of our water resources into CCORAL, is one of the most significant factors in the enhancement of the utility of this tool. The development of the Sourcebook as a comprehensive resource guide is therefore a timely contribution to advancing efforts to improve the resilience of the Caribbean Water Sector.

The severe disruptions in our water systems caused by extreme weather events over the last few decades have served as a stark reminder of the specific vulnerabilities of the region's water sector. The Intergovernmental Panel on Climate Change (IPCC) in its Fifth Assessment Report (AR5) confirmed with high confidence that systemic risks associated with extreme weather events will lead to a breakdown of infrastructure networks and critical services such as electricity, water supply, health and emergency services. Also included in these critical risks are those related to food security, drought, flooding and precipitation variability and extremes, impacting further on rural livelihoods, income security, access to water for drinking and irrigation, particularly for poorer populations in urban and rural settings. Among these our water resources remain one of the single most critical factors in determining the development path of our economies. These impacts are likely to be exacerbated by the associated loss of terrestrial and inland water ecosystems, a major concern for many of our countries in this region.

It is within the above context that building resilience in the water sector is deemed essential to the well being of the region. *The Regional Framework for Achieving Development Resilient to Climate Change and its Implementation Plan*, endorsed by the Heads of Government, provide the platform for the utilisation of CCORAL and building the sector's resilience.

Dr Kenrick Leslie, CBE
Executive Director,
Caribbean Community
Climate Change Centre

Preface

by the Chair of the Global Water Partnership-Caribbean

Global Water Partnership Caribbean

This Sourcebook, the first of its kind in the Caribbean, has been developed to support implementation of the Regional Framework for Achieving Development Resilient to Climate Change and the accompanying Implementation Plan. both developed by the Caribbean Community Climate Change Centre (CCCCC).

The main aim of the Sourcebook is to guide planners, project developers and water sector practitioners on the main elements to be considered in the planning and execution of actions aimed at improving water resources management practices, to build the resilience of the water sector to the impacts of climate change and variability. Many of the tools build on the existing principles of Integrated Water Resources Management (IWRM) as a means of managing climate variability and change.

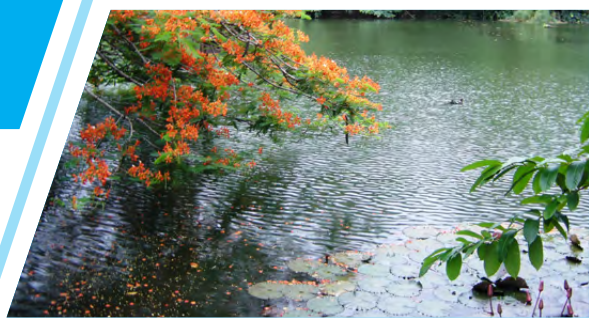
The Sourcebook is specific in its treatment of risk management as it relates to current climate variability as well as the slow onset impacts of climate change. The Caribbean has been reeling from the impacts of extreme weather events for some time now, imposing a compelling reason for giving high priority treatment to managing these current realities whilst not putting future development efforts at risk to climate change. In many cases, managing current risks will involve transforming current mindsets from a business as usual complacency to a proactive building of adaptive capacities to manage uncertain climatic futures.

The incorporation of the Sourcebook into the Caribbean Climate Online Risk and Adaptation Tool (CCORAL), developed by the CCCCC, will enhance the functionality of that instrument to respond to climate influences on the water sector. The Sourcebook will also support the implementation of the Global Water Partnership-Caribbean (GWP-C) Water, Climate and Development Programme for the Caribbean.

We at GWP-C, are delighted to have had the opportunity to work with our national partners and collaborate with the CCCCC on this publication, merging our joint expertise on Integrated Water Resources Management and Climate Resilience. We hope that this Sourcebook will see widespread use and application towards the promotion of Water Security and Climate Resilience in the Caribbean.

Judy Daniel
GWP-C Chair

Acknowledgements



The Global Water Partnership Caribbean (GWP-C) and the Caribbean Community Climate Change Centre (CCCCC) wish to express their thanks to all those who contributed to the development of the Sourcebook. The work has progressed through a partnership between GWP-C and CCCCC, supporting the implementation of the Regional Framework for Achieving Development Resilient to Climate Change (CCCCC, 2009). It also provides supporting resources for GWP-C's Water, Climate and Development Programme (WACDEP).

The work has been funded by the Climate and Development Knowledge Network (CDKN) which is funded by the UK Department for International Development and the Dutch Ministry of Foreign Affairs.

Special thanks go to Natalie Boodram (GWP-C), Keith Nichols (CCCCC) and Patricia Leon (CDKN) who in addition to providing expert inputs also coordinated the development of the Sourcebook. The work was undertaken by HR Wallingford (George Woolhouse, Nigel Walmsley, Steven Wade, Emma Brown and Geoff Pearce) in collaboration with the Overseas Development Institute (ODI) (Neil Bird and Alice Caravani) and Joyce Thomas Peters. Thanks also go out to Avril Alexander (former Regional Coordinator GWP-C) and Trevor Thompson (former GWP-C Chair) who facilitated the initial stages of the WACDEP Programme.

Finally, our thanks go out to all those who provided expert input to the Sourcebook through regional workshops and reviewing draft outputs. These persons include Angela Munroe (GWP-C), Susanne Skyllerstedt (GWPO), Alex Simalabwi (GWPO), Alison Cambray (CDKN), Emily Watson (ODI), Torkil Jønch Clausen (GWPO), Susanne Joseph (CAWASA), Albert Daley and Orville Grey (Ministry of Land, Water and Climate Change, Jamaica), Ivan Rodrigues (Antigua Public Utilities Authority), Floyd Homer (Trust for Sustainable Livelihoods), Michael Andrew and Farzana Yusuf-Leon (Water Resource Management Agency of Saint Lucia), O'Reilly Lewis (CDB), John Mwansa and Alex Ifil (Barbados Water Authority) Cyril Roberts (CARDI), Mark Bynoe (CCCCC), Emil McGarrell (Ministry of Housing and Water, Guyana), Herbert Thomas (Water Resources Authority of Jamaica), Rupert Lay (OECS Secretariat) and Marilyn Crichlow. We truly appreciate the invaluable contributions of these stakeholders.

Introducing the Sourcebook

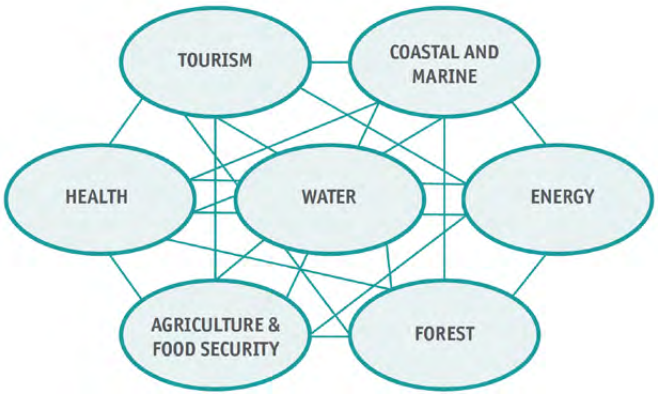
Achieving development resilient to climate change

The Caribbean is exposed to both current climate variability as well as future climate changes. The economic, social and environmental impacts experienced during recent climate hazards such as hurricanes, floods and droughts highlight the need for action to reduce risks to acceptable levels. The impacts of these hazards are likely to be most severe for poor and vulnerable communities which do not have the resources or adaptive capacity to prepare for such risks or to manage their effects.

Water is the primary medium through which climate change influences Earth's ecosystem and thus the livelihood and well-being of societies (UN-Water, 2010). Water resources and water services are impacted by current climate variability through floods, droughts, hurricanes and other climate hazards. Because water resources and services both rely on other sectors (such as energy) and support other sectors (such as tourism), the impacts are complex and interdependent.

Impacts extend beyond the sphere of influence of the water sector and require cooperation between sectors in order to manage these interdependencies. The Implementation Plan for Regional Framework for Achieving Development Resilient to Climate Change (CCCCC, 2012) places water at the centre of efforts for climate resilience (see Figure i).

Figure i - The sectoral interdependencies related to building climate resilience (reproduced from CCCCC, 2012)



Climate change presents an additional challenge to planners and managers as it is likely to exacerbate existing hazards. Broad trends for the Caribbean based on climate model projections include: warmer temperatures, higher sea levels, reduced rainfall, and increased storm intensity. However, there remains large uncertainties in the scale of these changes and this presents a major challenge for long term planning. Further high level information on climate change projections for the Caribbean region is presented in Annex A.

Given these uncertainties, strategies are required which bring benefits under a wide range of future scenarios (referred to as no and low regret options) and which remain flexible to adapt to changes over time which are not well constrained at present.

Climate resilience is a relatively well established concept in the Caribbean, being the central theme of the Regional Framework for Achieving Development Resilient to Climate Change (CCCCC, 2009) and the accompanying Implementation Plan (CCCCC, 2012). The strategic vision of the regional framework is "a regional society and economy which is resilient to a changing climate".

This Sourcebook has been developed to support implementation of the Regional Framework for Achieving Development Resilient to Climate Change, with a particular focus on the water sector.

Purpose of the Sourcebook

This Sourcebook aims to strengthen the capacity of users to manage and mitigate climate related risks and more specifically:

- ***Understand the problem:*** *To better understand risks posed by current climate variability and future climate change*
- ***Identify and appraise options:*** *To improve climate resilience to current and future climate variability and change, referred to as adaptation options*
- ***Deliver solutions:*** *To prepare bankable projects and develop financing and implementation strategies*
- ***Monitor and move forward:*** *To enhance monitoring and evaluation of water security and climate resilience*

The Sourcebook offers users a framework for enhancing climate resilience throughout the decision making cycle. Ultimately, the Sourcebook is intended to stimulate the identification and implementation of investments to enhance climate resilience, thereby underpinning sustainable development and growth in the region.

Target users

The target audience for this Sourcebook comprises water resources managers and water service providers who are seeking an understanding of how to better manage climate risks. This includes decision makers, planners, project developers and their teams. The Sourcebook aims to strengthen their understanding and commitment to risk-based approaches and to enhance decision making with respect to climate resilient investments.

The application of the Sourcebook will require collaboration across sectors which are related to or dependent on water to ensure solutions accommodate the wider economic, social and environmental aspects of water management.

Using the Sourcebook

The Sourcebook takes a phased approach to decision making for building climate resilience around four broad themes: Understand the problem; Identify and appraise options; Deliver solutions; and Monitor and move forward (see Figure ii). These form the high level structure of the Sourcebook document.

The decision making framework presented in the Sourcebook is not intended to be a new process, rather it is representative of existing development planning decision making processes. Likewise, the Sourcebook is not intended to be followed as a step by step process. Each section can be utilised independently.

The Sourcebook aims to serve as a reference source and supplementary guidance document for use by practitioners as and when the need arises, for example, when they are seeking better understanding of particular tools or methods to support their day-to-day decision making processes.

Figure ii - Decision making framework for water security and climate resilience

The Sourcebook does not and indeed cannot directly answer specific questions related to climate resilience as these are necessarily country and context specific. The Sourcebook therefore encourages a questioning mode of thinking and provides guidance on methods, tools and approaches that help users address and answer these questions.

The Sourcebook navigator on the following pages provides an overview of the structure and content and this can be used to quickly access the most relevant section of the publication. In addition to the main body of the Sourcebook a glossary, a summary of acronyms, reference list, and annexes containing supplementary information are provided.

Understand the problem

The overall purpose of this phase of decision-making is to arrive at a common understanding on the priority existing and future climate risks to water resources and water service provision, and their potential impacts on development objectives.

Outcome: A strong, evidenced case for investment in climate resilient measures, based on an understanding of the climate risks facing different stakeholders.

Sourcebook content: Tools, methods and approaches include

1. Assessing existing climate risks

- 1.1 Engaging stakeholders in climate risk assessment
- 1.2 Rapid framing of climate impacts
- 1.3 Mapping the pathways between hazards, vulnerability and impacts
- 1.4 Prioritising impacts to assess levels of risk
- 1.5 Building the evidence base through technical studies

2. Assessing future climate risks

- 2.1 Understanding the role of climate change and development scenarios in the Caribbean
- 2.2 Determining the level of complexity for scenarios
- 2.3 Identifying data and information sources to develop scenarios
- 2.4 Building climate and development scenarios
- 2.5 Applying scenarios to assess future climate risk

3. Making a strong case for action

- 3.1 Identifying impact metrics to make a strong case
- 3.2 Using economic assessment of the impact of climate variability and change
- 3.3 Aligning the case for action with regional, national and sectoral policies and strategies
- 3.4 Identifying champions as a catalyst for action
- 3.5 Communicating the case for action

Monitor and move forward

The purpose of this phase of decision-making is to monitor and evaluate the impacts of investments in climate resilient development.

Outcome: Enhanced monitoring and evaluation frameworks which track the impact of investments in climate resilience, building on lessons learned.

Sourcebook content: Tools, methods and approaches include

10. Benefitting from results based monitoring and evaluation

- 10.1 Results-based monitoring and evaluation
- 10.2 Incorporating climate change in existing monitoring and evaluation systems
- 10.3 Benchmarking and performance measurement

11. Learning lessons and communicating findings

- 11.1 Benefitting from learning reviews
- 11.2 Disseminating findings and regional learning

Identify and appraise options

The overall purpose of this phase of decision-making is to identify and appraise a coherent set of cost effective and feasible climate resilient adaptation options which address urgent and high priority risks.

Outcome: A strong, well-articulated and evidenced case for high priority options to build climate resilience.

Sourcebook content: Tools, methods and approaches include:

4. Understanding the principles of building resilience in water management

- 4.1 No and low regrets options are robust to climate change uncertainty
- 4.2 Enhancing resilience in water brings co-benefits to other sectors
- 4.3 Preparing for long term climate change requires a flexible pathway of actions

5. Using CCORAL to identify adaptation options

- 5.1 Introducing CCORAL
- 5.2 Applying CCORAL in the context of water management

6. Building on existing work to identify adaptation options

- 6.1 Reviewing past plans, policies and risk assessments to identify adaptation options
- 6.2 Building on the lessons from case studies and ongoing initiatives
- 6.3 Reviewing regional and international databases to identify opportunities for resilience

7. Prioritising adaptation options for implementation

- 7.1 Selecting appropriate prioritisation techniques
- 7.2 Multi criteria analysis (MCA)
- 7.3 Benefit cost analysis (BCA) and Cost Effectiveness Analysis (CEA)
- 7.4 Specialised decision making techniques

Deliver solutions

The purpose of this phase of decision-making is to secure finance for bankable projects which will enhance climate resilience.

Outcome: A suite of bankable projects, maximising leverage from climate financing sources for taking these forward.

Sourcebook content: Tools, methods and approaches include:

8. Taking options forward for implementation

- 8.1 Preparing bankable investment projects and programmes
- 8.2 Integrating adaptation options into development planning processes
- 8.3 Mainstreaming climate resilience

9. Identifying sources of finance to implement adaptation options

- 9.1 'Traditional' financing sources
- 9.2 Appreciating the growing importance of climate finance
- 9.3 Seeking opportunities to fund climate change related actions
- 9.4 Pragmatic considerations to be aware of when seeking funding

Assessing existing climate risks

1

Key messages

- Identifying stakeholders' roles, responsibilities and reliance on water related services provides the context for understanding how different stakeholders are affected by climate risks
- An important first step in managing future climate change risks is to assess the impacts of current climate hazards on water resources and water services
- Impact chains can be used to understand pathways between climate hazards, vulnerabilities and the direct and indirect impacts on water resources and water services
- Risk assessment can identify priority climate impacts according to criteria on the severity of consequences and likelihood of occurrence of climate hazards
- Gaps in the knowledge identified during risk assessment stages can be used to specify new studies and assessments

Sample tasks and activities

- Identify the stakeholder groups at risk from water related hazards and dependent on water security
- Review sources of information on climate hazards and impacts, and work with stakeholders to identify significant impacts and the underlying climate hazards and vulnerabilities
- Construct impact chains to understand how climate hazards, vulnerabilities and impacts are interlinked within and across different stakeholder perspectives and sectoral interests
- Prioritise risks according to agreed criteria on the likelihood and severity of the impacts
- Propose and justify technical studies which would help to address information gaps and provide evidence on climate risks. Consider the barriers and opportunities associated with these proposals

A first step towards climate resilience is having a good common understanding and agreement on the high priority climate risks currently facing water resources management and service provision in addition to the economic, social and environmental systems which rely on water. In many cases there is already a good understanding of these risks in which case the main task in this step is to come to a level of agreement on the priority risks and to provide supporting evidence that can be used to influence decision makers.

This section provides practical approaches to understanding current climate risk and techniques to enhance the knowledge-base where information exists.

1.1. Engaging stakeholders in climate risk assessment

Because the inter-linkages between water, climate and development are complex, a broad constituency of stakeholders are likely to be engaged in water security and climate resilient planning and development. Bringing together stakeholders who are directly responsible for water management and those who are dependent on water services will provide a broad range of perspectives on the different water related climate risks.

The aims of the stakeholder definition stage include:

- Gaining a common understanding of who has a stake in water management
- Understanding the roles and responsibilities of each stakeholder as they relate to water management issues
- Understanding the interaction between stakeholders including conflicts, synergies and the decision making processes which govern these interactions

In the Caribbean, key stakeholders to engage in the process are likely to include some or all of the following:

- Water resources agencies – Ministries and departments responsible for water resources
- Sector agencies reliant on water – Departments of environment, agriculture, tourism, industry, planning and finance
- Water service providers – Water utilities, agricultural water services
- Water user representatives and private users – Community groups, farmers, tourism operators, business and industry representatives
- Disaster risk offices
- Climate change focal points
- Technical specialists – Universities, research organisations, technical staff within government agencies
- Regional organisations – for example; CAWASA, CWWA, CCCCC, CDEMA, CARDI, CDB, CARPHA, CIMH
- Capacity development and networking organisations – CAP-NET, GWP-C, UNESCO-IHE, Universities
- Development partners

Framing the climate risks facing water resources management and water services will require a common understanding of the roles, responsibilities and objectives of each stakeholder as they relate to water management. This can be carried out using three potential approaches outlined below. Further information on each approach is provided in Box 1.1:

Stakeholder analysis: Stakeholder analysis is a useful tool to frame the process of identifying stakeholders and their roles and responsibilities regarding the use of water resources. It can be applied rapidly through workshops and interviews and is a good way to bring stakeholders together to initiate a discussion of key issues.

Situational analysis: Often more involved than a stakeholder analysis, it requires an in-depth review of the institutional and legal arrangements for water management across the various stakeholders involved in or dependent on water management. It can also include technical elements of water resources assessment, demand assessment, environmental impact assessment and social impact assessment. A number of national situational analyses for water have already been carried out in the Caribbean through inter alia, the CDB, the GWP-C and the GEF-IWCAM project. These provide valuable information and should not be replicated unless it can be demonstrated that further information is required.

Ask yourself...

Which stakeholders should be involved in building resilience in water management?

What are the roles, responsibilities and objectives of each stakeholder group?

How do stakeholders interact and what guides these interactions?

Network analysis: Network analysis is a tool to assist the understanding of the relationships between stakeholders. It provides a visual representation, mapping pathways, clusters and centrality of stakeholders and the types of interaction such as command, information or resources.

Box 1.1 – Tools for stakeholder, situation and network analysis

Stakeholder Analysis and Network Analysis - World Bank Tools for Institutional, Political, and Social Analysis of Policy Reform

The World Bank sourcebook on tools for institutional, political and social analysis of policy reform is targeted at practitioners and provides an overview of numerous analytical techniques for policy reform, including stakeholder analysis and organisational mapping. Section 7 of the sourcebook provides an overview of the tools and their application at different levels of planning.

Source: Holland, J. 2007. Tools for Institutional, Political, and Social Analysis of Policy Reform: A Sourcebook for Development Practitioners. World Bank, Washington D.C., USA. Available at: http://siteresources.worldbank.org/EXTTOPPSISOU/Resources/1424002-1185304794278/TIPs_Sourcebook_English.pdf

Stakeholder Analysis and Situation Analysis - UNEP Integrated Water Resources Management Planning Approach for Small Island Developing States (SIDS)

This guidebook presents a process and a range of tools to assist SIDS with IWRM planning. These include stakeholder analysis and situation analysis. In addition a wide range of case examples from IWRM planning in SIDS are provided.

Source: UNEP. 2012. Integrated Water Resources Management Planning Approach for Small Island Developing States. UNEP. 130 + xii pp. Available at www.unep.org/pdf/sids.pdf

Stakeholder Analysis - Caribbean Natural Resources Institute (CANARI) Guidelines for Stakeholder Identification and Analysis

The CANARI guidelines provide a methodology for stakeholder analysis for natural resource management in the Caribbean. Although not aimed at the water sector directly, it represents a useful primer on the subject and is appropriate to the Caribbean context.

Source: Caribbean Natural Resources Institute. 2004. Guidelines for Stakeholder Identification and Analysis: A Manual for Caribbean Natural Resource Managers and Planners, ISBN 1-890792-07-1. Available at www.canari.org/Guidelines5.pdf

Situation Analysis – GEF-IWCAM IWRM Roadmaps

As part of the GEF-IWCAM project, IWRM road maps were produced for Antigua & Barbuda, Barbados, Dominica, Grenada, Jamaica, Saint Kitts & Nevis, Saint Lucia, Saint Vincent & the Grenadines and Trinidad & Tobago. These contain the results of situational analyses for the water sector and could be used to support stakeholders in understanding the interactions and current status of water management at a national level.

See the GEF-IWCAM project website at http://iwcam.org

1.2. Rapid framing of climate impacts

"Water is the first sector to be affected by changes in climate. Climate Change leads to intensification of the hydrological cycle and subsequently it has serious effects on the frequency and intensity of extreme events. Sea level rise, increased evaporation, unpredictable precipitation and prolonged droughts are just a few manifestations of climate variability directly impacting the availability and quality of water" (Cap-Net, 2009)

Ask yourself...

Is there a common understanding of the terminology of climate risk management across stakeholder groups?

An initial activity which may assist stakeholders frame the climate impacts which they currently face is to categorise impacts by the type of climate hazard which is the underlying cause of the impacts. Water related climate hazards may be drawn into two broad categories: drought and flood. Drought, and insufficient water availability has a wide range of impacts from competition to resources to water quality impacts. Flood, and excess water through storms and other extreme events causes damage to assets and other damaging effects. Although categorisation does not capture the complex interdependencies, it can be used as a frame of reference for discussing impacts at a general level across diverse stakeholder groups. Understanding the root causes of these negative impacts both in terms of the climate hazards and human vulnerabilities can help to identify options to reduce vulnerabilities. Box 1.2 summarises some of the key terminology used in climate risk assessment, with more information available in the Sourcebook glossary and Annex B which discusses key concepts.

> *Given the inherent physical characteristics of small islands, the AR5 reconfirms the high level of vulnerability of small islands to multiple stressors, both climate and non-climate (high confidence, robust evidence, high agreement)*
>
> ***IPCC Fifth Assessment Report (IPCC, 2014c)***

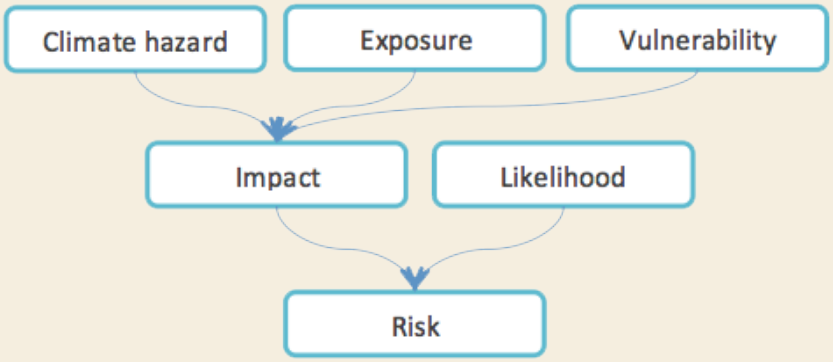
Key questions to discuss include:

- What are the main impacts due to climate hazards for different stakeholders?
- How are impacts distributed across different stakeholder groups?
- Which factors are most important in determining impact severity, climate hazards or human vulnerabilities and exposure?
- Which climate hazards are most significant in causing impacts?
- Which vulnerabilities play an important role in contributing to severity of impacts?
- What is the geographical distribution of exposure and vulnerability to climate hazards?

One key question to resolve early on is exactly who or what is exposed to climate impacts. The answer largely depends on the stakeholder's perspectives, roles and responsibilities. Water service providers will primarily be concerned with risks to their indicators or performance (such as continuity of water supply or costs of asset maintenance). Tourism operators may be concerned with risks to the continuity of supplies, quality of supplies and cleanliness of watercourses and the marine environment. At a national level, government ministries may be concerned with any risk which impacts on social wellbeing of the population and the economic conditions in the country.

Box 1.2 – Key terminology, climate hazards, human vulnerabilities and resulting impacts

A consistent approach to terminology is useful when considering the risks posed by climate variability and change. The diagram below conceptualises the links between some of these key terms.



- **Climate hazard** – The physical manifestation of climate variability or change such as extreme rainfall or river flow, deficient rainfall or river flow, storm surge, sea level rise or heatwave for example
- **Exposure** – The number and type of assets, communities, ecosystems or items of value (referred to as receptors) which are influenced by the climate hazard. For example, a pumping station located on a flood plain may be exposed to high river levels
- **Vulnerability** – The characteristics of the receptors which make them more or less influenced by the hazard. For example a poorly constructed bridge will be more vulnerable to flood damage than a well maintained bridge[1]
- **Impact** – The consequence of a hazard occurring with an exposed receptor of a certain vulnerability. For example a flood hazard coupled with a pumping station in the floodplain which is not flood-proofed would result in the impact of an inoperable pumping station, loss of water supplies and increased expenditure to repair the pump station
- **Likelihood** – The chance of the hazard occurring. For example storm rainfall may cause localised flooding on a regular basis, while a major storm surge occurs less frequently
- **Risk** – The combination of likelihood and impact. High risk impacts could be those which occur rarely but have severe impacts, or which occur more frequently but have less severe impacts

This box gives a rapid overview of the key terminology. Refer to the glossary for more detailed definitions. Further information can be found in the IPCC's recent SREX report (see source below).

Source: Lavell, A., M. Oppenheimer, C. Diop, J. Hess, R. Lempert, J. Li, R. Muir-Wood, and S. Myeong. 2012: Climate change: new dimensions in disaster risk, exposure, vulnerability, and resilience. In: Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation [Field, C.B., V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi, M.D. Mastrandrea, K.J. Mach, G.-K. Plattner, S.K. Allen, M. Tignor, and P.M. Midgley (eds.)]. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change (IPCC). Cambridge University Press, Cambridge, UK, and New York, NY, USA, pp. 25-64. Available from the IPCC website at http://ipcc-wg2.gov/SREX/

[1] Note that this is based on the IPCC SREX definition of vulnerability rather than the IPCC Fourth Assessment report definition in which vulnerability is a function of both climate hazard and the characteristics of the system exposed to the hazard

Figure 1.1 broadly conceptualises these impacts based on high level reviews of climate risks in the Caribbean. These direct climate impacts will impact on social, economic and environmental systems through disruption to water resources and water services which support them.

While Figure 1.1 is based on Caribbean climate impacts, the categorisation is not exhaustive and countries will identify impacts which are not covered in the figure. Box 1.3 gives an example of the main impacts of climate change on wastewater treatment in the Caribbean. It links the climate hazard with the resulting impacts on the systems themselves.

Ask yourself...

How do the impacts your organisation experiences map onto Figure 1.1?

Which impacts are missing from Figure 1.1?

What are the perspectives of different stakeholders?

Figure 1.1 - Summary of water related climate impacts. Bold text indicates hazards while underlined text indicates the resulting impact (based on Pulwarty et al. 2010, Farrell et al. 2007, Farrell et al. 2010 and Cashman et al. 2009).

Climate change drivers	Reduced rainfall, higher temperatures	Storms, hurricanes, increased rainfall intensity, rising sea levels
Hazard	Drought	Floods
Impact of climate hazard on water service provision	• Drought risk to surface water reservoirs, river flows and aquifers leading to supply deficits for water services • Drought leading to salinisation of aquifers (compounded by over-abstraction) • Drought reducing dilution of pollutants and wastes causing water quality problems for service providers • Drought causing a reliance on water trucking and desalination increasing the cost of water provision to consumers	• Coastal, river and surface water flood risk to water infrastructure causing water supply contamination, service outage and damage to assets • Long term sea level rise and coastal erosion presenting a risk to water infrastructure • River flooding causing turbidity and sedimentation damaging infrastructure and causing treatment problems • Storm rainfall mobilising polluted runoff leading to water treatment problems and public health risks

Box 1.3 gives an example of the main impacts of climate change on wastewater treatment in the Caribbean. It links the climate hazard with the resulting impacts on the systems themselves.

Box 1.3 – Climate Change impacts on wastewater

The Caribbean Regional Fund for Wastewater Management (CReW), established in 2011, seeks to provide sustainable financing for the wastewater sector, support policy and legislative reform, and foster regional dialogue and knowledge exchange among key stakeholders in the Wider Caribbean Region.

The CReW has developed a series of factsheets on wastewater including wastewater basics, tourism, health, wastewater as a resource, and wastewater and climate change. The impacts of climate change on wastewater are examined in the latter factsheet. These impacts are provided below and highlight the main issues which wastewater managers and policy advisors should be aware of:

How does Climate Change Affect Wastewater Management?

- Existing wastewater treatment systems, whether centralized or decentralized, are likely to be less effective in providing adequate levels of treatment under climate change.
- Increases in ambient temperature as well as in the number of warm and extremely hot days may lead to warmer soil and water temperatures, lowering the effectiveness of decentralized sewage systems such as septic tanks, cesspits and constructed wetlands.
- Increasing temperature will lead to evaporation and increased sedimentation, which compromises water quality.
- More droughts and extreme rainfall events have impacts on non-existent or old, inadequate wastewater treatment facilities, highlighting the need for infrastructure that can cope with extreme surges of wastewater or reduction in water flow.
- Communities in riverbank settlements are affected during heavy rainfall when improper water closets are destroyed and waste is released directly into rivers and streams used by residents for bathing and drinking purposes.
- Increasing incidence of heavy rainfall can lead to a greater presence of substances like phosphates and nitrogen in agricultural runoff in the water which eventually leads to eutrophication.

GEF-CReW (Caribbean Regional Fund for Wastewater Management) Wastewater Series Factsheet #5: Wastewater and Climate Change Available from the CReW website at *www.gefcrew.org*

Box 1.4 – Further background information on climate risks in the Caribbean

CARIBSAVE Climate Change Risk Atlas

The Risk Atlas provides valuable contextual information on the broad range of climate risks facing the Caribbean and although it cannot provide tailored, local assessments of risks it provides an overview across sectors and is a first port of call for undertaking a risk assessment. *http://intasave-caribsave.org/resources/reports/*

CCCCC Clearinghouse

The CCCCC Clearinghouse is a repository of technical studies relating to vulnerability and risk assessment at local, national and regional levels which have been carried out by a range of agencies within the region including national governments, regional organisations and development partners. *http://clearinghouse.caribbeanclimate.bz*

Climate Change in the Caribbean: The Water Management Implications (Cashman et al. 2009)

This paper provides an overview of the implications of climate change on water resources in the Caribbean. Although taking a broad brush approach it nevertheless provides a useful background to the main drivers and issues faced at a regional level.
http://jed.sagepub.com/content/19/1/42

1.3. Mapping the pathways between hazards, vulnerability and impacts

Following on from framing the main impacts, a more focused examination of the pathways between hazards and impacts can improve the understanding of how impacts can link together in a chain of cause and effect. Figure 1.2 below maps out a hypothetical impact pathway related to the impacts of flooding from the perspective of a water service provider. The main elements involved are:

- **Climate hazard** – the natural hazard such as flooding or drought which is the source of the impact
- **Vulnerability of human systems** – the characteristics of the watershed, water supply systems or other human systems which exacerbate the effect of the climate hazard
- **Primary impact** – the immediate consequence of the combination of the hazard and vulnerability on the water system under consideration
- **Secondary impact** – the result of the primary impact on another system, such as physical assets or the provision of water related services
- **Tertiary impact** – the knock on effect of the primary or secondary impact on wider society, economic activities or the environment. These impacts are harder to quantify as they become further removed from the climate hazard but they may be of interest to high level decision makers as wider macro-economic impacts

Ask yourself...

Map the impact chains for high priority impacts relevant to your organisation

Does this help formulate and share thoughts on climate impacts?

Ask yourself...

Which organisations are responsible for managing each of the impacts identified?

Which impacts are within the responsibility of your organisation?

Each impact pathway will be different depending on the local context and the perspectives and responsibilities of the stakeholders involved. A water utility may have a relatively narrow focus on the impact of climate hazards on its service provision, whereas a ministerial department responsible for water resources management may take a much broader view on the impacts across a range of dependent users, including the environment.

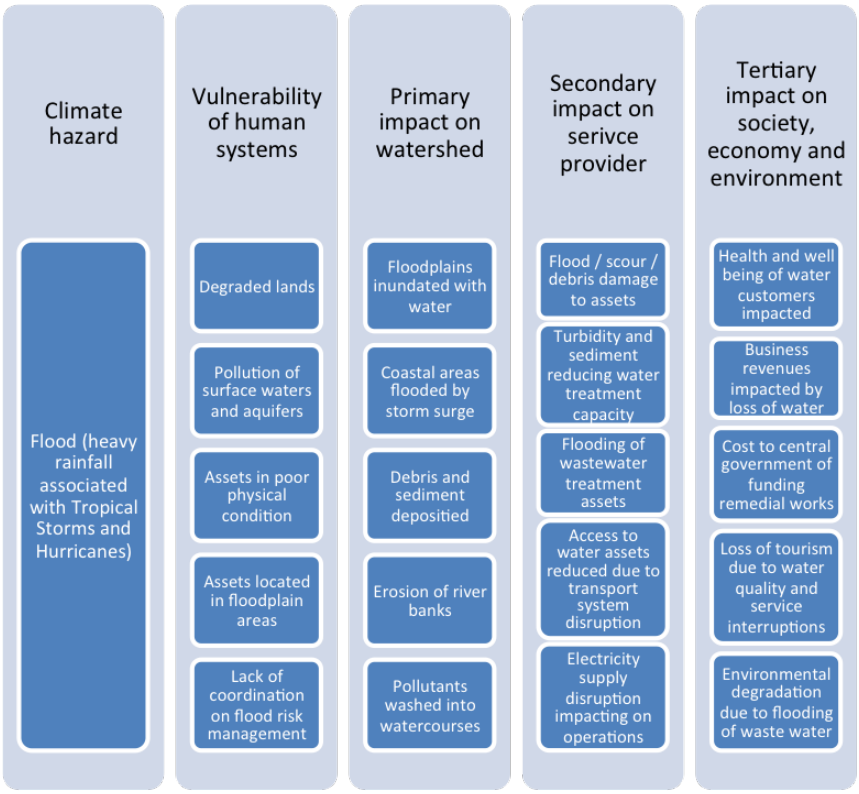
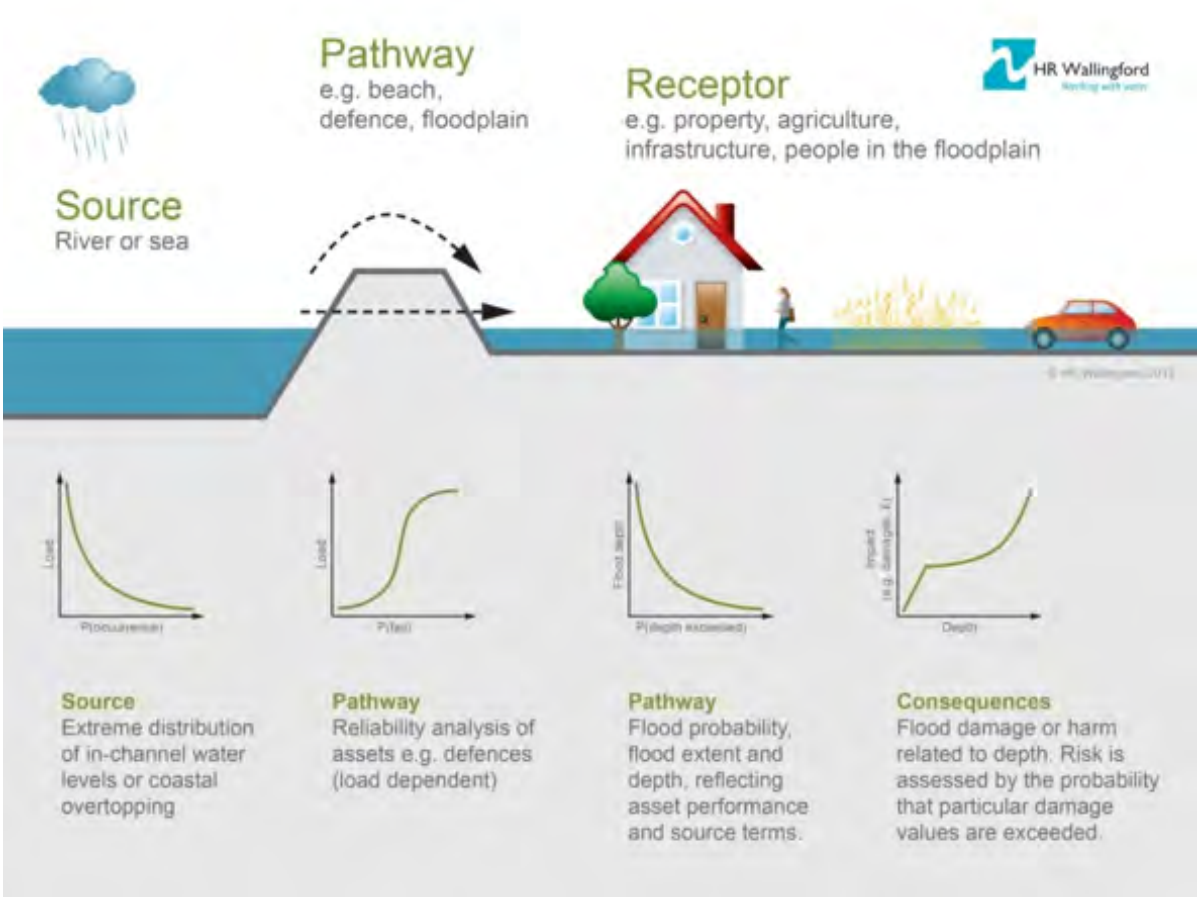


Figure 1.2 - Climate impact chains for a hypothetical example of a Caribbean water service provider

A number of different models exist for conceptualising how hazards result in negative impacts, the example above uses a combination of hazard and vulnerability to assess the impacts on receptors. Another approach is the source, pathway and receptor model. This is often used when considering flood risk as shown in the example in Figure 1.3. In this example the source of the hazard is high water levels (sea or river), the pathway is the route or process for flood water to pass inland, including floodplains and defences, and the receptors are human assets, lives and livelihoods which are exposed to the negative impacts of flooding.

Figure 1.3 - Source - pathway - receptor model for climate impacts due to flooding.



Box 1.5 – Further background on impact chains

The Climate Impacts: Global and Regional Adaptation Support Platform (ci:grasp)

This programme makes use of the concept of impact chains to link between the causes and effects of climate change. *http://pik-potsdam.de/cigrasp-2/ic/ic.html*

UNDP - Designing Climate Change Adaptation Initiatives: A UNDP Toolkit for Practitioners

This toolkit provides information on problem tree analysis, which is similar in concept to impact chains but is applicable more widely outside the sphere of climate risk assessment *Available at http://www.undp.org/content/undp/en/home/librarypage/environment-energy/low_emission_climateresilientdevelopment/designing-adaptation-initiatives-toolkit/*

1.4. Prioritising impacts to assess levels of risk

Having identified impacts and their underlying hazards and vulnerabilities, a prioritisation of impacts is required to assess levels of risk and target resources towards managing these risks most effectively. This exercise also helps to build a common view amongst stakeholders of the levels of risk being experienced which may help facilitate a coordinated response to risks. Note that this section is referring to current climate risks, based on the experiences of practitioners; the consideration of changes in the future will be discussed in the next section.

Ask yourself...

What indicators of impact consequence are most relevant in my context?

What sources of information can I access to calculate indicators?

The level of risk is commonly assessed using two criteria: the likelihood of the impact (how often it is likely to occur) and the consequence of the impact (how severe the consequences are to the economy, society and the environment), conceptualised in Figure 1.4. This process can be carried out through stakeholder workshops. However, in order to develop indicators of the likelihood and severity of impacts some additional supporting work may be required to provide evidence on the likelihood and consequences of impacts where these are not well understood.

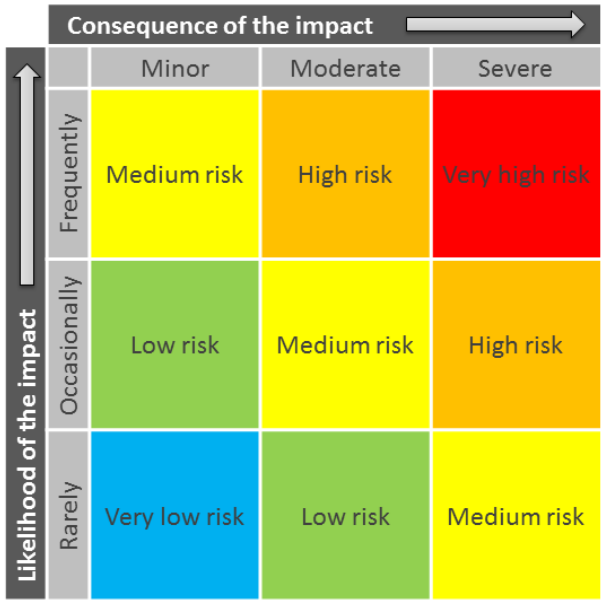


Figure 1.4 - Generic risk assessment matrix which can be used to rank impacts according to likelihood and consequences

The indicators which can be used to assess likelihood and consequence of climate impacts should ideally be quantitative wherever possible to allow comparison between impacts. However, this information may not be available in a workshop environment, and may need additional research to compile. Therefore, a workshop may be useful to identify potential indicators and inform a work programme to collate the necessary information to conduct the risk assessment. Tables 1.1 and 1.2 set out some of the considerations when identifying indicators of consequence and likelihood.

Table 1.1 - Potential questions and sources of information for assessing the likelihood of climate impacts

Ranking criteria	Key question	Potential sources of information	Example ranking
Frequency of occurrence	How often has this occurred in the past?	Official reports, media reports, local knowledge	Once per 100 years/ once per 10 years/ once per year

Table 1.2 - Potential questions and sources of information for assessing the consequence of climate impacts

Ranking criteria	Key question	Potential sources of information	Example ranking
Economic Consequences	What are the economic costs of the impact occurring?	Insurance costs, reconstruction of assets, loss of business, loss of income, loss of tourism	Minor and acceptable / moderate and undesirable / severe and unacceptable
Social consequences	What are the social costs of this impact occurring?	Health and wellbeing, loss of life, unemployment, displacement	
Environmental consequences	What are the environmental costs of this impact occurring?	Pollution of watersheds and aquifers, erosion of coasts and rivers, destruction of habitats	
Legal consequences	What were the legal implications of this impact occurring?	Fines and sanctions, legal cases	
Reputational consequences	What are the reputational / political implications of this impact occurring?	Loss of public trust	

The assessment of the current climate risks facing water resources and water services will provide a solid foundation for considering both future risks associated with a changing climate and the identification of options which can reduce these risks and support adaptation to climate change.

Box 1.6 – Further background on assessing levels of risk

Caribbean Community Secretariat - Caribbean risk management guidelines for climate change adaptation decision making.

These guidelines provide further background material on prioritising climate impacts, including the use of simple scoring systems, and some of the key considerations to take into account.

Caribbean Community Secretariat. 2003. Adapting to Climate Change in the Caribbean (ACCC) Project. Caribbean risk management guidelines for climate change adaptation decision making. 86p. ISBN 976-600-159-6. Available at http://200.32.211.67/M-Files/openfile.aspx?objecttype=0&docid=2879

Ask yourself...

What are the main gaps in information or evidence which are needed to quantify the level of risk?

What types of data collection and studies could close these gaps?

1.5. Building the evidence base through technical studies

Gaps in the knowledge base are likely to be highlighted when assessing climate impacts and risks. Collecting data and conducting studies can be used to close knowledge gaps and as such they represent low regrets actions which support climate resilience.

Ask yourself...

In your experience what are the success factors for technical studies, for example water resources assessments?

Technical studies could potentially include the following:

- Water balance modelling to understand water supply and demand and identify future areas for investment
- Mapping vulnerability hotspots such as land degradation, saline intrusion, network leakage, drought impacts
- Agricultural water modelling to understand crop requirements and potential changes over time with a changing climate
- Digital Terrain Model (DTM) development and comprehensive flood hazard mapping. This can be used to identify assets exposed to flood risk and project changes in future flood risk with new developments
- Sea level rise and coastal inundation modelling to track the assets exposed to storm surge and long term sea level rise
- Coastal erosion modelling under a range of protection scenarios, including the use of hard engineering and soft engineering such as mangroves
- Water system network modelling (drinking water and drainage) to plan investments in network improvements and identify areas to target for efficiency improvements

However, caution should be exercised when proposing ambitious technical studies as data requirements may be relatively high and a clear understanding of the risks posed by insufficient data on the quality of the study outcomes should be gained at the project concept stage. Box 1.7 presents an example of some of the data related challenges faced during a flood mapping project in the Caribbean.

Box 1.7 – Challenges in technical studies, an example from Caribbean flood risk mapping

The CARICOM Regional Organisation for Standards and Quality (CROSQ) undertook a study into flood hazard mapping at national scale for Trinidad and Tobago, St Vincent and the Grenadines and Montserrat. This was carried out to provide a national level map for screening flood risk and supporting revision to building development codes.

The challenges associated with data requirements included:

- **Insufficient rainfall data to be able to generate robust design storm rainfall profiles to apply to hydraulic models**. This was a function of both insufficient data collection as well as overlapping institutional roles (for example agricultural and meteorological departments).
- **Inadequate ground survey data to be able to accurately model flood pathways**. The project made use of satellite based ground elevation data in the absence of a higher resolution and spatially consistent data sets. This limited the level of detail at which the resulting flood maps could be utilised.

Future flood risk mapping projects should ideally run preliminary feasibility studies to gather and assimilate all available rainfall data as well as carrying out a comprehensive ground survey prior to undertaking flood modelling work.

Source: Lumbroso, D.M., Boyce, S., Bast, H. and Walmsley, N. 2011. The challenges of developing rainfall intensity-duration-frequency curves and national flood hazard maps for the Caribbean. The Journal of Flood Risk Management, 4 (1). pp. 42-52. 2011. Available at http://eprints.hrwallingford.co.uk/605/

Some of the potential challenges when commissioning new studies include:

- **How will the outputs be used?** The institutional environment must be able to absorb and utilise the results of the study otherwise it will become shelved or even forgotten. The concept of using technical studies as evidence to directly influence policy is not new (see Box 1.8). For example, if flood mapping is being undertaken consideration will need to be given on how it will be incorporated into the development control system, used for strategic flood risk planning and whether wider institutional strengthening is needed in parallel to technical studies.

Ask yourself...

What are the main barriers to the uptake of findings from technical studies into policy and planning?

- **Who is going to use the results?** Technical studies may make use of modelling and mapping tools developed by specialist consultants. Recipient planners may not have the technical capacity to use such tools or interpret their results, or the tools themselves may be prohibitively expensive for recipients to maintain. Clear consideration should be given as to what level of capacity development is required / desirable to make use of technical tools and results.
- **Who is going to undertake the technical studies?** National level planners require an understanding of technical tools and methods in order to develop project concepts and outline terms of reference. However, expecting planners to undertake a technical role is unrealistic and such work should be the remit of technical specialists.
- **What data are available to support the study?** Taking a phased approach in which a feasibility study / methodology to gauge the data requirements will avoid wasting resources on studies which are technically unfeasible.
- **What is the significance of the study for the economy, society and the environment?** The ambition and scale of the study should be proportional to the potential economic, social and environmental impacts of the systems under consideration. This ensures that limited resources are being utilised proportionally to the problems under consideration.
- **What is the most appropriate modelling technique for impact and vulnerability assessment?** There are a diverse range of assessment approaches available. Detailed quantitative modelling depends on the availability of suitable models and sufficient data (observed and climate change information) to derive meaningful results. Quantitative models are generally sector specific (although hydrological models for river systems are a fundamental part of many water related sector activities). A lack of data may mean that simpler qualitative approaches and expert elicitation methods using stakeholder approaches are the only viable methods.
- **What specific components need to be included or excluded from the assessment, in order to meet its objectives?** For example, does the assessment require the use of future population and other socio-economic data to estimate future risks, or is it only concerned with sensitivity to the climate? Should the assessment include anticipated adaptation, including autonomous adaptation and existing sector policies, or should it provide a baseline without these included? Does it need to include monetisation of potential impacts or risks, or will a qualitative description be sufficient? Will it include an evaluation of actions for increasing resilience or adaptation to climate change?

Box 1.8 – Evidence-based policymaking (EBP) relevant to developing countries

Studies and research which address knowledge gaps should be used to support evidence-based policymaking. Bearing this in mind, policy makers should provide the demand for knowledge and evidence to respond to knowledge gaps. Technical specialists should then focus on the needs of policy makers and other decision makers by targeting research activities to respond to these needs.

EBP is a discourse or set of methods which informs the policy process rather than aiming to directly affect the eventual goals of the policy. It advocates a more rational, rigorous and systematic approach. The pursuit of EBP is based on the premise that policy decisions should be better informed by available evidence and should include rational analysis

Source: Sutcliffe, S & Court, J., 2005, Evidence-Based Policymaking: What is it? How does it work? What relevance for developing countries? Overseas Development Institute. Available at http://www.odi.org.uk/publications/2804-evidence-based-policymaking-work-relevance-developing-countries

In addition to filling knowledge gaps, studies can build the capacity and understanding of staff engaged in undertaking or managing such studies. However, they are likely to be more time consuming and costly than collating current evidence and should include these collation activities to avoid duplication of effort. Further, new studies should be carefully considered and justified in order to ensure they offer value. A wide range of approaches exist and often these are tailored on a case by case basis depending on the questions being answered and the information and data available to undertake these studies. Approaches range broadly from qualitative and stakeholder led through to quantitative modelling studies.

Table 1.3 provides a summary of some of the most common technical modelling approaches which are used to assist in water related planning for water resources, wastewater management and flood risk assessment. This table is intended to provide a high level overview of these types of techniques and signposts for further information. Undertaking such studies will require specialist input to ensure they are technically feasible and offer value for money. Figure 1.5 gives an indicative spatial extent for these types of modelling activities. It should also be noted that modelling can be undertaken as a one off study and the results used to inform decision making. Moreover, it is more sustainable if built into a broader programme of capacity building whereby modelling tools are continually maintained and developed as decision support tools to aid planners in providing objective and evidence based decisions.

Figure 1.5 - Illustrative application of specialised modelling tools for assessing water and climate impacts, Saint Lucia has been used for illustrative purposes only

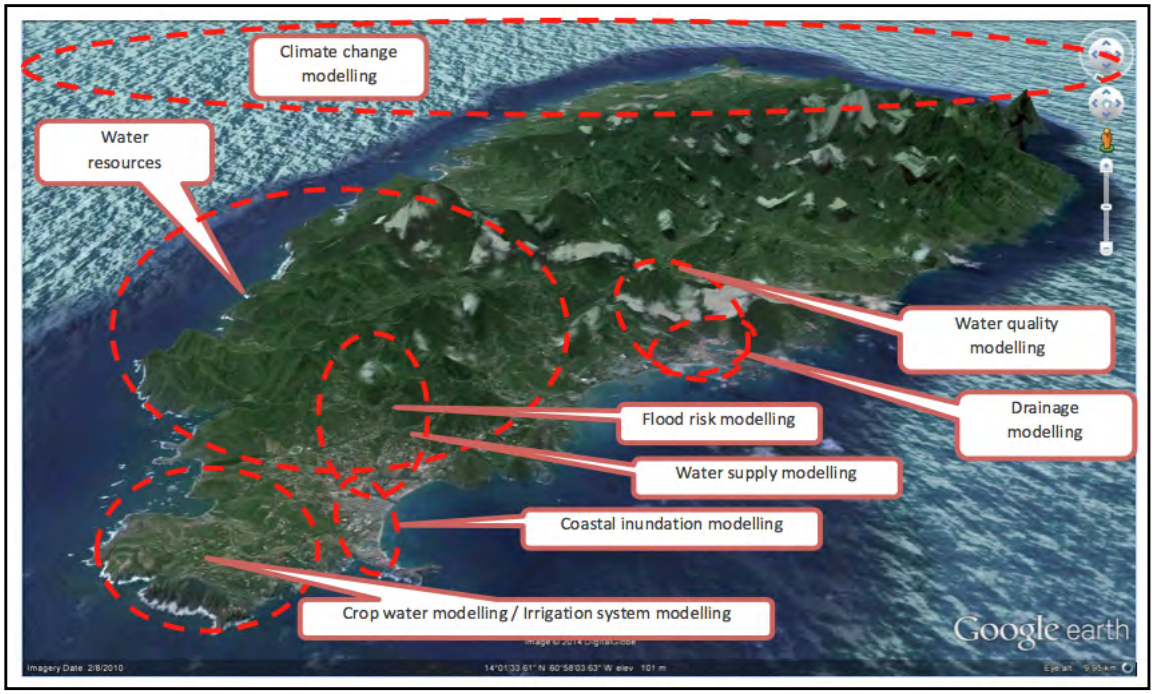


Table 1.3 - Summary of technical modelling tools for water related planning and decision making

	Description and purpose	Data requirements	Links to other technical studies	Modelling tools used	Including climate change
Climate change modelling	Representation of the global or regional climate system. Allows understanding of the changes over time of climate variables such as temperature, rainfall and extremes such as floods and droughts	Highly complex science scenarios are already available globally and regionally (see Section 2).	Climate change scenarios are input to a wide range of technical studies including many of those described below	Global Circulation Models (GCM) Regional Climate Models (RCM)	Global Greenhouse Gas emissions are included in the GCM models to model climate change
Water resources modelling	Provides an understanding of the total water resources available and the response of water resources to drought events. Can be used to assess the impacts of development and climate change on resources. Does not usually address water quality or flood risk issues	Requires temperature, rainfall, historical river flow and groundwater level time series and mapping of geology and soil types. A lack of such data limits the accuracy of water resources studies	Supports water allocation activities such as supply modelling, irrigation modelling and general abstraction licencing, including setting environmental flow limits Supported by climate change modelling which provides scenarios for water resources modelling	Hydrological models Rainfall-runoff models Hydraulic models	Scenarios of rainfall and temperature change are used to assess potential changes in resource availability. Sea level rise scenarios for coastal aquifers
Water supply modelling	Provides an understanding of the demand for water and the performance of supply networks. Can be used to investigate development scenarios and network improvement strategies	Requires detailed asset location, specification and performance data in order to model the system. Asset data are also essential for general asset management activities	Supports strategic planning of water supplies as well as operational management of networks and asset management Supported by water resources assessments which give an overview of the total potential supplies	Hydraulic water network models	Climate change may influence water resources which has a knock on effect on supplies. Qualitative assessments of climate change impacts on treatment and distribution
Crop water modelling	Represents the water requirements of rain fed and irrigated crops. Used for strategic land use planning including scenarios of climate change to assess land suitability. Also used for short term assessment of field conditions and seasonal irrigation requirements	Requires rainfall, temperature, soil and the water use characteristics of potential crop types	Supports irrigation system modelling and strategic and operational agricultural and land use management activities Supported by climate change scenarios and seasonal forecasting which can be input to crop water models	Soil water accounting models	Climate change scenarios of temperature and rainfall are used to assess crop water requirements in future
Irrigation system modelling	Used to represent the hydraulic performance of irrigation systems for strategic planning, operational efficiency or equitability purposes	Requires asset data to support modelling as well as water resources assessment to evaluate source water availability	Supports irrigation planning and development activities Supported by crop water modelling which may be integrated into the hydraulic modelling of irrigation systems. May also support water quality modelling of irrigation return flow	Hydraulic systems models	Climate change may influence water resources which has a knock on effect on supplies

Table 1.3 (cont'd) - Summary of technical modelling tools for water related planning and decision making

	Description and purpose	Data requirements	Links to other technical studies	Modelling tools used	Including climate change
Drainage modelling	Used to support strategic investment planning of drainage systems their management and improvement	Requires detailed asset location, specification and performance data in order to model the system. Asset data are also essential for general asset management activities Storm rainfall required to assess performance of drainage systems	Supports water quality modelling by estimating volumes of wastewater released into the environment treated and untreated. May also support flood inundation modelling	Hydraulic models of drainage systems	Climate change scenarios of storm rainfall may be included to assess how drainage systems perform in future
Water quality modelling	Supports the implementation of environmental regulations and supports assessment of the need for enhanced environmental control (in freshwater and marine contexts)	Requires a range of supporting data including climate and hydrology, records of discharges of pollutants such as wastewater and agrochemicals, supported by water quality sampling	Supports strategic planning of wastewater systems and pollution control regulation Supported by drainage modelling and irrigation system modelling if relevant. Climate change scenarios may also be applied	Water quality systems models (often built into hydraulic river models)	Climate change scenarios of temperature and changing river flows are used to assess decay and dilution of pollutants
Flood risk modelling	Represents risk of flooding due to river and surface water flooding. Used to underpin land zoning for regulating development away from flood risk Also provides evidence to support investment in flood management measures	Requires storm rainfall characteristics and river flow records especially of significant historical flood events Also required are detailed topographical and river survey data	Supports strategic planning of investment flood management Supported by climate change scenarios for storm rainfall	Hydrological models for representing storm runoff Hydraulic models of rivers and floodplains	Climate change scenarios of storm rainfall can be used to asses future flood risks
Coastal inundation modelling	Uses projections of storm surge and wave conditions to represent flooding of coastal assets. Used to underpin land zoning for regulating development away from flood risk Also provides evidence to support investment in flood management measures	Requires marine modelling of surge and wave conditions to derive design water levels. Also required is detailed coastal topography and defence asset information	Supports strategic planning of investment in flood management Supports assessment of the impacts of sea level rise on coastal inundation	Hydraulic models for coastal plains Storm surge modelling	Climate change scenarios of storm surge and sea level rise can be used to assess future flood risks

Assessing future climate risks

2

Key messages

- Scenarios can provide a common frame of reference for understanding the complex interactions between future developmental and climate pressures on water resources and water services
- Scenarios provide a means to consider a broad coverage of uncertainties in the estimates of future climate and development pathways
- Climate change projections are available from a range of sources across the Caribbean and work continues to refine and reduce uncertainties in projections at a global and regional level
- Scenarios should have a clear purpose, be as simple and transparent as possible and directly relevant to the climate risks and institutional contexts of organisations using them
- Scenarios may be used to assess how the impacts of current climate related hazards such as floods and droughts may change in the future

Sample tasks and activities

- Hold a workshop to discuss how future scenarios are used in decision making at the moment and what types of scenarios might be used to assist planning
- Explore some of the readily available sources of climate change information to develop high level water, climate and development scenarios which are relevant to high priority climate risks
- Consider how scenarios might change the existing priority climate risks in terms of the direction of change of the risks in the future

Scenarios of both climate and development pathways are helpful for decision making. Pressures on water resources and water services will arise not only from climate change but also from more traditional drivers. These include, population growth and economic development coupled with attendant problems such as pollution and land degradation.

This section introduces the concepts of scenarios for climate change and development and provides guidance on the purpose and processes for developing scenarios. Scenarios are useful planning tools to assist decision makers understand and manage the range of uncertainty in future climate change and development pathways. In the context of water this can include scenarios of water availability and demand from different user groups.

Further high level information on climate change projections for the Caribbean region is presented in Annex A.

2.1. Understanding the role of climate change and development scenarios in the Caribbean

Scenarios provide plausible representations of potential future situations. If we could accurately predict the future, then planning would require only a single scenario. In reality the future is uncertain and more than one scenario must be considered. Scenarios are required for planning purposes in order to specify assumptions about the conditions that planned investments will need to respond to in the future. For example, scenarios of water demand and population are often combined with scenarios of climate change to facilitate better planning for future investments in water supply systems. Scenarios may also be used at a higher level to examine the types of policy responses which are required to manage future changes and maintain development objectives.

Scenarios of both climate and development pathways are helpful for decision making and should ideally both be considered. Climate change will impact on water availability and demand but these impacts contain a wide range of uncertainty especially with respect to rainfall. However, population growth and economic development coupled with attendant problems such as pollution and land degradation could play an equally important role in stressing future water resources.

Ask yourself...

How are scenarios currently using to inform planning?

Box 2.1 – The Future of fresh water in the Caribbean

"The demand for water by countries in the Caribbean is expected to increase due to population increase, increased agricultural and industrial productivity, and the growth of recreational and tourism industries" (Farrell et al., 2007)

"Irrespective of climate change scenarios, the water resources of the Caribbean basin are going to come under increasing pressure. The likely decrease in rainfall, lengthening of dry seasons and temperature increases" as a result of climate change "will result in less available water resources throughout the region" (Cashman et al., 2010)

Scenarios can serve a number of purposes including:

- Providing a common position or understanding on the range of future changes which should be planned for
- Identifying future risks as a basis for developing policy response options
- Identifying desirable development scenarios and mapping out the pathway to achieve the scenario
- As inputs to technical models and studies such as water resources assessments in order to estimate future impacts

More specifically in the Caribbean water context scenarios could provide the following projections:

Ask yourself...

What are the priority risks which scenarios could be used to assist in understanding?

- **Future demand for water** from different users (municipal, agricultural, industrial for example) – based on scenarios of population growth, economic development and changes in weather patterns
- **Future water availability** in terms of surface water and groundwater resources – based on changes in temperature, rainfall, recharge into aquifers and river flows
- **Changes in flood risk** due to climate change, including coastal flooding and the resulting risks to infrastructure and other assets
- **Land degradation** and its resulting impacts on water quality and flood risk based on scenarios of land management
- **Water pollution and water quality** based on scenarios of pollution control, population growth and industrial / agricultural development

Figure 2.1 shows a set of simple illustrative scenarios which can be used to explore the range of uncertainty in climate change impacts on water availability due to changing climate and the change in demand due to population and economic growth. This allows decision makers to consider the level of risk they are willing to accept and the different interventions needed to ensure sustainability of supplies under these scenarios.

Figure 2.1 - Illustrative scenarios for water supply and demand

Change in demand for water due to growth and development		
	Scenario 2a: High demand / low climate change +30% demand +5% supply **-25% deficit**	**Scenario 3: High demand / high climate change** +30% demand -20% supply **-50% deficit**
	Scenario 1: Low demand / low climate change +10% demand +5% supply **-5% deficit**	**Scenario 2b: Low demand / high climate change** +10% demand -20% supply **-30% deficit**
	Change in availability of water due to climate change	

Identifying variables to be used in a scenario

In the context of water resources and water services in the Caribbean the primary variables of interest are the changes in climate hazards such as floods and droughts in the future which will have knock on impacts on water availability, demand and quality. In addition scenarios of changes in future demands for water through population growth, lifestyle changes, agricultural practices and other developmental factors play an important role in scenarios.

Ask yourself...

Which variables would be useful for your strategic planning?

Key climate and non-climate scenario variables are identified in Table 2.1 below.

Table 2.1 - Key climate and non-climate scenario variables

Climate variables	Non-climate variables
• Change in annual average and seasonal rainfall and temperature • Sea level rise • Extreme rainfall and wind speeds • Storm surge and wave intensity • Heatwaves • River flow and groundwater recharge	• Population growth • Economic conditions • Water demand by sector • Urbanisation • Policy choices on water and land management and disaster risk

2.2. Determining the level of complexity for scenarios

Ideally scenarios should be as simple and straightforward as possible while still achieving the overall purpose in order to ensure that the assumptions behind each scenario can be readily understood. Technical modelling work such as water resources assessment may require a more comprehensive and quantitative set of scenarios than scenarios for testing policy options or raising awareness on climate change.

As an example the Caribbean Weather Impact Group (CARIWIG)[1] project in the Caribbean is providing model generated rainfall data sets which are representative of a range of future climate scenarios. These rainfall series have been developed using a weather generator which provides large volumes of rainfall data which can be applied to technical studies such as water resources assessment or flood risk studies. This is an example of relatively complex scenarios which can be used to drive quantitative models.

In contrast the CARBISAVE Risk Atlas (CARIBSAVE, 2012) has produced concise, high level climate change scenarios which are designed to provide contextual information to support the risk assessment in the Atlas. Box 2.2 provides the example of summary projections for Jamaica. These represent the crystallisation of a large body of technical work into a set of simplified information which can be readily digested by high level decision makers and climate non-specialists.

Box 2.2 - CARIBSAVE Climate Risk Atlas climate change projections for Jamaica

Temperature: Annual mean temperature changes for Jamaica, simulated by Regional Climate Models (RCMs) indicate increases of 2.9 to 3.4˚C by the 2080s under a higher emissions scenario.

Precipitation: Both General Circulation (GCM) and RCM results indicate decreases (by 10 - 41%) in annual rainfall for Jamaica as a whole particularly throughout March, April, May, June, July and August. However, changes in seasonal precipitation simulated by the RCM vary considerably depending on the driving GCM with HadCM3-driven RCM projections indicating the largest decreases in precipitation.

Sea Surface Temperatures (SSTs): GCMs project annual mean SST increases of 0.9 to 2.7˚C by 2080s relative to the 1970-99 average in waters surrounding Jamaica across the three scenarios.

Tropical Storms and Hurricanes: North Atlantic hurricanes and tropical storms appear to have increased in intensity over the last 30 years. Observed and projected increases in SSTs indicate potential for continuing increases in hurricane activity and model projections indicate that this may occur through increases in intensity of events but not necessarily through increases in frequency of storms.

Source: Simpson, M. C., Clarke, J. F., Scott, D. J., New, M., Karmalkar, A., Day, O. J., Taylor, M., Gossling, S., Wilson, M., Chadee, D., Fields, N., Stager, H., Waithe, R., Stewart, A., Georges, J., Sim, R., Hutchinson, N., Rutty, M., Matthews, L., and Charles, S. 2012. CARIBSAVE Climate Change Risk Atlas (CCCRA) - Jamaica. DFID, AusAID and The CARIBSAVE Partnership, Barbados, West Indies. Available at http://intasave-caribsave.org/

[1] More information is available on the CARIWIG website (http://www.cariwig.org/)

2.3. Identifying data and information sources to develop scenarios

Scenario generation involves defining the themes and area of interest for the scenario to ensure that it is targeted towards a useful problem or risk which is under consideration. This should ideally be a collaborative process between climate specialists and decision makers responsible for managing climate risks. For example, the risk of municipal water shortages may require scenarios of future drought occurrence coupled with municipal water demand, agricultural demands and risks such as pollution.

Sources of information for climate change scenarios

Several regional initiatives for climate change modelling have resulted in the provision of climate change projections within the region each of which has its strengths and limitations. These are summarised in Table 2.2 below. Some of these resources provide scenarios in a document format while others provide maps and raw data through a web portal. Figure 2.2 provides an example of the type of web portal interface which can be used to access scenario data. They provide a good starting point for accessing climate change data and information for the Caribbean in a user friendly format. In addition to these the Inter-governmental Panel on Climate Change (IPCC) reports[2] provide further contextual information and the IPCC data distribution centre[3] provide much of the background climate change model data although this is primarily aimed at climate researchers rather than non-specialists.

Other national level climate scenarios may be available in some cases. For example the Climate Studies Group, Mona (CSGM) has produced a comprehensive set of climate change projections for Jamaica at a national and sub-national level (see Climate Studies Group, Mona (2012)).

Ask yourself...

Using the sources in Table 2.2 summarise climate change projections for your country on a single side of paper

[2] Available from the IPCC website at www.ipcc.ch

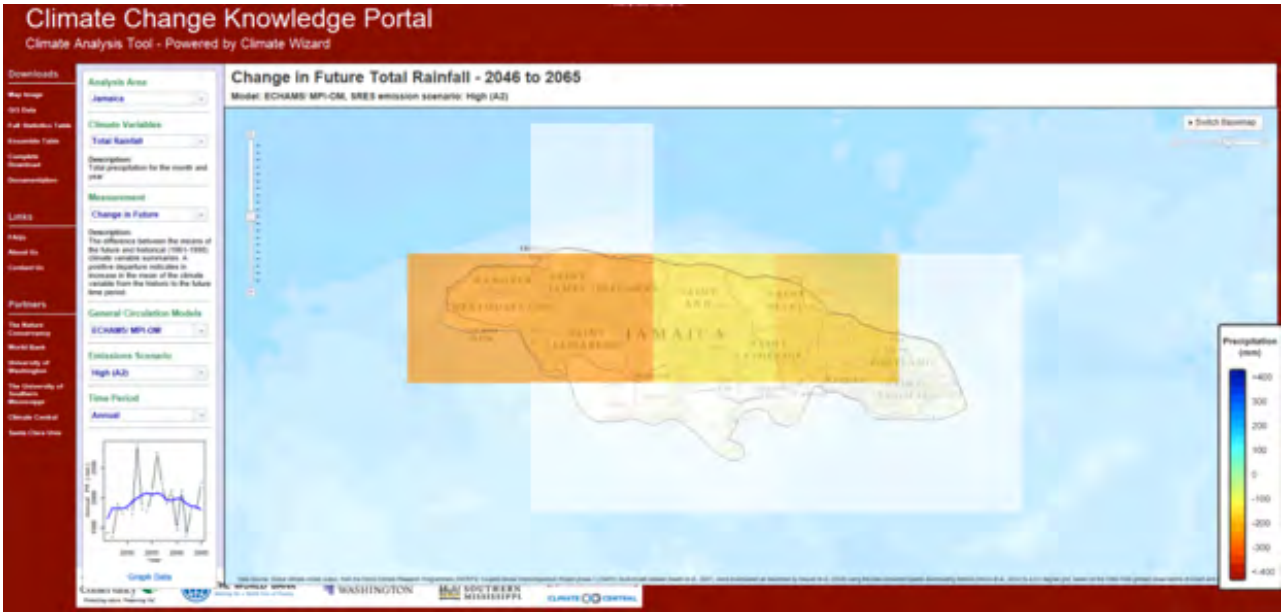
[3] Available from the IPCC Data Distribution Centre website at www.ipcc-data.org

Table 2.2 - Summary of user friendly sources of climate change information to develop scenarios for the Caribbean

Climate change information source	Description	Information and data
UNDP Climate Change Country Profiles	These profiles are a valuable source of summary information on climate change projections for the Caribbean at national level. Summary reports are provided which give an overview of the projected climate changes for each country and this is supported by a library of more detailed supporting data which could be adapted for quantitative technical studies. One of the advantages of this dataset is its use of 15 General Circulation Models (GCMs) to capture uncertainties in climate science. *http://www.geog.ox.ac.uk/research/climate/projects/undp-cp/*	TR T/P E SLR
CARIBSAVE Climate Change Risk Atlas	The CARIBSAVE Climate Change Risk Atlas provides high level climate change projections and comprehensive impacts assessments for a range of sectors and themes including water resources. The climate projections contained within the Atlas are based on 15 GCMs as well as PRECIS, a Regional Climate Model (RCM) driven by two GCMs to provide a more locally representative set of projections. *http://intasave-caribsave.org/resources/reports/*	TR T/P E SLR IA
CCCCC / INSMET Climate Change Projections	The CCCCC hosts climate change projections produced in collaboration with INSMET. These are hosted on the CCCCC website and provide maps of climate projections on a 50x50km grid as well as the underlying data. The data are based on the PRECIS regional climate model driven by two GCMs to provide some allowance for the uncertainties associated with GCM models. *http://www.caribbeanclimate.bz/index.php?Itemid=88&option=com_wrapper&view=wrapper*	T/P
World Bank /Nature Conservancy Climate Change Knowledge Portal	The World Bank Climate Change Knowledge Portal provides easily accessible climate change projection data, including downscaled data at the global level through its Climate Analysis Tool application. The downscaled data is depicted at a resolution of 50x50km and derived from daily datasets from nine GCMs. More than 23 climate statistics are available and include gridded datasets and monthly averages for country, continents, and major river basins. Data visualization of the downscaled data is provided through an interactive interface allowing users to customise their request and produce bespoke mapping and data outputs that can be used for developing their own climate change scenarios. *World Bank Climate Change Knowledge Portal* *http://climateknowledgeportal.worldbank.org* *Climate Analysis Tool http://climateknowledgeportal.climatewizard.org/*	T/P E

Note: (TR) = Recent historical trends; (T/P) = Temperature and precipitation projections; (E) = Extremes projections (hurricanes, heavy rainfall); (SLR) = Sea level rise projections; (IA) = Impacts assessment (on economy, society, environment)

Figure 2.2 - Interface of the World Bank / Nature Conservancy Climate change knowledge portal Climate Analysis Tool



Sources of information for water and development scenarios

Scenarios covering the changes in economic, social and environmental conditions require information on the observed trends and projected future conditions for key areas. These include: population growth and migration, sector output and growth, policy decisions and legislative changes. These can be difficult to assess given that economic growth is closely tied to global economic conditions and changes which are far beyond the control of individual nations. However, the types of information which may be used to create development scenarios could include:

- Water utilities reporting the recent trends in per capita and overall water demand for municipal and industrial users and estimates of future demand if these are available
- Ministry of Planning estimates of population growth and distribution, which can be used to forecast changes in water demand
- Agricultural departments reporting on the trends and projections for agricultural development including irrigation developments
- Sector growth strategies, plans and vision statements for water dependant sectors such as agriculture, industry and tourism
- Recent and planned changes in legislation and incentives which may impact on water and land use practices

2.4. Building climate and development scenarios

The process for developing scenarios specific to your organisation's requirements will require a combination of skills. Climate specialists may be required to provide guidance on the wide range of climate projections available. Water management specialists and hydrologists can provide guidance on the impacts of climate changes on watershed systems. Water planners and managers can provide a perspective on the changing demands for water and sector planners can provide information on the trends and projections in water dependent sectors. Bringing these different perspectives together through workshops and meetings can be used to gather information on the different aspects of climate and development and to develop a common understanding of the different drivers and their potential impacts.

Ask yourself...

Which stakeholders should be engaged to develop scenarios of water demand and climate change?

Simple summary climate change scenarios can be accessed for each country at a national level through resources such as the Climate Change Risk Atlas. Alternatively, bespoke scenarios can be developed using some of the tools outlined in Table 2.2.

Development scenarios for water are broader in scope than climate change scenarios and will require dialogue between a range of stakeholders including sector specialists and national planning and finance advisors in order to develop credible and consensus led scenarios for development and their implications for water resources and water services. Box 2.3 provides further resources which offer technical background on the development of scenarios.

Box 2.3 – Further resources on developing water, climate and development scenarios

UNDP - Formulating Climate Change Scenarios to Inform Climate-Resilient Development Strategies

The United Nations Development Programme (UNDP) has produced a guidance document aimed at project managers and decision makers providing technical guidance on the development of climate change scenarios for climate change impact assessments. The diversity of requirements is recognised in the pragmatic stepwise approach that the guidance takes.

Source: Puma, M.J. and Gold, S. 2011. Formulating Climate Change Scenarios to Inform Climate-Resilient Development Strategies: A Guidebook for Practitioners. UNDP, New York, NY, USA. Available at http://www.undp.org/content/undp/en/home/ourwork/environmentandenergy/focus_areas/climate_strategies/green_lecrds_guidancemanualsandtoolkits.html

UNDP – Developing Socio-economic Scenarios for Use in Vulnerability and Adaptation Assessments

This handbook provides a framework for developing integrated socio-economic scenarios that can function at the local, national and regional and/or global levels. The handbook aims to improve the construction of socio-economic scenarios in two ways. First, it broadens the scope of factors to be included. Second, the handbook focuses on the local sectors that are most relevant for policy, agriculture and water resources

Source: Malone, E.L., Smith, J.B., Brenkert, A.L., Hurd, B., Moss, R.H. and Bouille, D. 2004. Developing Socio-economic Scenarios for Use in Vulnerability and Adaptation Assessments. UNDP, New York, NY, USA. Available at http://www.adaptationlearning.net/guidance-tools/developing-socioeconomic-scenarios-use-vulnerability-and-adaptation-assessments

World Bank - Participatory Scenario Development Approaches for Identifying Pro-Poor Adaptation Options: Capacity Development Manual

The World Bank has developed a guidance manual in participatory scenario development which is aimed at engaging at a community level to develop scenarios and adaptation options. Although this Framework is aimed at government planners and technical staff the principles for developing scenarios can be used as a basis for workshops.

Source: World Bank. 2010. Participatory Scenario Development Approaches for Identifying Pro-Poor Adaptation Options: Capacity Development Manual. World Bank Discussion Paper no. 19. Available at http://www.iisd.org/publications/pub.aspx?id=1410

2.5. Applying scenarios to assess future climate risk

This section refers back to Section 1 which deals with assessing climate risks based on current experience and recent trends. The scenarios developed will allow the risk assessment to be revisited, and the scenarios to be overlaid on the risks identified. Although there is a large uncertainty associated with climate change and development futures, this exercise can at least provide a measure of the direction of change for the climate risks.

Ask yourself...

How might future climate change and development scenarios change current climate risks identified in section 1?

Figure 2.3 provides an illustrative example of applying scenarios to an existing risk assessment. In this case drought risk to tourism has been identified as a medium risk currently. However, a future scenario indicates that droughts will become more likely in the future. The consequences of drought on the tourism industry remain the same in the future in terms of loss of income and reputation. This combination leads to drought risk being upgraded from medium to high risk and highlights the need for actions to reduce the level of risk through enhancing the security of water supplies.

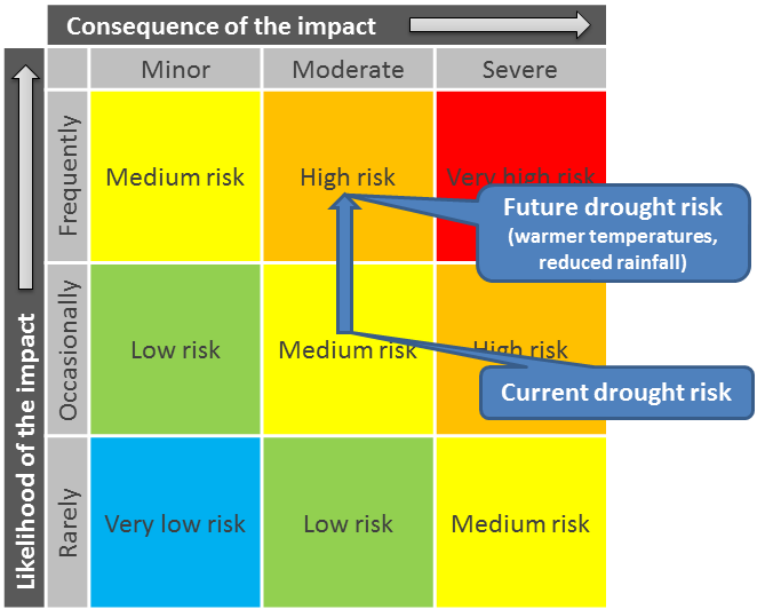


Figure 2.3 - Generic risk assessment matrix illustrating the change in drought risk under a future climate and development scenario

The example above is a simplification for illustrative purposes; it does not present the results of a range of different scenarios. In many cases this would result in too much information for planners. Often low, central and upper estimates are considered. It is then the job of the planner to determine the level of risk which is acceptable based on the severity of the impact. For example, flooding of critical infrastructure may be considered very severe and an upper estimate of climate change may be used to ensure against the uncertainty. Less severe impacts may not merit the consideration of upper estimates of climate change which may not materialise.

Risk preferences are an important component of decision making. These describe the level of risk which organisations are willing to accept. For example in the UK, water supply companies clearly define the levels of risk which they plan for (Ofwat, 2007). Broadly speaking these are as follows:

- Non-essential use ban implemented not more than once every 10 years
- Drought orders issued not more than once every 40 years
- Interruption to piped domestic supplies are considered unacceptable

The selection of these risk preferences is based on a number of factors including public perception of an acceptable level of service set against the investment cost of maintaining higher levels of service. In terms of climate change risk preferences UK water companies are relatively risk averse and plan to accommodate a wide range of climate change uncertainty.

3

Making a strong case for action

Key messages

- Making a strong case for action can be an initial trigger for attracting greater domestic and international financing into climate resilient development
- Powerful arguments for enhancing resilience benefit from clear metrics on the costs of inaction and benefits of taking action
- Clearly aligning the case for action with aspirations under existing national and regional development strategies can strengthen buy-in from high level decision makers and development partners alike
- Champions are important in gaining high level political traction and can leverage support through their political presence and convening power
- Disseminating the case for climate resilient development will require different communication products for different stakeholders including policy briefs, technical reports, workshops, and media outlets

Sample tasks and activities

- Identify the sources of information on climate impacts and the types of metrics which would make a strong case for resilience
- Review key regional, national and sectoral documents (policies, strategies and visions), identifying objectives which depend on water or support climate change adaptation
- Secure buy-in by high level decision makers and identify potential champions to deliver the evidence at a high level
- Develop communication products to raise awareness across key stakeholders

The purpose of making a strong case for resilience is to influence high level decision makers to allocate resources to support initiatives for climate resilience. These decision makers could include national planners, development partners and funding agencies. Making a case involves providing robust evidence on actions which are required and delivering this to influence decision makers.

This section discusses some of the tools and techniques for making a compelling case for climate resilience.

3.1. Identifying impact metrics to make a strong case

In order to present a strong case for climate resilience a clear audience must be identified to receive the message, this will then define the type of evidence and tools used to communicate it. The audience will vary depending on the institutional context but may include ministries of finance and planning, development partners, international and national funding agencies and other high level decision makers. The evidence should aim to persuade high level decision makers to increase the allocation of resources for projects, programmes and other initiatives to enhance climate resilience.

Water is the primary medium through which climate change influences Earth's ecosystem and thus the livelihood and well-being of societies (UN-Water, 2010). Climate variability impacts directly on water resources and the water services for the many economic, social and environmental functions water supports. The impacts of drought, for example, reach into many sectoral interests such as health, tourism, agriculture and industry. Flooding associated with storms and hurricanes can also impact these sectors by disrupting access to water supplies and through damage to water related infrastructure. Making the case for resilience in the water sector should reference these wider impacts to demonstrate the role which water plays in supporting Caribbean economies, society and environment.

Ask yourself...

What are the types of impact metrics appropriate and measurable in your context?

A variety of metrics for impacts on these could be developed; some examples are set out in Table 3.1 below. Where it is not possible to estimate economic impacts a simpler metric may be used, for example number of persons impacted.

Table 3.1 - Potential water related impact metrics to make a case for resilience

Economic costs	Social costs	Environmental costs
• Loss of revenue to utilities • Increased cost due to water trucking and emergency operations • Loss of revenue to businesses including critical economic sectors such as agriculture and tourism • Cost of replacing / repairing damaged infrastructure • Insurance and legal costs	• Number of persons impacted by loss of supply (municipal and business) • Health effects (cases of water borne diseases for example) • Number of adverse media articles representing a reputational cost • Change in food and other household expenses	• Area of important habitat lost or damaged • Reduction in ecosystem services (supporting tourism, food security, flood protection etc) • Area of watersheds suffering from degradation such as erosion or pollution

Box 3.1 presents an example of work carried out by the CARIBSAVE partnership for UNDP to assess the impacts of sea level rise in the Caribbean. It provides a good example of the different types of impacts which may be quantified and communicated to decision makers.

Box 3.1 - Quantification and Magnitude of Losses and Damages Resulting from the Impacts of Climate Change

This study provides a quantification of the impacts of sea level rise in the Caribbean. It uses elevation models combined with inventories of key assets to represent the exposed areas. This is coupled with estimates of sea level rise, storm surge and coastal erosion to model the impacts on these assets.

A range of different impact metrics are used including economic impacts, persons displaced, damage to critical infrastructure (power, transport), tourism facilities and habitats.

For example the following impacts are projected for a 2m sea level rise:

- Over 3,000 km^2 of land area lost (e.g. 10% of The Bahamas, 5% Antigua and Barbuda)
- Over 260,000 people displaced (e.g. 10% of population of The Bahamas, 6% Antigua and Barbuda)
- At least 233 multi-million dollar tourism resorts with beach assets lost or greatly degraded at the majority of tourism resorts
- Damage or loss of 9 power plants
- Over 3% of agricultural land lost, with implications for food supply, security and rural livelihoods (12% in The Bahamas, 8% in St. Kitts and Nevis, 5% in Haiti)

Source: Simpson, M.C.,Scott, D., Harrison, M., Sim, R.,Silver, N., O'Keeffe, E., Harrison, S., Taylor, M., Lizcano, G., Rutty, M., Stager, H., Oldham, J., Wilson, M., New, M., Clarke, J., Day, O.J., Fields, N., Georges, J., Waithe, R., McSharry, P. 2010. Quantification and Magnitude of Losses and Damages Resulting from the Impacts of Climate Change: Modelling the Transformational Impacts and Costs of Sea Level Rise in the Caribbean (Key Points and Summary for Policy Makers Document), United Nations Development Programme (UNDP),Barbados, West Indies. Available at http://intasave-caribsave.org/

Box 3.2 presents an example of an assessment of the 2009-2010 drought in Jamaica undertaken by the National Water Commission (NWC). It provides an example of a more localised assessment rather than the high level examples provided above, dealing with municipal supply to a single metropolitan area.

Box 3.2 - Reporting the impacts of the 2009-2010 drought in Jamaica

This study provides a discussion of the impacts of a drought event on municipal water services provision in Jamaica during a severe drought. It covers both technical aspects of the water availability and production as well as direct costs incurred on the utility. In addition, knock on economic and social impacts are discussed although the supporting data and linkages between cause and effect were limited in some cases. For example admissions into hospital for water related diseases rose 16% during the drought but it is not possible to ascertain with more confidence the exact cause of this rise (trucking vs. piped water).

One benefit of assessing the impacts of a past event rather than modelling the future is the highlighting of unforeseen consequences. For example unlicensed operators are reported as trucking untreated water for domestic consumption posing a public health risk.

Source: Barnett, M,W. National Water Commission, Jamaica. 2010. The Impact of the Recent Drought on the National Water Commission (NWC) Water Supply Services to Kingston & St. Andrew, Jamaica. Available at http://cehi.org.lc

3.2. Using economic assessment of the impact of climate variability and change

Financial planners may look for an economic case for investing in climate resilience, and economic impact assessments can provide these types of estimates. A common approach to quantifying impacts in the Caribbean is the assessment of the economic damages incurred due to hurricanes through direct damage to infrastructure and loss of income associated with such damage. For example the economic impacts of Hurricane Ivan which struck Grenada in 2004 were evaluated in terms of direct costs and indirect losses totalling EC$2.4 billion dollars, 227% of the islands GDP (OECS, 2004). These economic assessments make a strong case for enhancing resilience to reduce the crippling impacts of such intensive risks.

In addition, modelling studies can be used to estimate the economic costs of climate change. This is most straightforward when considering infrastructure assets or the costs of interruptions to economic activities rather than social costs. A Caribbean example of this type of study is provided in Box 3.3.

Box 3.3 – Climate change - Assessing the cost of inaction in the Caribbean

Macro-economic studies present a strong case for action on climate change. This particular study assessed the economic risks associated with climate change posed by the impacts of hurricanes, the impacts of climate change on tourism, and the impacts of sea level rise on infrastructure. The report compares the climate related costs for two scenarios, one in which global emissions remain unchecked and a one in which significant effort is placed in reducing emissions. The difference in cost between the two scenarios would have to be borne by the Caribbean based on the global response to climate change. Its results indicate that the cost of global inaction on climate change could be as high as 21.7% of Caribbean GDP annually by 2100. This type of assessment highlights the relevance of the Liliendaal Declaration on maintaining levels of warming below 1.5°C.

Cost of inaction (High climate change impact minus low climate change impact scenarios) ($US Billion)

	2025	2050	2075	2100
Storms	$ 1.1	$ 2.8	$ 4.9	$ 7.9
Tourism	$ 1.6	$ 3.2	$ 4.8	$ 6.4
Infrastructure	$ 8.0	$ 15.9	$ 23.9	$ 31.9
Total	$ 10.7	$ 21.9	$ 33.7	$ 46.2
% Current GDP	5.0%	10.3%	15.9%	21.7%

Source: Bueno, R. ; Stanton, E.A. ; Ackerman, F. ; Herzfeld, C. 2008. The Caribbean and Climate Change: The Costs of Inaction. Report commissioned by the Environmental Defense Fund. Available at http://ase.tufts.edu/gdae/caribbeanclimate.html

The impacts of droughts, landslides and other climate related issues such as smaller scale flood events on society and environment are more difficult to quantify in such stark terms and are therefore less widely assessed. However, the impacts are likely to be most severe for poor and vulnerable communities which do not have the resources to prepare for such risks or manage their effects. This continued exposure to low levels of risk is a concept referred to as Extensive Risk[1] and is often under estimated because it is more pervasive than discrete events such as hurricanes.

Box 3.4 provides further resources on making the case for investing in water management.

[1] Extensive Risk: The widespread risk associated with the exposure of dispersed populations to repeated or persistent hazard conditions of low or moderate intensity often of a highly localized nature which can lead to debilitating cumulative disaster impacts.

Box 3.4 - Further resources on making the case for the economic benefits of water across sectors

Making Water A Part Of Economic Development (SIWI, undated)

Presenting the macro-economic case for the benefits of water can be a powerful argument amongst financial planners. This report set out some high level arguments for investing in water and would be a useful resource for water planners to identify the types of facts, figures and methodologies which can be used to present a case for resilience.

Source: Stockholm International Water Institute (SIWI) Making Water A Part Of Economic Development (SIWI, undated). Available at http://www.who.int/water_sanitation_health/waterandmacroeconomics/en/

3.3. Aligning the case for action with regional, national and sectoral policies and strategies

Part of the purpose of making a case for water security and climate resilient development is to reinforce the message that this is not new; rather it is helping to achieve commitments that have already been agreed at a high level by government ministers and their advisors.

There is now widespread consensus on the urgent need for immediate action to tackle climate change through adaptation and this has been reiterated at many United Nations Framework Convention on Climate Change (UNFCCC) and regional dialogues on climate change. At a regional level the Regional Framework for Achieving Development Resilient to Climate Change (CCCCC, 2009) and the accompanying Implementation Plan (CCCCC, 2012) set out the agreed regional position on the main actions on climate resilience. Box 3.5 sets out the five main strategic elements of the Regional Framework which set the regional objectives regarding managing the risks posed by climate variability and change.

The following policies, strategies and visions could be utilised to demonstrate the need for enhanced water resources management:

- Actions set out in the Implementation Plan for Regional Framework for Achieving Development Resilient to Climate Change (CCCCC, 2012)
- National climate change and disaster risk management strategies and plans, including the UNFCCC led National Adaptation Plan (NAP) process
- National vision statements (such as Jamaica's vision 2030, see Box 3.6)
- National sector strategies and action plans for water management, agriculture and land management
- Donor and development bank regional and country investment strategies
- Climate and other regional funding objectives and high level results frameworks

Ask yourself...

Which high level agreements could be used to support the case to manage significant climate risks?

Box 3.5 - The five main strategic elements of the Regional Framework for Achieving Development Resilient to Climate Change

- Mainstreaming climate change adaptation strategies into the sustainable development agendas of CARICOM states
- Promoting the implementation of specific adaptation measures to address key vulnerabilities in the region
- Promoting actions to reduce greenhouse gas emissions through fossil fuel reduction and conservation, and switching to renewable and cleaner energy sources
- Encouraging action to reduce the vulnerability of natural and human systems in CARICOM countries to the impacts of a changing climate
- Promoting action to derive social, economic, and environmental benefits through the prudent management of standing forests in CARICOM countries

Source: Caribbean Community Climate Change Centre (CCCCC). 2009. Regional Framework for Achieving Development Resilient to Climate Change (2009-2015)

At a national level, vision statements, policies and strategies may contain objectives which closely align with managing climate risks and enhancing the resilience of water resources management. Box 3.6 identifies some of the water and climate related objectives in Jamaica's National Development Plan, Vision 2030.

Box 3.6 - Aligning Jamaica's Vision 2030 with climate resilience and water security needs

Aligning a high level vision statement with objectives can strengthen the case for implementation. Jamaica's vision 2030 contains high level outcomes which support action to manage climate risks through water infrastructure, sustainable resources management and reducing hazard risks.

- National Outcome # 9: Strong Economic Infrastructure: Vision 2030 Jamaica will ensure the development of world-class transport, telecommunications, water supply and sanitation infrastructure that contributes to the competitiveness of our producers and improved quality of life for our people
- National Outcome # 13: Sustainable Management and Use of Environmental and Natural Resources: This will ensure the continued provision of essential environmental goods and services as we recognize that proactive environmental management is increasingly becoming the basis for the success of economies and social systems
- National Outcome # 14: Hazard Risk Reduction and Adaptation to Climate Change: Under Vision 2030 Jamaica "we will place greater emphasis on hazard risk management activities and programmes for reducing our existing and future vulnerability. We will incorporate climate change scenarios in future economic and land use planning and provide a framework to ensure that we reduce the risks associated with natural hazards by integrating hazard considerations into our country's development planning"

Source: Planning Institute of Jamaica. 2009. Vision 2030 Jamaica National Development Plan ISBN 978-976-8103-28-4. Available at www.pioj.gov.jm

Beyond water related goals and commitments, improving water resources management and water services brings co-benefits in terms of broader objectives associated with poverty reduction and disaster risk management. Demonstrating the links between water management and these higher level objectives will help to raise the profile of water initiatives and gain support from funding agencies. For example, implementing a water resources and land management programme will bring benefits to local communities in terms of the sustainability of agriculture, water supplies and economic activities such as tourism while at the same time reducing the vulnerability of watersheds to erosion and degradation associated with natural hazards.

Aligning with scientific and technical recommendations

In addition to existing strategies and policies, scientific and technical studies may provide high level recommendations for action. These may be well recognised within the international community and can be aligned with national level cases for action. This demonstrates to the international community and potential funding agencies that the case is based on the current scientific evidence. The Intergovernmental Panel on Climate Change (IPCC) provides findings and recommendations in its Fifth Assessment Report related to climate change and Small Island Developing States (SIDS). Figure 3.1 presents these and provides an illustrative interpretation for the type of actions they could imply for water resources. This type of alignment could be important for international.

Figure 3.1 - Illustrative mapping of IPCC Fifth Assessment Report (IPCC, 2014c) conclusions onto potential actions for water management

IPCC conclusion for SIDS (IPCC, 2014c)	Implications for water security and climate resilience
"Current and future climate related drivers of risk for small islands during the 21st century include sea level rise, tropical and extra-tropical cyclones, increasing air and sea surface temperatures, and changing rainfall patterns (high confidence, robust evidence, high agreement)"	The impact of these climate changes on water resources should be assessed and built into planning processes to help balance water availability and demands on water resources in the long term
"Sea level rise poses one of the most widely recognized climate change threats to low-lying coastal areas on islands and atolls (high confidence, robust evidence and high agreement)"	The impacts of sea level rise on coastal assets and aquifer systems should be assessed and considered when planning strategic investments in water systems
"Given the inherent physical characteristics of small islands, the AR5 reconfirms the high level of vulnerability of small islands to multiple stressors, both climate and non-climate (high confidence, robust evidence, high agreement)"	Climate change impacts and the impacts of development pressures on water should be considered together when planning future water resource development
"Small islands do not have uniform climate change risk profiles (high confidence)"	Countries should strengthen their monitoring and modelling capacity for water management at basin level to better understand local risks. Regional work programmes are still important
"Adaptation to climate change generates larger benefit to small islands when delivered in conjunction with other development activities, such as disaster risk reduction and community based approaches to development (medium confidence)"	Strategic water resources planning should consider both long term changes in water availability (such as changing rainfall) as well as the impact of extremes on water infrastructure and supply systems
"Adaptation and mitigation on small islands are not always trade-offs, but can be regarded as complementary components in the response to climate change (medium confidence)"	Water resources management should seek to maximise the efficiency of water services and utilise ecosystems approaches to adapt to a changing climate and contribute to mitigating climate change
"The ability of small islands to undertake adaptation and mitigation programs, and their effectiveness, can be substantially strengthened through appropriate assistance from the international community (medium confidence)"	Water resources and supply planners should present a strong case to the international community to seek opportunities for technical assistance and financing for adaptation

3.4. Identifying champions as a catalyst for action

Ask yourself...

How could an influential champion support progress towards building resilience?

A champion is an influential, dynamic and passionate individual, able to drive a process forward and who brings with them institutional "image" and profile. A committed champion with the right connections and knowledge about the sector, helps to open doors and launch a process rapidly. In selecting a champion, it is important to understand what needs to be changed or influenced, and the nature of the difficulties that may be encountered (GWP, undated).

Champions have been found to be an important factor in the success of Integrated Water Resources Management (IWRM) implementation. In the context of making a case for enhancing climate resilience champions are valuable to deliver evidence for resilience and to influence national and regional priorities. One such example of the use of champions to deliver a message is the annual High Level Session Ministerial Forum of Caribbean Water Ministers (see Box 3.7) which provides an opportunity for high level decision makers to come together, discuss issues and champion progress in water management.

Box 3.7 The Annual High Level Session Ministerial Forum of Caribbean Water Ministers (convened by the Global Water Partnership Caribbean and Caribbean Water and Wastewater Association)

The High Level Session (HLS) brings together Caribbean Water Ministers and senior officials involved in water resources management to share experiences and ideas for addressing water issues affecting the region and individual countries. It represents a forum for championing water issues and results in a declaration which represents the recommendations of ministers. The declarations provide continued high level support for actions on the ground to further implement IWRM in the Caribbean as well as renewing the commitment of minsters to champion sustainable water management.

The Ministerial Forum is a joint initiative of the Caribbean Water and Wastewater Association (CWWA) and its partner the Global Water Partnership-Caribbean (GWP-C) which began in 2005 as a session within the CWWA's Annual Conference and Exhibition.

Source: Outcomes and declarations from the high level ministerial sessions on water are available at http://www.gwp.org/en/GWP-Caribbean/GWP-C-IN-ACTION/High-Level-Session-Ministerial-Forum-on-Water-/

3.5. Communicating the case for action

The case for water security and climate resilience, growth and development should be succinct and digested readily by non-specialists. Policy papers and briefs are often used to engage with high level decision makers; they must provide a persuasive argument justifying the recommendations presented in the paper. Policy papers are generally more comprehensive while policy briefs are more succinct.

Policy papers and briefs are calls to action for the target audience. To be effective for a high level audience they must address real world problems, suggest courses of action to address those problems, and also convince the target audience of the suitability of the recommendations (Box 3.7). The aim should be to ensure that the underlying analysis is targeted at practical and implementable solutions. The emphasis is not necessarily to show what should be done but to persuade the audience to do what they know should be done. Timing of message delivery is often crucial.

Box 3.8 provides further resources for communicating the case for action.

Box 3.8 - Planning checklist for policy papers and briefings based on the Overseas Development Institute RAPID toolkit (Hovland, 2005)

In preparing policy papers and briefings, the following questions are of interest:

- Which stage(s) in the policymaking process are you trying to influence?
- Which stakeholders have been/are involved at each stage of the policymaking process?
- Have you identified a clear problem to address? Can you summarise it in two sentences?
- Do you have sufficiently comprehensive evidence to support your claim that a problem exists?
- Have you outlined and evaluated the possible policy options that could solve this problem? What evaluation criteria did you use?
- Have you decided on a preferred alternative?
- Do you have sufficient evidence to effectively argue for your chosen policy alternative over the other options?

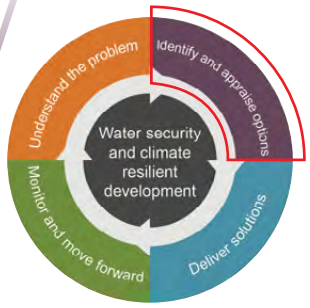
Source: Hovland, I. 2005. Successful Communication: A Toolkit for Researchers and Civil Society Organisations. Research and Policy in Development (RAPID) Programme, Overseas Development Institute (ODI). London, UK. www.odi.org.uk/resources/docs/192.pdf

Box 3.9 - Further resources on communication tools to make the case for resilience

Communicating climate change: A toolbox for local organisations in the Caribbean

The Caribbean Natural Resources Institute (CANARI) have developed a toolbox for communicating climate change risks to a range of stakeholders including communities and high level policy makers. It also gives an overview of different communications tools such as media, websites and videos.

Source: CANARI 2009. Communicating climate change: A toolbox for local organisations in the Caribbean. Port of Spain, Trinidad and Tobago: Caribbean Natural Resources Institute. Available at www.canari.org



4

Understanding the principles of building resilience in water management

Key messages

- No and low regret options perform well under current climate variability and a range of future climate change
- Research and innovation can enhance efficiency of water management and use, and can be considered low regret
- Enhancing resilience brings co-benefits to other sectors, including the mitigation of climate change
- Integrated Water Resources Management (IWRM) is an effective tool to support climate resilience
- Preparing for long term climate change requires flexible development pathways

Sample tasks and activities

- Consider what no and low regret options might look like in your context, identify examples of innovative water management from across the Caribbean and discuss the barriers and opportunities for their uptake
- Consider how options which enhance water management will benefit other productive economic, social and environmental sectors
- Consider how planning systems can accommodate future uncertainties in climate and development and how flexibility is being maintained or reduced by decision making processes

Opportunities to build resilience through improved water management are diverse and dependent on local contexts and local risks. It is therefore difficult to make general recommendations on the types of adaptation options which might be appropriate in different contexts. However, it is possible to identify some of the underlying principles for resilience which are widely applicable to water management issues.

This section provides a primer on some of these principles to support identification of locally appropriate adaptation options in the Caribbean context.

4.1. No and low regrets options are robust to climate change uncertainty

> *Many of the impacts threatened by climate change are just extreme examples of challenges that are already addressed on a daily basis across the world. Countries which have established effective institutions and infrastructure to deal with today's climate are better placed to deal with the more extreme variability which we expect tomorrow*
>
> ***(GWP, 2007)***

This message reflects the need for adaptation options to increase resilience towards current levels of climate variability while supporting adaptation to longer term changes in climate. The implications for water resources management are twofold:

- **Firstly, getting the fundamentals right.** General improvements in water resources management will help manage climate risks now and in the future through better information, policy, regulation, allocation and cooperation. This reduces the vulnerability to current climate variability and paves the way for more proactive climate change adaptation
- **Secondly, facing the climate change challenge.** Water resources management must consider potential climate and development change to make sure it is sustainable

The concept of no regret and low regret actions addresses this link between resilience to current and future climate risks, these are further discussed in Box 4.1. These concepts are based on the premise that actions should be prioritised which manage current risks and also perform well under a range of future uncertainty. This requires a consideration of both current conditions being experienced as well as the potential future scenarios and how they would impact on the options. No and low regret options should be prioritised as they bring benefits under existing and future conditions.

No and low regret options are said to be 'robust' to climate change uncertainty. Testing robustness to uncertainty can be carried out through prioritisation techniques and sensitivity analysis, see Section 7 of the Sourcebook.

Box 4.1 – No and low regret options for adapting to climate change (based on World Bank, 2012).

No regret adaptation options are not affected by uncertainties related to future climate change because they help address problems associated with current climate variability, while at the same time, build adaptive capacity for future climate change.

An example of a no regret intervention would be enhancing provision and dissemination of climate information as well as access to early warning systems by local communities living in flood and/or drought prone areas.

Low regret adaptation options are those where moderate levels of investment increase the capacity to cope with future climate risks. Typically, these involve over-specifying components in new building or refurbishment projects. For instance, installing larger diameter drains at the time of construction or refurbishment is likely to be a relatively low-cost option compared to having to increase specification at a later date due to increases in rainfall intensity (World Bank, 2012).

Source: World Bank. 2012. Mainstreaming Adaptation to Climate Change in Agriculture and Natural Resources Management Projects. Adaptation Guidance Notes. Available at http://go.worldbank.org/T3FMU3FDXo

No and low regret options typically aim to reduce the vulnerability of systems to climate variability and to increase the capacity of the systems to adapt to a changing climate in future. It should be noted that in practice very few options are truly 'no regret' as all investments will have some opportunity cost associated with them (Wilby & Vaughn, 2011). Some indicative water related adaptation option examples are provided in Table 4.1 below.

Table 4.1 - Examples of water related no/low regrets options at different levels (AMCOW, 2012)

Planning level	Example no/low regret option
Regional level	• Data sharing • Developing decision support systems for water management • Disaster risk reduction through management of residual risks such as disaster risk insurance
National-level	• Carrying out comprehensive climate risk assessments to inform strategic planning centrally or by sector • Building links between research organisations and policymakers for land and water management • Review of planning regulations and systems through a 'climate risk lens' to understand how guidance or regulation could accommodate climate change and climate risks
Sub-national and local levels	• Review of climate risks posed to sub-national infrastructural systems (water supply, transport, power) • Municipal flood risk management strategy development • Drought management planning at basin level • Land and water management demonstration projects to improve livelihoods and generate lessons • Income diversification and micro-finance to improve resilience of communities • Review of the distribution of climate risks across communities focusing on vulnerable sections of the community

Research and innovation can enhance efficiency of water management and use

Innovation for managing climate risks and adapting to a changing future climate can be considered through two broad approaches outlined below:

- **Doing things differently** – How can decision making processes, plans or projects be adjusted to make them more resilient to climate variability and change? This can be carried out by screening of ongoing activities for climate risks.
- **Doing different things** – What new and additional activities which are not part of current processes could enhance resilience? This could include developing new research programmes, pilot projects, collaborative partnerships or testing new technologies.

Ask yourself...

What are the barriers to the uptake of innovative technologies and how can these be removed?

Research into water efficient technologies and their roll out across the region offers the potential to reduce water wastage thereby reducing the impacts of droughts on water supply systems and reducing operation costs in water systems. This needs to be supported by incentives and regulations to promote roll out of innovative technologies such as tax breaks, subsidies and other financial mechanisms.

The Caribbean Climate Innovation Centre (CCIC) has recently been established as a result of the collaboration between the Caribbean Industrial Research Institute (CARIRI) in Trinidad and Tobago and the Scientific Research Council (SRC) in Jamaica. This organisation will catalyse investment in climate resilience through finding and implementing locally appropriate and sustainable green solutions to reduce harmful emissions and to adapt to climate change.

Innovative approaches to enhance the resilience of water resources systems and water services could include the following:

- Rain water harvesting to augment piped supplies (see Box 4.2)
- Research into feasibility of groundwater sources where untapped potential may exist
- Development of innovative water efficiency technologies and incentives in domestic and municipal water supplies
- Research and development into efficient irrigations systems and their roll out within the region
- Re-use and recycling of grey and black water for irrigation
- Regional and national research and development of modelling, mapping tools and manuals for water resources assessment and flood risk to provide water planners with robust methods for water resources management, service provision and asset risk management. Further resources for identifying innovative adaptation options is provided in Box 4.3

The IPCC Fifth Assessment Working Group Two report on Small Islands identifies climate change research challenges which should be addressed in small islands (IPCC, 2014c). These comprise:

- Lack of climate change and socio-economic scenarios and data at the required scale
- Difficulties in detecting and attributing past impacts on small islands to climate change processes
- Uncertainty in the projections is not a sufficiently valid reason to postpone adaptation planning
- Need for a range of climate change-related projections beyond temperature and sea level
- Need to acknowledge the heterogeneity and complexity of small island states and territories
- Within country/territory differences need to be better understood

Box 4.2 - GWP-C Rainwater harvesting toolbox

The Global Water Partnership-Caribbean (GWP-C) has developed a Toolbox on Rainwater Harvesting (RWH) in the Caribbean to share information on RWH and to improve knowledge on conducting RWH under safe and sanitary conditions. The Toolbox is a compilation of research materials on RWH in the Caribbean and best practices applicable to the Region.

Source: The toolbox is available at http://www.cehi.org.lc/Rain/Rainwater%20Harvesting%20Toolbox/index.htm

Box 4.3 – Further resources on technology needs assessments for water related climate change adaptation

UNEP has developed a guidebook for identifying and implementing technologies for climate change adaptation in the water sector. This book is a guide to the most relevant adaptation technologies and practices for the water sector in developing countries. In addition to descriptions and explanations, the guidebook outlines practical steps for implementing these technologies illustrated with case studies. It not only lays out institutional and capacity building requirements but also explores costs and other potential barriers to getting projects off the ground. Finally, the text is supplemented by a rich list of references to external sources and case studies.

Source: Elliot, M., Armstrong, A., Lobuglio, J. and Bartram, J. 2011. Technologies for Climate Change Adaptation—The Water Sector. T. De Lopez (Ed.). Roskilde: UNEP Risoe Centre. Available at http://www.thegef.org/gef/TT_tech_needs_assessment

4.2. Enhancing resilience in water brings co-benefits to other sectors

Many options which enhance the resilience of water resources bring co-benefits to a wide range of stakeholders beyond the water sector. Some of these options may include reducing energy requirements thus supporting climate change mitigation objectives. Options which support resilience as well as mitigating climate change are referred to as climate compatible development options (CDKN, 2010).

Ask yourself...

What opportunities for co-benefits exist in your context? What are the barriers to implementing these?

Identifying the wider benefits of enhancing resilience in the water sector can be used to raise the profile of water management, attract funding and support from outside the sector and build partnerships across sectoral silos towards common aims. Examples of co-benefits in the Caribbean context are given for wastewater treatment and sustainable land management in Table 4.2

> *Adaptation and mitigation on small islands are not always trade-offs, but can be regarded as complementary components in the response to climate change (medium confidence)*
>
> ***IPCC Fifth Assessment report (IPCC, 2014c)***

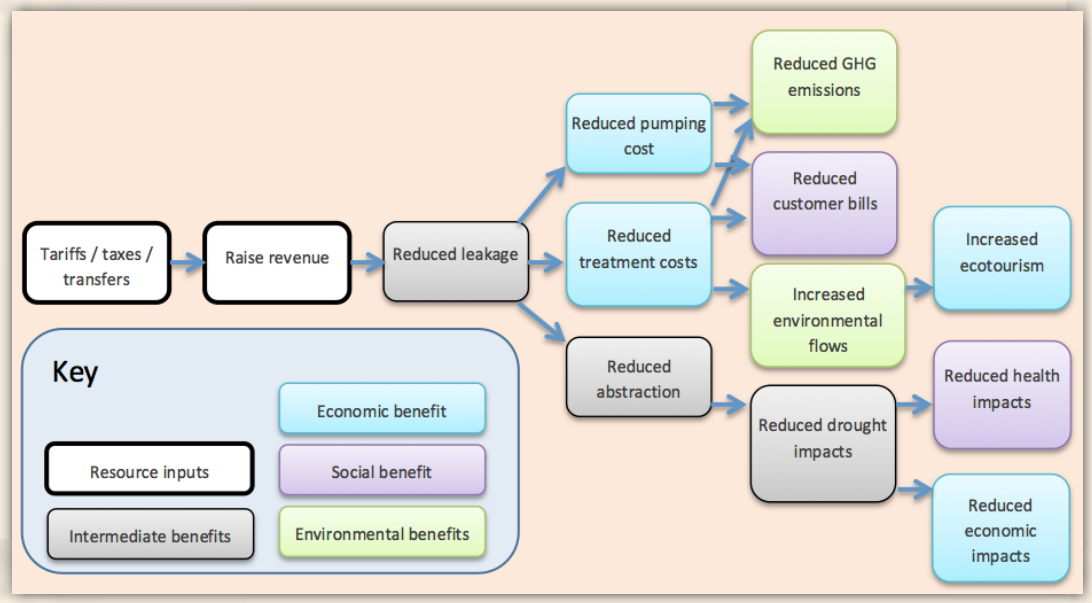
Table 4.2 - Examples of co-benefits for two water management activities

Example water management activity	Example no/low regret option
Wastewater treatment	• Maintains water quality for other users (surface water courses and aquifers) • Maintains ecosystems services • Preserves environmental quality required for tourism • Preserves water quality for marine fisheries • Reduces human environmental and food health risks
Sustainable land management	• Reduces soil erosion and consequent reduction in agricultural production • Reduces soil erosion and subsequent deposition of silt and turbidity in the marine environment, maintaining fisheries and tourism activities • Reduces runoff and flood risk downstream • Increases stability of land, reducing landslide risks • Maintains ecosystems services with associated societal and economic benefits • Preserves environmental quality required for tourism • Reduces polluted runoff and associated human environmental health risks

Box 4.4 presents an example of how reducing leakage in water supply systems brings benefits to a range of stakeholders.

**Box 4.4 – Co-benefits in water management:
The example of reducing leakage in municipal water supply**

Integrating water management across sectors and seeking improvements in efficiency through management tools or infrastructure improvement can yield benefits to a number of different users. In this hypothetical example, reduction in leakage brings a cascade of wider benefits including reduced greenhouse gas emissions which may be eligible for specialist finance for climate change mitigation.



Integrated Water Resources Management (IWRM) across sectors supports climate resilience

The basis of IWRM is that there are a variety of uses of water resources that are interdependent. The failure to recognize interdependency, coupled with unregulated use can lead to water wastage and the unsustainability of water resources in the long term. Integrated management does not segregate water users or take a sectoral approach as is done in many countries. Rather, water allocation and management decisions consider the impact of each use on the others. In doing so, the cross-cutting goals of social, economic and environmental sustainability are considered collectively and cross-sectoral policies are examined to shape more coherent, coordinated policies. In short, IWRM recognizes that water is a scarce natural resource subject to many interdependencies in conveyance and use (Cap-Net, 2009).

Ask yourself...

How is water allocation managed across sectors and users? How could this be improved?

GWP asserts that the best approach to manage the impact of climate change on water is that guided by the philosophy and methodology of IWRM (GWP, 2007). IWRM provides a wealth of tools and approaches to enhance the management of water resources for economic, environmental and social benefits. IWRM does not require the initiation of parallel processes and ambitious reforms; IWRM tools can be used opportunistically. The IWRM Toolbox is a web based resource providing a wealth of useful tools and case studies for implementing aspects of IWRM (see Box 4.5)

Ask yourself...

What tools and approaches would most benefit water management in your context? (see for example the GWP toolbox)

Box 4.5 - The Global Water Partnership (GWP) Integrated Water Resource Management Toolbox

The IWRM ToolBox is a free and open database with a library of background papers, policy briefs, technical briefs and perspective papers as well as huge sections of case studies and references.

The Toolbox also contains a wealth of tools for water management which support climate change adaptation and should be a primary resource for those involved in water resources management as a resource base for identifying opportunities to improve water resources management.

Source: The GWP Toolbox is available at the following website http://www.gwp.org/en/ToolBox/

SIDS desiring to implement IWRM need not start with expensive and time consuming institutional reforms. They can start small, using pressing water related issues as 'entry points', and fine-tuning their IWRM strategies from experience. This pragmatic approach towards sustainable water management promotes co-ordinated development and management of water, land and related resources without compromising the sustainability of vital ecosystems (UNEP, 2012)

4.3. Preparing for long term climate change requires a flexible pathway of development actions

While this Sourcebook advocates the identification of no and low regret adaptation options as a high priority, consideration of climate change impacts on long term programmes of investment is also needed. Maintaining flexibility and taking an iterative approach in planning systems ensures that decisions are not 'locked in' to a particular course of action over a long time period with large climate change and other uncertainties.

Ask yourself...

Which actions can be undertaken now and which can be delayed?

What are the interdependencies between actions which determine their success?

Long lived infrastructure assets present a particular cause for concern when considering the impacts of climate change. Water related infrastructure requires a substantial capital investment, can be inflexible once implemented and may be required to operate for many decades. Assessing the impacts of climate change on such proposals is critical including changing rainfall patterns, changing flood risk and rising sea levels.

One important strategy is to maintain flexibility in water systems to minimise the risk of being locked into a single course of action. In practice, this may require actions such as:

- **Designing adaptable infrastructure**. Water infrastructure often has a long life span and will be used in climate and societal conditions which could be very different to the present day. Infrastructure which can be upsized or adjusted with minimum cost and disruption is better placed to cope with future uncertainty. This might include designing water treatment works which can be upsized in the future if demand increases more than is expected.
- **Building in safety factors to infrastructure to accommodate uncertainty in future climate**. For example, increasing the capacity of a proposed dam may be used to offset the uncertainty in future rainfall patterns. The cost of doing this during the construction phase may be much lower than attempting to add capacity at a later date or construct additional sources. However, this is only applicable where the additional upfront costs are low relative to the risk offset.
- **Utilising a range of options to achieve an outcome.** In the context of water this could include diversifying water sources such as groundwater, surface water, desalination, rainwater harvesting, water recycling and water efficiency measures. This spreads risk of climate change impacts across a range of measures rather than relying on a single solution. It should be noted that climate change is only one of many considerations in developing such options. For example desalination is resilient to drought but is energy intensive to operate from a cost and climate change mitigation viewpoint.

- **Supporting infrastructure with non-structural measures.** Non-structural measures are inherently more adaptable than fixed infrastructure assets. For example, water tariffs can be reformed on a periodic basis and used to influence consumer demand behaviour. Investments in information, planning and policy can provide greater confidence in the planning and design of infrastructure assets.

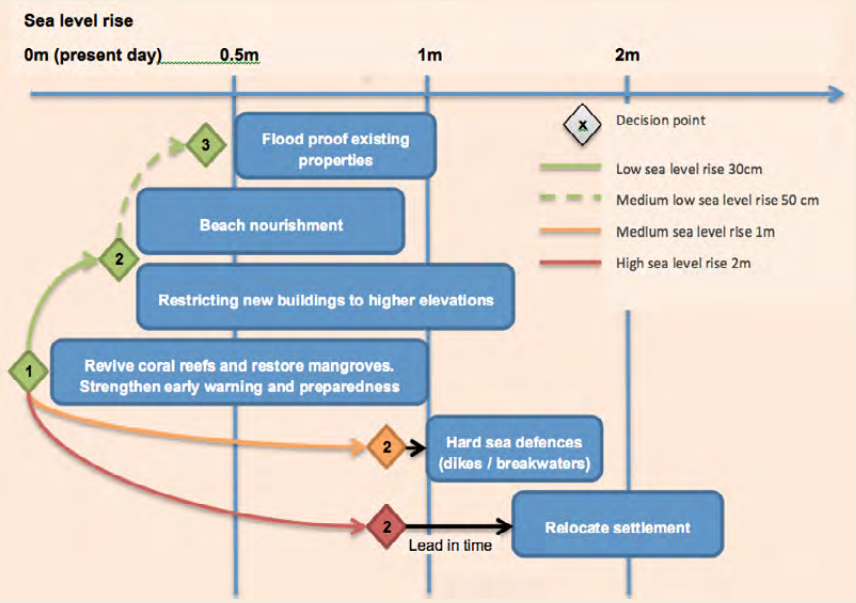
There is a wide range of background information available on adaptive decision making and a concise introduction is provided by Ranger (2013), see Box 4.6. However, translation of the principles of adaptive decision making into practice is dependent on the problem being considered.

Box 4.6 – Flexible planning for climate change adaptation: a hypothetical example of coastal flood risk planning for SIDS.

The Thames Estuary 2100 project (TE2100) has become the classic example of a progressive approach to adaptation (Reeder and Ranger, 2011). The lessons gained from that case study are readily applicable to a broader range of interventions. Here, we show an illustrative example of how the 'adaptation pathways' approach applied in TE2100 can be used to explore the sequencing of a coastal storm surge flood management plan for a highly exposed settlement in a small-island state.

For this settlement, sea levels are expected to rise by between 30 cm and 1 m by 2100, but in a worst-case scenario, could rise by more than 2m. Local consultations led to the development of a number of potential options, which are effective over different ranges of sea level rise (as shown by the positions of the blue boxes below). From here, it is possible to design packages of measures that perform best for different future scenarios. For example, if sea levels were known to follow a medium-low scenario (green dashed line), then the optimal package would include reviving coral reefs and restoring mangroves; strengthening early warning and preparedness; beach nourishment; and flood-proofing new and existing properties. In the high scenario (red solid line), the best strategy would be to begin a gradual relocation of the settlement to higher land.

A challenge for the advisers is that it is difficult to switch between these 'optimal' packages as more is learnt without incurring significant costs. For example, while it would be easy to scale up from a low to a medium-low scenario by flood-proofing properties, moving from this to a high scenario plan would mean abandoning those properties. Similarly, taking the worst-case scenario only would not be appropriate due to its high social and cultural impact.



Box 4.6 (contd.) – Flexible planning for climate change adaptation: a hypothetical example of coastal flood risk planning for SIDS.

The adaptation pathways diagram, shown above, can help an adviser to consider ways to build in flexibility through adapting incrementally over time. The aim is to develop an adaptation plan that reduces risk progressively, while avoiding foreclosing options prematurely or taking action that could mean wasted investments or unnecessary cost.

The four pathways mapped out above each involve waiting and learning before making the inflexible and costly choice between flood-proofing existing properties, building hard sea defences and relocating the settlement. But there is a cost to this delay as the settlement faces a growing danger from storm surges. To reduce this risk, the plan proposes to implement a number of low-regret measures, including reviving coral reefs, restoring mangroves, and strengthening early warning systems and preparedness. But new properties continue to be built and this will lock in increasing vulnerability – to rectify this, the plan recommends a temporary restriction on development in the flood-prone area.

From this plan it will be possible to define appropriate decision points where the decision must be made to switch to a set pathway (decisions at these points are numbered from 1 to 3). The decision point will depend on (a) the sea level rise at which an intervention becomes effective; (b) the rate of sea-level rise; and (c) the lead time of the intervention. The plan requires regular monitoring and review to reassess the pathways and decision points.

Source: Ranger, N. 2013. Topic Guide. Adaptation: Decision making under uncertainty. Evidence on Demand, UK. 2013. 86 pp. The original topic guide from which this case study has been reproduced is available from the Evidence on Demand website at http://www.evidenceondemand.info

This case study has been reproduced in its entirety from a UK Department for International Development Topic Guide on Adaptation (Ranger, 2013)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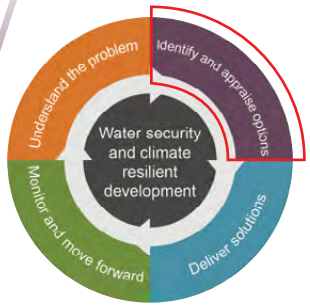


Using CCORAL to identify adaptation options

5

Key messages

- Managing climate risks requires action at a range of levels from policy adjustment at a national level, right through to changes in planning practices and project development
- The Caribbean Climate Online Risk and Adaptation TooL (CCORAL) is a Caribbean specific web-based platform for screening decision making activities and identifying climate risks for all sectors including the water sector

Sample tasks and activities

- Working with stakeholders map out potential policies, legislation and regulations, plans, budgets and projects which could benefit from screening through CCORAL and prioritise these for screening
- Applying CCORAL to assess risks and to strengthen climate resilience in:
    - Water policies and strategies and those relating to or dependent on water
    - Legislation and regulation concerning water rights, allocations, pollution and disaster management
    - Water resources allocation plans and water service providers. long term supply and demand balance planning
    - Budgeting activities for water service providers and the economic incentives and sanctions which influence water use
    - Water related projects such as infrastructure development for service provision and irrigation as well as operational practices such as operational rules and manuals

The Caribbean Climate Online Risk and Adaptation TooL (CCORAL) is a Caribbean specific web based platform for screening decision making activities to identify climate risks and response options to manage these risks across all sectors. It is intended to be triggered as part of day to day planning and decision making.

This section provides additional resources to support the use of CCORAL in the context of water related planning and decision making activities. It is not intended to replace CCORAL but rather to support users in identifying options to reduce climate risks when applying CCORAL.

5.1. Introducing CCORAL

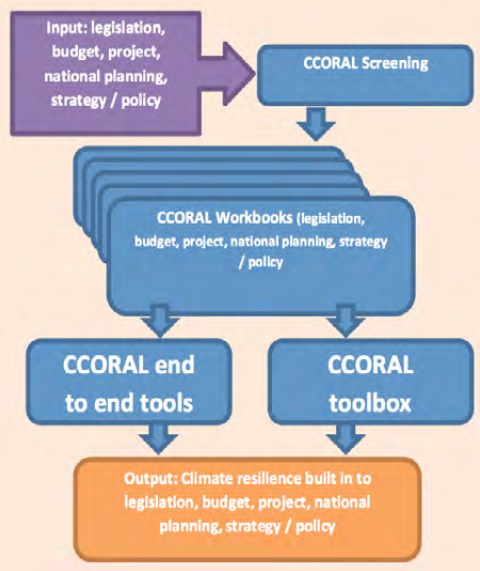
The process of using CCORAL begins with a quick screening exercise which identifies the level of climate influence in the decision making activity. This is followed by more detailed application of workbooks which provide a checklist of questions for users to identify the main risks and risk reduction options. Workbooks are organised around five broad types of decision making:

- strategy and/or policy
- legislation
- national planning
- budget preparation/evaluation
- programme and/or project

Ask yourself...

How could the application of CCORAL be integrated into planning processes?

Box 5.1 - The Caribbean Climate Online Risk and Adaptation tooL (CCORAL)



CCORAL
Caribbean Climate Online Risk and Adaptation TooL
Delivering Climate Resilient Development

CCORAL was developed by the Caribbean Community Climate Change Centre (CCCCC) and was launched in July 2013. CCORAL provides an online platform which can be used to screen policies, legislation, plans, programmes, projects and budgets to identify climate risks and options which can build resilience supporting sustainable development in the Caribbean. It uses a series of checklists and worksheets to guide non-climate change specialists through the process of identifying how climate variability and change may affect the decision making activity. A toolbox then helps the user identify resources which may help them identify adaptation options.

CCORAL is a web-based tool so can be continually supported and improved as required by users.

Source: CCORAL is available at the following website http://ccoral.caribbeanclimate.bz

These represent the broad decision making tools which may be adjusted to enhance resilience. Following on from the workbooks end-to-end risk management tools are available as well as a toolbox of more targeted resources to assist in climate risk management. Box 5.1 summarises the processes applied in CCORAL.

CCORAL is intended to be applied to policies, strategies, legislations, regulations, plans, budgets and projects when the opportunity arises to amend or revise them. The key point here is that adaptation options are relevant across a wide range of decision making levels. Adjusting the ways in which policies address climate risks is as important as adjusting the way in which water resources are managed or adjusting how projects are developed. Taking action across these levels is important to ensure that climate risks are mainstreamed into all aspects of decision making.

5.2. Applying CCORAL in the context of water management

This section focuses on some of the potential options to change the way in which water resources are managed to enhance their resilience to climate risks. It can be used as a reference guide when applying the CCORAL workbooks to provide more water specific resources. It has been aligned with the CCORAL workbook decision making activities in Table 5.1 below.

Table 5.1 - Water related decision making tools which may be appropriate for CCORAL screening

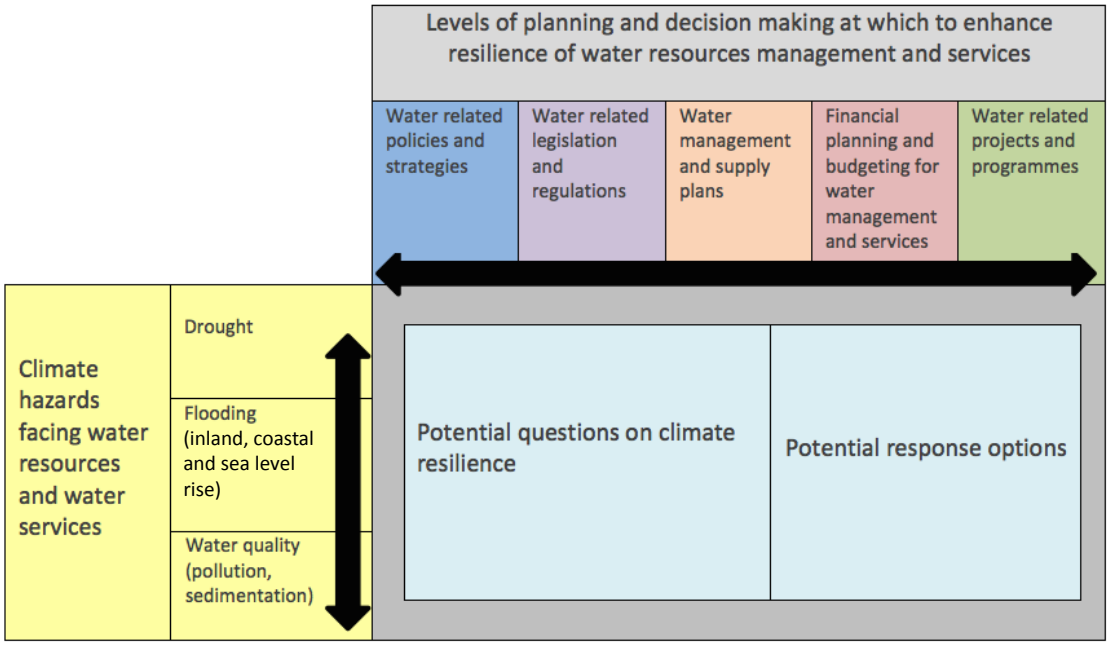
CCORAL decision making level	Examples of water related decision making tools which CCORAL could be used to screen
Strategy and/or policy	• National water policy • Water resources management policy • Water related/dependent sectoral policies (agriculture, industry, tourism, environment for example)
Legislation	• National water laws • Water permitting and allocation laws and regulations • Environmental pollution laws and regulations • Water utility regulations • Development and land use regulations
National planning	• Water resources development plans • Water supply plans • Water resources assessments • Catchment management plans • Sectoral plans which are dependent on water (agriculture, industry, tourism, environment for example)
Budget preparation/ evaluation	• Water resources agency budget papers • Water service provider budget papers • Water dependent sector budget papers (agriculture, industry, tourism, environment for example)
Programme and/or project	• Strategic water resources infrastructure such as reservoirs • Water related infrastructure projects (raw water storage, treatment, distribution, wastewater) • Irrigation and drainage projects • Flood protection infrastructure • Auxiliary infrastructure such as data collection and monitoring • Operational processes such as water system management and maintenance

A theme running through CCORAL is the identification of how climate hazards may impact on the decision making activity and then what options are available to strengthen or amend it to enhance its resilience to climate change.

A set of adaptation response matrices have been developed which identify key questions on how climate hazards are addressed in water related decision making activities and the potential adaptation options available to manage the impacts of these hazards. These matrices are provided over the following pages and the structure of the matrices is introduced in Figure 5.1. Climate hazards have been defined broadly into drought, flooding and water quality. The questions and adaptation options are drawn from the CCORAL workbook questions and have been adapted and built on in the context of water.

The matrices should be used to supplement the questions in the CCORAL workbooks when applying workbooks to water related decision making.

Figure 5.1 - Water and climate adaptation response matrix to support CCORAL workbooks



The application of CCORAL to any one particular decision making process will highlight how other decision making processes can be improved, and this open ended approach is desirable to allow the links between different decision making processes to be understood. For example, applying CCORAL to a water supply plan may highlight areas for action at the regulatory and policy levels which are outside the direct control of the planners involved in water supply. This can be used to trigger a broader review of regulations thus expanding the scope of resilience.

Ask yourself...

Which relevant experts and other stakeholders could assist in identifying options to manage risks?

The process of applying CCORAL

The response matrices can be used to rapidly assess the types of options which may be available but the approach in applying CCORAL should ideally be participatory to maximise the range of options from a range of stakeholder perspectives:

- **Brainstorming and workshops** with technical experts in water resources management, service delivery and climate at a national, regional and international level may be able to bring good practice and know how into water resources management and water service delivery
- **Reviewing regional best practices** and examples of adaptation options being undertaken. Learning lessons from pilot initiatives, scaling these up and transferring principles from existing practices can all help (see Section 6)
- **Looking at other sectors and building partnerships** to share knowledge and experiences which may be transferrable in terms of climate risk management. In the context of water, such cross sector partnerships are vital in managing a resource upon which sectoral activities depend (such as tourism, agriculture, industry as well as municipal water supplies)

Questions and responses for resilient water related policies and strategies

Policies and strategies may include those centrally focused on water resources but should not neglect policies and strategies which relate to or strongly depend on water. This is especially the case for those countries which have not developed water policies and strategies. For example strategies for agricultural or tourism development could be adjusted to require water resources assessments or to promote water efficiency measures.

Box 5.2 – Further resources on climate resilience through water policies

Global Water Partnership - Checklist for change: Defining areas for action in an IWRM strategy or plan

This brief focuses on those areas for action that relate to the political, social, economic and administrative systems needed to develop and manage water resources. It provides an overview of potential areas which could be addressed as part of water policy development or reform.

Source: GWP. 2006a. Checklists for change: Defining areas for action in an IWRM strategy or plan, Policy Brief No. 1. Available at http://www.gwp.org/en/ToolBox/PUBLICATIONS/Technical-Briefs/

Global Water Partnership - Triggering change in water policies

This brief provides a range of high level activities which can be used to initiate and catalyse change in water policies. This presents a good opportunity to revise policies in order to enhance climate resilience. Change is a political process and therefore a negotiated one. It is informed by a host of factors—history, public perception, development challenges, and social and economic context. There are no universally applicable solutions. Nevertheless, analysis from experiences of change does reveal common elements among the successes and among the failures. This brief is intended to provide practical guidance to those involved in the critical process of social change and learning (GWP, 2009)

Source: GWP. 2009. Triggering Change in Water Policies, Policy brief No. 8. Available at http://www.gwp.org/en/ToolBox/PUBLICATIONS/Policy-Briefs/

OECD - Water and Climate Change Adaptation: Policies to Navigate Uncharted Waters

This report, Water and Climate Change Adaptation: Policies to Navigate Uncharted Waters, provides guidance to policy makers to help improve the prioritisation, efficiency, timeliness and equity of their policy responses. The report sets out a risk-based approach for adapting to climate change that promotes water security. It also documents key trends and highlights best practice from the OECD Survey of Policies on Water and Climate Change Adaptation, which covers all 34 OECD countries and the European Commission. Although focussed on OECD rather than Caribbean nations, the broad policy options and best practices can help frame the main issues which policymakers should consider on water and climate change.

Source: OECD. 2013. Water and Climate Change Adaptation: Policies to Navigate Uncharted Waters, OECD Studies on Water, OECD Publishing. Available at http://dx.doi.org/10.1787/9789264200449-en

WATER RELATED POLICIES AND STRATEGIES

Climate hazard	Potential questions on climate resilience	Potential response options
Drought	• Does a national water policy exist? • How do existing national development and sectoral policies address water? • What are the missions and objectives of water management agencies regarding drought? • How do water related policies address variability in water availability and drought? • How do policies address the competing uses of water? • How will the policy objectives be impacted by drought events and long term changes in water availability? • Can the policy be amended to reduce the impact of drought on water resources and water service provision?	• Develop a national water policy and/or vision on water • Align water policies with climate change adaptation policies, sector policies and national development policies • Harmonise water related policies such as agriculture, tourism and industry on drought management and water efficiency • Ensure policies can manage competing uses for water through institutional coordination • Ensure policies explicitly address variability in resources availability and the potential for long term change • Set a periodic review process for policies to allow their adaptation to changing conditions and emerging lessons • Ensure policies broadly follow the principles of Integrated Water Resources Management (IWRM). IWRM provides a wide range of tools which through improving the management of water resources, enhance their resilience to climate variability and change
Flooding (inland, coastal and sea level rise)	• What is the national policy on flood risk? • Which agencies are responsible for managing flood risk? • Which policies are responsible for addressing flood risk and how are these policies coordinated? • How does the policy address climate extremes and inland/ coastal flooding? • How could the objectives of the water or water related policy be impacted by inland or coastal flood events? • How does the policy address long term sea level rise as a risk to water resources management and water services? • Can the policy be amended to reduce the impact of flooding on water resources and water service provision?	• Develop a national policy or vision on flood risk • Ensure the policy clearly identifies the institutional responsibilities regarding flood risk management • Align related policies on land zoning, spatial planning, disaster risk with flood risk policies • Ensure water policies include objectives on flood risk management to enhance the resilience of water systems to flooding in existing and future assets • Ensure water policies include measures to manage the long term risks posed by sea level rise
Quality (pollution, sedimentation)	• What is the policy framework for managing environmental water quality? • How do water policies align with policies on environmental protection, pollution and health policies? • How do water policies address risks posed to water quality during droughts, flooding and other climate related events? • Does the policy consider long term changes in water quality due to climate change and development pressures? • Can the policy be amended to reduce the impact of droughts, flooding and other climate extremes on the quality of water resources?	• Ensure water policies include objectives on maintaining raw and treated water quality • Align water policies with environmental protection policies • Ensure water policies align with disaster risk policies and strategies • Ensure water policies are aligned with land management policies and these are strengthened to reflect the needs of water resources management

Questions and responses for resilient legislation and regulation

Legislation and regulation related to water is a broad topic area covering high level 'water laws' which address the basic principles of rights of usage and allocation and the related aspects of service provision and pollution control. In terms of climate risks it also overlaps with the authority of disaster management agencies in terms of drought and flood events.

Box 5.3 – Further resources on climate resilience through legal and regulatory instruments

Global Water Partnership Toolbox - Legal Framework (A2), Regulatory bodies and enforcement agencies (B1.05) and Regulatory Instruments (C6)

The GWP Toolbox section on Legal Framework (A2), Regulatory bodies and enforcement agencies (B1.05) and Regulatory Instruments for water resources management provides valuable lessons on legal and institutional roles and responsibilities which underpin sustainable water resources management and thereby enhance resilience to climate risks.

Source: Global Water Partnership Toolbox website available at http://www.gwp.org/en/ToolBox/TOOLS

IWCAM legislative toolkit

This Toolkit allows national legislative draftspersons and technocrats to work together in amending and/or drafting appropriate legislation in support of the core objectives of the Land Based Sources of Marine Pollution (LBS) Protocol. This guideline document, although prepared with direct relevance to the LBS Protocol, can be used in other SIDS regions, as a reference document when amending legislation in support of other Multilateral Environmental Agreements (MEAs). In the context of climate resilience it indicates the type of legislative amendments which can be used to reduce water quality risks to water resources systems.

Source: GEF-IWCAM. 2008b. Toolkit for Institutional, Policy and Legislative Improvements in Support of the IWCAM Approach in Caribbean SIDS. ISBN 978-976-95251-0-8. Available at http://www.iwcam.org/documents/technical-reports/toolkit-for-institutional-policy-and-legislative-improvements-iwcam-approach-in-caribbean-sids/view

WATER RELATED LEGISLATION AND REGULATIONS

Climate hazard	Potential questions on climate resilience	Potential response options
Drought	• Which legal and regulatory instruments relate to management of water resources? • How do the above legal and regulatory instruments address drought conditions? • How is water regulated and allocated during droughts including permitting systems and abstraction licences? • Do legal and regulatory instruments address the potential long term changes in climate which could impact on water availability • How might drought impact on the adherence of responsible parties to legislation/regulation regarding water? • Can the legislation/regulation be amended to enhance the resilience of its objectives to drought?	• Ensure legislation/regulation clearly addresses the allocation of resources between users including the roles and responsibilities of agencies involved • Ensure legislation/regulation can accommodate the variability in water availability in terms of prioritisation of user needs • Ensure the provision of abstraction licences is informed by data and is enforced during droughts • Ensure legislation/regulation includes provisions for water management during drought events • Ensure regulations require drought planning • Harmonise legal responsibilities of disaster risk agencies and utilities / water resources agencies • Ensure legislation/regulation takes a long term view of water resources allocation including the need to adapt to changing social, economic, environmental and climate changes • Ensure legislation promotes water efficiency to manage demand during droughts • Ensure water legislation separates the functions of water resources management from water services and water users • Set up regulatory agencies and empower these to enforce water resources management legislation
Flooding (inland, coastal and sea level rise)	• Which legal and regulatory instruments relate to flood risks? • Which organisations are responsible for managing flood risks and how are their roles defined? • Can the legislation/regulation be amended to reduce the impact of flooding on water resources and water service provision?	• Develop legal and regulatory instruments for managing flood risk • Ensure legislation/regulation is aligned with disaster risk policies and strategies, including flood risk management legislation and regulation • Ensure legislation/regulation is aligned with relevant planning and spatial development policies, legislation and regulation • Ensure legislation requires the use of flood hazard zoning in developing water supply plans and projects, especially regarding critical infrastructure in flood zones • Set up regulatory agencies and empower these to enforce flood risk and spatial planning legislation
Quality (pollution, sedimentation)	• Which legal and regulatory instruments address environmental water quality and pollution and how effective are these at managing water quality risks? • How does the legislation/regulation address risks posed to water quality during droughts, flooding and other climate related events? • Can the legislation/regulation be amended to reduce the impact of droughts, flooding and other climate extremes on the quality of water resources?	• Ensure legislation/regulation includes objectives on maintaining raw and treated water quality through setting standards and enforcement for pollution control and land management • Ensure water legislation/regulation align with disaster risk policies and strategies • Ensure water legislation/regulation are aligned with land management policies, legislation and regulation, and these are strengthened to reflect the needs of water resources management

Questions and responses for resilient water resources and services planning

Water resources planning is the technical process of assessing resources and allocating between user groups. In terms of water services it also covers strategic planning to ensure the supply and demand balance is maintained. Water resources planning should take into account the plans and strategies of other water dependent activities such as irrigation development and large scale private sector developments in tourism and industry.

Box 5.4 – Further resources on climate resilience through water resources and services planning

The Organisation for Economic Cooperation and Development - Strategic Financial Planning – The FEASIBLE tool

Water utilities often lack the necessary level of investment to maintain infrastructure, reduce leakage to acceptable levels and manage climate risks such as droughts and water quality risks associated with flooding. Strategic Financial Planning (SFP) provides an approach for understanding the multi-year financial flows required to support water utilities. As such it supports resilience of water systems through planned investment against changes in demand and the requirements for upgrade and maintenance of infrastructure. This OECD report describes the principles for financing as well as the FEASIBLE tool which was developed to assist utilities in SFP.

Source: OECD. 2011. Meeting the Challenge of Financing Water and Sanitation: Tools and Approaches, OECD Studies on Water, OECD Publishing. ISBN 978-92-64-12052-5 Available at http://dx.doi.org/10.1787/9789264120525-en

Global Water Partnership - Economic and planning tools for enhancing water efficiency

Improving water efficiency allows countries to reduce water scarcity and maximize the benefits provided by existing water infrastructure. It also frees up water for other uses and reduces environmental degradation. Efforts to improve water efficiency can therefore contribute directly to the development goals of many countries especially those that are chronically short of water or the capital to invest in water development. This paper provides a synthesis of the main options for enhancing efficiency within an IWRM context. It will assist water decision makers with developing plans which enhance efficiency of water use.

Source: GWP. 2006. Taking an integrated approach to improving water efficiency, Technical Brief No. 4 (2006). Available at http://www.gwp.org/en/ToolBox/PUBLICATIONS/Technical-Briefs/

WATER MANAGEMENT AND SUPPLY PLANS

Climate hazard	Questions on climate resilience	Potential response options
Drought	• What are the current systems for assessing and managing water resources? • What are the current systems for planning water services? • How does water resources management address drought risks? • How does water supply planning address drought risks? • What evidence from previous drought events is used to inform planning? • What are the planning objectives for maintaining water resources and water supplies during drought periods? • How is the potential for long term change in climate and water availability considered in planning? • How are future changes in demand for water considered in planning? • How are demand and supply side options considered when planning water supply?	• Develop a water resources planning and management framework if none exists including planning guidelines • Ensure water resources planning coordinates across user groups allocating and prioritising water during drought periods • Undertake data collection, hydrological modelling and mapping to provide the technical evidence and information to support water resources assessments • Develop scenarios of climate change and demand to inform water resources planning • Carry out strategic water supply planning making use of supply side (new infrastructure) and demand side (water efficiency) options for maintaining the supply demand balance, prioritised through cost benefit analysis and risk assessment • Promote measures to enhance efficiency and water demand management • Make use of innovative technology through pilot projects to identify areas for efficiency improvements or potentially new sources of water • Develop drought management plans which specifically address the actions to be taken in line with disaster risk management plans and institutions • Set in place a periodic review process for water resources and water supply plans to update • Undertake reviews of the impacts of past drought events on water resources and water services • Undertake modelling studies to understand the potential benefits and costs of investment options such as rainwater harvesting, leakage management and new infrastructure
Flooding (inland, coastal and sea level rise)	• How does water resources management address flood risks? • What are the primary impacts of inland and coastal flooding on water resources management and service provision? • How will long term sea level rise impact on water availability and service provision?	• Ensure water resources development plans screen significant capital works for flood risk at an early stage of plan development • Identify flood risks posed to the existing asset inventory (through current risk mapping and zoning) and including risk reduction measures in planning • Assess the risk of aquifer salinisation through sea level rise and over-abstraction of groundwater as part of strategic resource planning • Developing national and basin flood risk management plans, which integrate inland, coastal and sea level rise flood risks
Quality (pollution, sedimentation)	• How do drought and flood events impact on water quality and what are the impacts on water users? • How do water resources and water supply plans address risks posed to water quality during droughts, flooding and other climate related events? • Can the plans or planning guidelines be amended to reduce the impact of droughts, flooding and other climate extremes on the quality of water resources?	• Ensure water resources plans take water quality risks into account as well as water availability and demand during their development, such as development pressures on pollution discharges into watercourses • Ensure water resources plans explicitly address investments in pollution control and management to support sustainable water supplies • Ensure water supply plans link to land management regulations and other environmental regulations • Assess the risks to water quality posed by rising temperatures both in terms of environmental flows and waste water treatment processes

Questions and responses for resilient water resources financing and budgeting

This covers reviewing the expenditure of water service provision to identify where budget is being allocated to activities at risk from climate variability and change. In the context of water it also covers the economic tools (incentives and sanctions) which can be applied to enhance the resilience of water resources management and water service provision.

Box 5.5 – Further resources on climate resilience through budgetary and financial instruments

The Organisation for Economic Cooperation and Development - A Framework for Financing Water Resources Management

A lack of finance for water resources management is a primary concern for most OECD countries. This is exacerbated in the current fiscal environment of tight budgets and strong fiscal consolidation, as public funding provides the lion's share of financial resources for water management. This report provides governments with a framework to assess and strengthen the financial dimension of water resources management. It proposes a set of four principles to frame financing strategies for water management, with a specific focus on the potential role of economic instruments (OECD, 2012)

Source: OECD. 2012. A Framework for Financing Water Resources Management, OECD Studies on Water, OECD Publishing. Available at http://dx.doi.org/10.1787/9789264179820-en

EU Water Initiative Finance Working Group - Financing for Water and Sanitation A Primer for Practitioners and Students in Developing Countries

The EU Water Initiative Finance Working Group (EUWI-FWG) has produced a primer on conventional principles for water financing including tariffs, taxes, transfers and repayable funding sources. It includes a discussion on the application of each funding source and a discussion on leveraging finance.

Source: EU Water Initiative Finance Working Group (EUWI-FWG). 2011. Financing for Water and Sanitation A Primer for Practitioners and Students in Developing Countries. Available at http://www.euwi.net/files/EUWI_FWG_Primer_on_Financing_2011.pdf

FINANCIAL PLANNING AND BUDGETING FOR WATER MANAGEMENT AND SERVICES

Climate hazard	Questions on climate resilience	Potential response options
Drought	• What is the financial framework for water management in terms of costs and revenue streams? • What are the pricing incentives which are used and how do these support water efficiency? • How do drought events impact on the financial sustainability of water services? • What are the budgetary allocations for drought risk management including monitoring, management and planning?	• Implement economic sanctions and incentives for efficient water use for example, tariff structures and tax breaks on efficiency technology • Implement variable pricing strategies to manage water demand during droughts whilst maintaining equity of supplies • Assess the costs and benefits associated with drought risks and response measures to demonstrate value for money and attract finance • Ring fence funding for water resource management activities to enhance efficient and effective management of water during droughts
Flooding (inland, coastal and sea level rise)	• What are the costs associated with rehabilitating infrastructure following flood events? • How do flood events impact on the financial sustainability of water services? • What are the budgetary allocations for flood risk management including modelling, mapping, planning and construction of flood protection infrastructure? • Who should fund flood risk management and who is currently bearing the costs of flooding and flood management?	• Assess economic costs due to flood impacts in order to present the case for investment in managing flood risk to assets and avoiding additional future exposure to flood risk • Develop financing strategies for flood risk management building on a mix of domestic, bilateral and multilateral sources as appropriate
Quality (pollution, sedimentation)	• What is the financial framework for managing water quality risks and wastewater treatment to water services such as pollution of aquifers and surface waters? • How do water quality problems impact on the financial sustainability of water services? • Who should fund preventing pollution and who is currently bearing the cost of pollution problems? How can these costs be equitably distributed?	• Implement economic sanctions and incentives for pollution control and waste management for example, discharge consents and conditionality to finance environmental enforcement • Establish a financing framework for wastewater treatment and discharge, incentivising recycling where possible • Consider payments for environmental services in order to preserve quality of water sources • Raise awareness of the economic benefits of waste management and control in terms of avoided costs of water treatment and other considerations such as tourism and amenity losses from pollution

Questions and responses for resilient water related projects and processes

Water projects can include both municipal service infrastructure (storage, treatment, distribution, collection, wastewater treatment and disposal) as well as related infrastructure such as irrigation systems. In addition, it covers the operational practices and procedures for water management such as operational control rules.

Box 5.6 – Further resources on climate resilience in water projects and operational processes

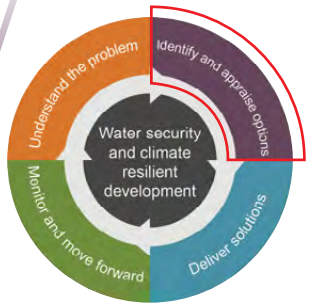
Global Water Partnership - Taking an integrated approach to implementing water efficiency

This GWP Technical Brief sets out some of the principle actions which may be undertaken to enhance the efficiency of water use. Improving water efficiency allows countries to reduce water scarcity and maximize the benefits provided by existing water infrastructure. It also frees up water for other uses and reduces environmental degradation. Efforts to improve water efficiency can therefore contribute directly to the development goals of many countries especially those that are chronically short of water or the capital to invest in water development

Source: GWP. 2006b. Taking an integrated approach to implementing water efficiency. Technical Brief No. 4. Available at http://www.gwp.org/Global/ToolBox/References/Taking%20an%20integrated%20approach%20to%20implementing%20water%20efficiency%20(GWP,%202006)%20ENGLISH.pdf

WATER RELATED PROJECTS AND PROGRAMMES

Climate hazard	Questions on climate resilience	Potential response options
Drought	• How are drought and climate change addressed in project preparation processes for water infrastructure? • What design standards are used to assess the performance of new infrastructure for water storage and supply? • How could water projects be impacted by drought and long term change? • How is drought managed in the operational processes of water resource management and service provision? • What are the monitoring and assessment data and tools available to support drought risk management?	• Consideration of the impacts of historical droughts on the performance of similar water projects • Analysis of historical hydro-meteorological data and to assess the resilience of projects to drought proportional to the scale of the investment being considered • Consideration of non-structural alternative or supplementary measures to achieve the desired outcome which are at lower risk of failure or disruption due to drought • Assessment of the potential risks posed by climate change through scenario analysis especially to long lived infrastructure investments • Consideration of operational measures to enhance resilience to droughts such as reservoir control rules or other practices aligned with disaster management • Promotion of non-structural measures to meet water demands such as efficiency measures, re-use and recycling of water • Diversify water sources to avoid over-reliance on a single source (surface / groundwater / desalination / recycling) • Develop drought early warning and monitoring systems and utilise these for triggering warnings and actions
Flooding (inland, coastal and sea level rise)	• How is flood risk addressed in project preparation processes? • What flood risk mapping (inland, coastal, sea level rise) and other information is used to assess the risk posed to new infrastructure developments? • How could water projects be impacted by inland and coastal flooding and long term sea level rise / coastal erosion? • What data and information on flood risk, such as flood risk modelling and mapping available to support planning decisions?	• Consideration of the impacts of historical flood events on the performance of similar water projects • Assessing the exposure of the planned project to flood events through flood plain mapping for the project areas in detail proportional to the scale of the investment being proposed • Produce flood plain mapping including climate change and sea level rise scenarios • Assessment of the potential risks posed by climate change through scenario analysis • Utilisation of available flood and hurricane risk warning • Revising design standards to include flood risk considerations and climate change allowances
Quality (pollution, sedimentation)	• How are potential impacts of droughts and floods on water quality assessed when developing new infrastructure? • How could water projects be impacted by water quality issues?	• Consideration of the impacts of historical water quality problems on the performance of similar water projects • Consideration of the performance of waste water treatment works under higher temperature scenarios • Identification of measures to reduce water quality risks through pollution control, waste management and reuse and land management practices.



Building on existing work to identify adaptation options

6

Key messages

- A growing body of information is available both regionally and internationally on the effectiveness of initiatives to enhance climate resilience
- The CCCCC website and information clearinghouse are valuable sources of case studies and lessons learned from past initiatives
- Pilot and demonstration projects can provide opportunities to replicate, upscale and transfer innovative approaches and new technologies
- Reviewing regional and international databases of climate change adaptation initiatives can identify potentially useful responses to address climate change risks

Sample tasks and activities

- Review past studies and risk assessments and identify recommendations which could be implemented to enhance resilience
- Evaluate the barriers which have delayed implementation of these actions and propose solutions to overcome challenges
- Working with stakeholders, transfer knowledge and ideas from successful projects in the region and in SIDS
- Review regional and international databases of climate change adaptation initiatives and evaluate whether initiatives being implemented in other SIDS and elsewhere internationally could be adapted to your local context

A growing body of examples and evidence is available both regionally and internationally on a wide range of initiatives for climate change adaptation and enhancing water management. Reviewing and taking the lessons learned from these initiatives can help to identify measures or actions which could be adapted to local contexts. This can include scaling up pilot projects, transferring ideas and innovation from other countries or sectors and revisiting past initiatives and plans to catalyse recommendations which have not been acted on already.

This section provides approaches for identifying adaptation options by building on the growing body of work on climate change adaptation and water management.

6.1. Reviewing past plans, policies and risk assessments to identify adaptation options

A growing body of work on climate change impacts and adaptation options is available at national and regional level within the Caribbean. These include region wide assessments such as National Communications to the UNFCCC and initiatives such as the CARIBSAVE Risk Atlas. In addition, risk assessments may have been carried out as part of national, sector specific or sub-national levels. These may provide recommended actions to enhance resilience.

The Implementation Plan for the Regional Framework for Achieving Development Resilient to Climate change (CCCCC, 2012) also contains a range of actions to enhance climate resilience identified by stakeholders across the region. This should be a first port of call for identifying actions as the document has a high level of buy-in regionally and amongst development partners.

Box 6.1 provides an example of the recommendations arising from a study into the impacts of climate change on water resources in the Caribbean. Strategic planning of water resources including the use of water resources assessments and supply and demand balancing studies are widely recommended to underpin sustainable water management.

Box 6.1 – Policy recommendations for enhancing the resilience of Caribbean water systems

- Demand-side management which may include incentives (and sanctions, where appropriate) for conservation and use optimization
- Comprehensive assessment of existing and future demands by sector
- Assessment, repair and replacement of aging infrastructure
- Forecasting and risk assessment of extreme events i.e. droughts and floods which impact communities and sectors in different ways and hence require different management approaches
- Resolution of allocation issues such as trade-offs, use rights and user-conflict e.g. potable use vs. irrigation needs; domestic supply vs. sale of water to cruise ships etc.
- Investment in research and development not only with respect to augmentation and 'new' technologies but also with a view to optimising the distribution system and reducing operational costs without compromising quality of service
- Monitoring for quality assurance and control
- Implementation of integrated watershed management practices which can play an important role in the rationalization of resource use and allocation and protection of sources (both surface and groundwater)
- Rationalization and updating of legislation paying attention to effective enforcement

Source: Farrell, D., Nurse, L. and Moseley, L. 2007. Managing Water Resources in the Face of Climate Change: A Caribbean Perspective. Available at http://www.eldis.org/go/home&id=60277&type=Document

Plans and strategies for natural resources management have been developed across the Caribbean by governments, international financial institutions (IFIs), regional bodies and NGOs. Some of these plans are implemented while others are shelved. Reviewing these plans to identify potential opportunities can catalyse existing commitments which have not yet been acted upon. For example, the GEF funded IWCAM project developed IWRM road maps for a St Lucia, St Vincent & the Grenadines, Grenada, Barbados and Antigua and Barbuda. Box 6.2 provides some examples of recommendations from St Lucia's IWRM road map on activities to support the implementation of IWRM. Since these actions have already been through the process of validation and agreement it may be easier to develop them into project concepts than for newly formed ideas which do not have the same level of buy-in.

Ask yourself...

What strategies and plans have been developed but not acted on? What opportunities do these present?

Box 6.2 – Recommendations from St Lucia's IWRM road map on activities to support the implementation of IWRM

- Conduct an island wide comprehensive Integrated Water Resources Assessment (IWRA). This must include: surface water, groundwater (river groundwater, deep groundwater)
- Conduct water demand assessments for various user groups for the future (2010, 2015, 2020, 2025) based on country's development plan
- Conduct assessment to quantify the impact of climate change on the water resources. This should include cost of implementation of adaptation measures
- Conduct an assessment for the development of a water augmentation plan as a climate change adaptation measure. Based on the outcome water augmentation options need to be assessed i.e. desalination, rainwater harvesting, wastewater re-use, storm water use etc
- Establish appropriate monitoring systems for fresh and coastal water quality
- Conduct an assessment of the adequacy of the institutional and legal framework to deal with IWRM issues
- Development of an IWRM Master Plan
- Development of Implementation Strategy for the National Water Policy, Coastal Zone Management Policy and Operationalisation of the Water and Sewerage Act
- Assessment of national water human resource requirements
- Review and Upgrade of existing IWRM information System
- Development and Implementation of a Public Sensitization Plan to cover the National Water Policy, the Coastal Zone Management Policy and IWRM

Source: GEF–IWCAM. 2008a. Towards the Preparation of an Integrated Water Resources Management (IWRM) Plan – Roadmap Saint Lucia, Financed under the Global Environment Facility-funded Integrating Watershed and Coastal Areas Management (GEF-IWCAM) Project. Available at http://iwcam.org/documents/iwrm-roadmaps/saint-lucia-iwrm-reports

6.2. Building on the lessons from case studies and ongoing initiatives

A wide range of projects and programmes aimed at enhancing resilience to climate variability and change have been completed or are ongoing across the region. The CCCCC coordinates climate change related project activities across the region and the website[1] and information clearinghouse[2] are valuable sources of case studies and lessons from past initiatives. Opportunities to build on these case studies and ongoing initiatives may include:

- Making use of stakeholder networks developed as part of past or ongoing initiatives to identify further opportunities
- Taking principles and approaches used in one country or sector context and transferring these into new initiatives
- Taking the knowledge and recommendations arising from past initiatives and using these as entry points to develop new initiatives

Ask yourself...

Which projects or initiatives have been successful in the past? Could these be replicated?

[1] http://caribbeanclimate.bz/

[2] http://clearinghouse.caribbeanclimate.bz/

Some of the more significant regional initiatives related to water management and climate resilience are highlighted below, although these are by no means exhaustive.

The Caribbean Planning for Adaptation to Climate Change Project (CPACC), Adaptation to Climate Change in the Caribbean Project (ACCC), Mainstreaming and Adaptation to Climate Change (MACC) and Special Program on Adaptation to Climate Change (SPACC) projects were a series of major regional projects aimed at enhancing the resilience of the Caribbean to climate change. Pilot projects implemented and policies developed under these projects provide valuable case examples of the types of actions which can be undertaken to enhance resilience to climate change. These case studies are available from the CCCCC clearinghouse website.

The GEF funded IWCAM project included demonstration projects enhancing land and water management at specific locations across the region. The IWCAM demonstration projects and activities provide useful examples of the types of solutions which can be implemented to enhance the resilience of water management and are available on the IWCAM website[3]. Furthermore, they highlight the benefits for land, freshwater and coastal management which can be realised by integrating land and water management.

CARIWIN is a project on Integrated Water Resources Management (IWRM) in the Caribbean, led by the Brace Centre for Water Resources Management at McGill University and the Caribbean Institute for Meteorology and Hydrology (CIMH), Barbados. Tools developed in CARIWIN could be taken up and applied by water managers in a country to enhance the resilience of water management and planning.

The GEF funded CReW project is focused on enhancing wastewater management in the Caribbean. Inadequate wastewater management damages freshwater and marine environments. In terms of water resources management, improving wastewater management can enhance the resilience of water sources by reducing pollution of surface and ground water sources so it is a key action to build climate resilience. More information on this project is available from its website[4].

The GWP-C WACDEP programme is underway and will involve undertaking demonstration projects. The GWP-C WACDEP programme specifically addresses water security and climate resilience in the Caribbean and will enhance the capacity of the region to respond, as well as providing valuable case examples and knowledge products for the region. Further information on the WACDEP programme can be found on the GWP-C website[5].

The Pilot Programme for Climate Resilience (PPCR) has funded a range of project activities across the region through the **Caribbean Strategic Programme for Climate Resilience (SPCR)**. The Caribbean SPCR is funding investments for climate resilience in six countries across the Caribbean (Dominica, Grenada, Haiti, Jamaica, St. Lucia and St. Vincent and the Grenadines). These will provide lessons and case studies from which to draw lessons for future activities. Further information on the activities planned under the SPCR can be found on the PPCR website[6].

6.3. Reviewing regional and international databases to identify opportunities for resilience

Internationally there are a growing number of databases which contain information on practical adaptation actions. Although not specific to the region (apart from the CCCCC clearinghouse) these can provide a useful reference point for learning more about climate change adaptation in general and the range of actions which different countries are taking to enhance their resilience to climate change. Table 6.1 summarises the main international resources which are available documenting climate change adaptation initiatives.

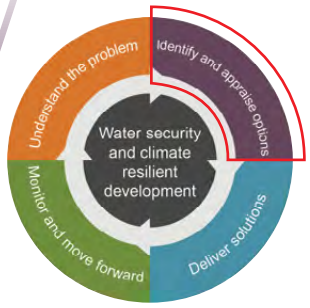
Ask yourself...

Do these sources of adaptation options provide you with innovative ideas for options in your own context?

[3] http://iwcam.org/
[4] http://www.gefcrew.org/
[5] http://www.gwp.org/en/GWP-Caribbean/
[6] https://www.climateinvestmentfunds.org

Table 6.1 - Synthesis of significant international databases of adaptation options

World region	Adaptation platform
Caribbean	The Caribbean Community Climate Change Centre stocktake of adaptation initiatives http://caribbeanclimate.bz/general/clearinghouse-search-tool.html
Pacific SIDS	The Pacific Climate Change Projects Database is intended to store and provide when required details of climate change projects and activities related to the Pacific Islands Framework for Action on Climate Change since 2006 http://www.pacificclimatechange.net/ SOPAC Water, Sanitation and Hygiene website http://www.pacificwater.org/
Worldwide	European Climate Adaptation Platform (CLIMATE-ADAPT) http://climate-adapt.eea.europa.eu/web/guest/home OECD Summary of climate change activities in OECD countries http://www.oecd.org/env/cc/adaptation-work-areas.htm UNFCCC NAP Central (under development at time of writing) http://unfccc.int/nap/ UNFCCC databases on adaptation practices, coping strategies, ecosystem based adaptation, tools and methods http://unfccc.int/adaptation/knowledge_resources/databases/items/6996.php We adapt – Provides resources and case studies on adaptation actions internationally http://weadapt.org GWP toolbox – provides case studies in IWRM implementation rather than climate change adaptation specifically http://www.gwp.org/ToolBox/ Knowledge Navigator - guide to online key climate change platforms http://kn.ids.ac.uk/ Adaptation Learning Mechanism - Provides resources and case studies on adaptation actions internationally http://undp.adaptationlearning.net/ IISD current and planned adaptation action in Africa, Asia-Pacific, and Latin America and the Caribbean http://www.iisd.org/adaptation/ap_review/



7

Prioritising adaptation options for implementation

Key messages

- Prioritisation can make use of techniques including multi-criteria analysis (MCA) and benefit-cost analysis (BCA) to provide a framework for assessing the performance of potential adaptation options
- Multi-criteria analysis is used in complex decisions where costs and benefits associated with each option are difficult to calculate or compare such as societal or environmental benefits
- Benefit-cost analysis is used where it is less challenging to convert all the different types of costs and benefits into monetary values for comparison and the economic performance of the option is considered of primary importance. Alternatively, cost-effectiveness analysis (CEA) is applicable where it is difficult to quantify benefits
- Specialised decision making techniques for climate change adaptation such as Robust Decision Making and Adaptive Management can be utilised for adaptation planning in some circumstances but are less widely understood and require specialist knowledge to implement

Sample tasks and activities

- Based on the adaptation options identified in earlier stages, identify the key stakeholders who should be involved in the prioritisation of these options
- Develop a series of criteria for the prioritisation of the adaptation options based on current decision making processes and the values which are important to the stakeholders involved
- Undertake a prioritisation exercise using one of the techniques covered in this section and develop a short list of high priority adaptation options synthesised into a succinct report which could be used to gain high level support from national and regional funding sources

A wide range of analysis techniques are available to help prioritise options for implementation. Each has its own strengths and weaknesses and the selection of the most appropriate technique needs to be considered on a fit for purpose basis.

This section discusses methods to assist with prioritisation including multi-criteria analysis (MCA), benefit-cost analysis (BCA) and cost-effectiveness analysis (CEA). In addition, some more specialised decision making techniques for climate change adaptation are introduced.

7.1. Selecting appropriate prioritisation techniques

Ask yourself...

What decision making tools are used when planning and budgeting for water resources and water services?

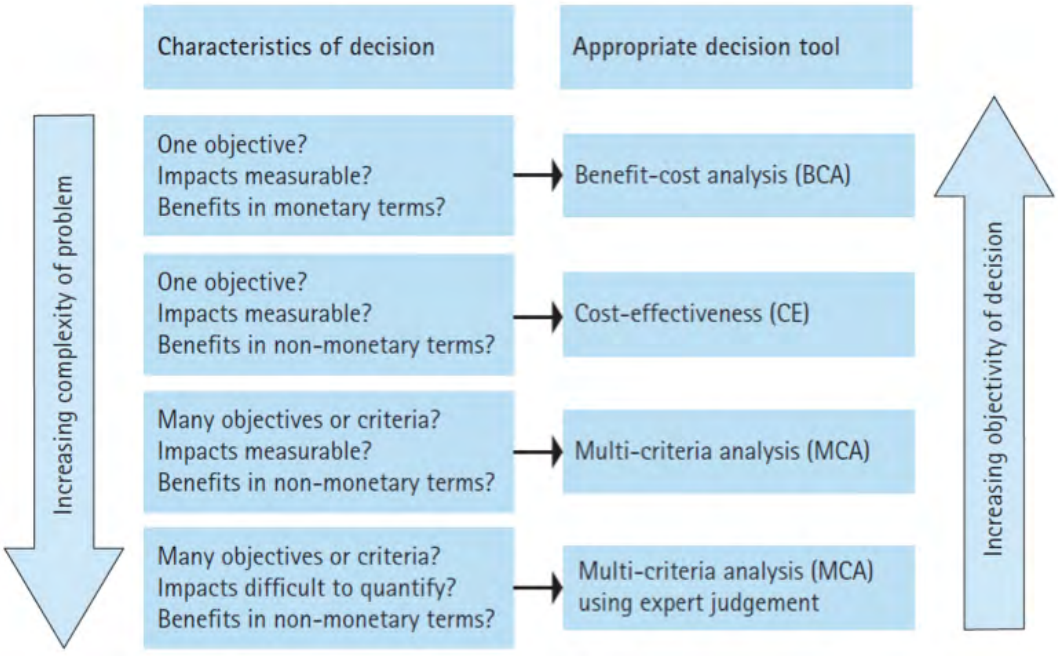
The aim of prioritisation is to determine whether an option should be implemented, and if several options are being considered, which of those should be implemented most urgently. BCA and CEA are single criteria methods which seek to calculate whether the return on investment is worthwhile using a single monetary value. Their application requires an assessment of the monetary value of the costs and benefits of each option.

In the case of natural resources such as water, calculating the monetary benefits of options such as legislative reform or watershed protection can be challenging. MCA uses a range of different criteria which are considered together using a simple scoring system to come to a conclusion on the priority of the options being considered. This allows criteria such as ecosystem protection to be considered without requiring a monetary value. However, this still requires assumptions to be made on the relative importance of each criterion. The characteristics of the decisions to be made determine which approach – MCA, BCA or CEA – is the most appropriate. Figure 7.1 summarises the main considerations to be taken into account when selecting an approach. Box 7.1 provides a discussion on the considerations when using BCA, CEA and MCA for a hypothetical example in the case of drought resilience.

The UNFCCC (UNFCCC, 2011) has produced more detailed guidance on the strengths and weaknesses of each approach in a useful reference manual (see Box 7.2)

Financial planners and funding agencies may be able to relate more closely to financial arguments than arbitrary scoring metrics. For example, the World Health Organisation (WHO) conducted a BCA on water and sanitation which concluded that provision of clean drinking water provides a benefit to cost ratio of 2.4, and for sanitation a ratio of 7.3, for Latin America and the Caribbean (WHO, 2012). This presents a strong case for action. However, the assumptions for monetisation of costs and benefits will need to be clearly presented. The results of a MCA will also have to demonstrate clearly that the full range of stakeholders and experts have been consulted in the analysis (AMCOW, 2012).

Figure 7.1 - Key considerations on the use of MCA, BCA and CEA for prioritisation UNFCCC (2011)



Box 7.1 – Considerations on the use of MCA, BCA and CEA for a hypothetical adaptation options example for increasing resilience to drought

In this hypothetical example several options have been developed to reduce the risk of droughts causing water supply interruptions to municipal customers served by a piped network. These include constructing a new surface water reservoir, providing financial incentives for rain water harvesting and running a programme of leakage reduction in the network.

Benefit-cost analysis would require an evaluation of the cost of reservoir construction and operation, the likely uptake of subsidised rainwater harvesting and the programme of leakage reduction. The costs of constructing the reservoir can be estimated relatively easily by obtaining outline costings based on preliminary studies. The costs of subsidising rainwater harvesting are difficult to estimate as uptake could be difficult to predict and subsidy arrangements are variable. The cost of a leakage reduction programme is largely dependent on the target identified for leakage reduction. In addition, the benefits of each scheme would have to be calculated. These benefits range from social and health benefits due to improved levels of service, economic benefits to businesses and tourism and in the case of rain water harvesting and leakage reduction, reduced network operation costs in pumping and treating water. The benefits are relatively diverse and difficult to assign value compared to the costs. In the case of public water supply, which is considered a human right, it is relatively difficult to assign a cost to the levels of service which customers should expect.

Cost-effectiveness analysis does not require assessment of the benefits, it assumes that the decision has already been taken to reduce drought risks and that the only consideration is achieving that objective for the lowest cost. In the case of the three options a cost effectiveness analysis could examine how much would have to be spent on each solution to achieve the same level of drought protection. The reservoir may cost $5 million but the subsidies to increase rainwater harvesting storage to the equivalent level may cost $6 million and the leakage reduction programme may be able to reduce losses to offset the need for a new reservoir for $1 million per year over four years. In this case the leakage reduction option may be the most attractive.

A **multi-criteria analysis** would take a broader look at the issues associated with each option. This could include for example, financing terms – it may be possible to obtain grant funding for rainwater harvesting subsidies while the reservoir would require more expensive commercial financing. Impacts of climate change – the reservoir and rain water harvesting may be impacted by reduced rainfall in future but the leakage reduction programme will be unaffected. Effectiveness – the increased supplies from building a new reservoir may be more easily calculated than the use of rainwater harvesting systems which are managed by the users themselves.

In practice such an investment decision would normally be subjected to an economic assessment using benefit cost or cost-effectiveness analysis together with some form of multi -criteria analysis to capture the other factors and uncertainties which the economic assessment cannot easily take into account.

Prioritisation techniques should be used to assess the sensitivity of projects with and without assumptions of climate change. This can indicate which options are likely to perform well under a range of future climates. Analyses should include sensitivity tests on other criteria to understand which assumptions are the most sensitive to change and should also involve 'switching values' to understand how changing assumptions can lead to changing decisions. Overall, this type of sensitivity testing provides additional understanding on the range of uncertainties within which the decision sits.

Box 7.2 – Further resources on prioritisation techniques for climate change adaptation

UNFCCC - Assessing the Costs and Benefits of Adaptation Options: An Overview of Approaches.

The United Nations Framework Convention on Climate Change (UNFCCC) guidance on assessing costs and benefits for adaptation provides a useful introduction to options appraisal in the context of climate change adaptation. It also presents case studies on the application of the various techniques.

Source: UNFCCC. 2011. Assessing the Costs and Benefits of Adaptation Options: An Overview of Approaches. The Nairobi Work Programme on Impacts, Vulnerability and Adaptation to Climate Change. Available at http://unfccc.int/adaptation/nairobi_work_programme/knowledge_resources_and_publications/items/5136.php

7.2. Multi-criteria analysis (MCA)

Multi-criteria analysis (MCA) is intended to aggregate measurements of benefits and costs that cannot readily be measured on the same scale; this requires the subjective weighting of the importance of the benefits and costs to allow their comparison on a common, usually arbitrary, scale. Table 7.1 gives an indicative example of this type of scoring system for the hypothetical example discussed in Box 7.1. In reality the determination of which criteria are relevant for decision making and how each is scored and weighted is an important consideration which can influence the outcome of the analysis substantially.

Table 7.1 - Indicative MCA scoring table for the hypothetical example in Box 7.1

Criteria	Score = 1	Score = 2	Score = 3	Option 1 Reservoir	Option 2 Rain water harvesting	Option 3 Leakage reduction
Cost	>$10 million	>$1 million	<$1 million	2	2	2
Effectiveness of performance	Uncertain	Acceptable	Well proven	3	1	3
Risk of climate change impacts	High	Uncertain	Low	1	1	3
Total score				6	4	8

MCA has the advantage of being a participatory process in which different stakeholders provide different responses allowing the level of consensus and agreement to be assessed. Even if a formal scoring system is not adopted, the use of criteria can form a discussion structure to raise some of the issues for and against different options.

Box 7.3 provides further resources for undertaking MCA.

Selecting criteria for an MCA and obtaining general agreement on their applicability is crucial to the results of the MCA being accepted. The UKCIP Adaptation Wizard (UKCIP, 2013) provides some general criteria but these should be adapted to each specific context:

- **Effectiveness** – Will the actions meet your objectives?
- **Efficiency** – Do the benefits exceed the costs?
- **Equity** – The action should not adversely affect other areas or vulnerable groups
- **Flexibility** – Is it flexible and will it allow for adjustments and incremental implementation?
- **Sustainability** – Does it contribute to sustainability objectives and are they themselves sustainable?
- **Practicality** – Can the actions be implemented on relevant timescales?
- **Legitimacy** – Is it politically and socially acceptable?
- **Urgency** –How soon could it be implemented?
- **Costs** – Consider social and environmental costs, not just economic
- **Robustness** – Is the option able to cope with a range of future climate projections?
- **Synergies / coherence with other strategic objectives** – Does it help to achieve other objectives?

Box 7.3 – Further resources on multi criteria analysis

UK Department for Communities and Local Government. 2009. Multi-Criteria Analysis: A Manual

The UK Government has put together a comprehensive manual on MCA for practitioners, which is a valuable resource for those considering using the technique for decision making.

Source: UK Department for Communities and Local Government. 2009. Multi-Criteria Analysis: A Manual. Available at http://www.communities.gov.uk/publications/corporate/multicriteriaanalysismanual

7.3. Benefit-cost analysis (BCA) and cost-effectiveness analysis (CEA)

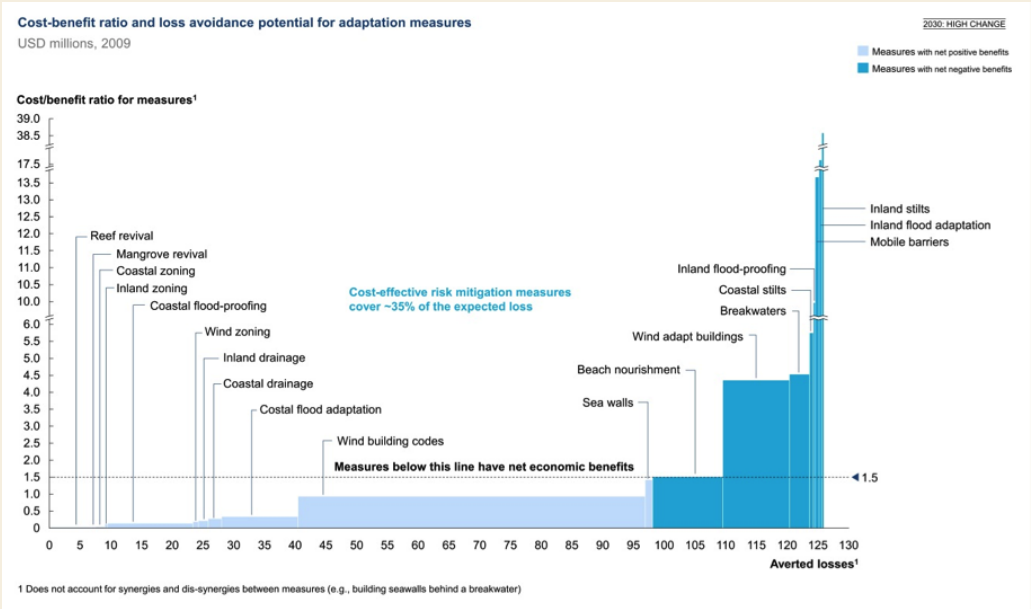
The most widely used single-criterion method is benefit-cost analysis (BCA) of individual projects in which a threshold value of the result (e.g. size of net present value, benefit–cost ratio or economic rate of return) is used to select candidate projects. The results would be in terms of economic value in the first instance but these financial results should also be tested since they affect public finances and could also determine the response of private agents to the proposed measures. BCA is a well-established method of project appraisal; ample guidance is available on its general use and its specific application to adaptation projects. However, BCA does not address the relative distribution of benefits and costs among different stakeholders and the choice of discount rate to deal with future costs and benefits is a deeply problematic area. Ensuring that social and economic costs and returns are included in the BCA and agreeing on their monetisation can be difficult but should be attempted. This is especially true in the area of natural resources management where externalities of development are far-reaching (AMCOW, 2012).

Another single-criterion method is the cost-effectiveness analysis (CEA) of a range of alternative ways of attaining the desired outcome. This is relevant where a country faces one or a small number of risks from climate change and is able to identify and cost the different ways of dealing with each of these risks. CEA is applicable where it is difficult to quantify benefits. The projects can be arranged on an ascending curve according to their cost per unit of 'benefit'. This is the basis of the adaptation cost curve by the Economics of Climate Adaptation (ECA) Working Group and this method has been applied in the Caribbean context by the Caribbean Catastrophe Risk Insurance Facility (CCRIF) (see Box 7.4)

Box 7.4 The Caribbean Catastrophe Risk Insurance Facility (CCRIF) results of the Economics of Climate Adaptation (ECA) Study

A component of the ECA study carried out by CCRIF provided a high level estimate of the cost effectiveness of adaptation options for eight pilot countries Anguilla, Cayman Islands, Antigua and Barbuda, Dominica, Barbados, Jamaica, Bermuda and St. Lucia.

This is a methodology for the identification, assessment and ranking of projects for the reduction of climate risk. It can apply to situations where there is a specific overriding climate related risk that can be addressed by a number of different policy responses. These responses may be alternative or cumulative in nature. The cost curve plots the quantitative impact of the various options on the problem (x axis) against their cost-effectiveness or cost per unit of benefit (y axis).



In the figure above, risk reduction options are presented for Barbados to reduce the negative impacts of climate change in 2030 under a high climate change scenario. The approach to assess the climate risks uses projections of future climate hazards (such as hurricanes) into the future as well as an assessment of the value of assets exposed to these hazards and the vulnerability of the assets (a measure of how much damage a hazard could inflict on an asset). Different adaptation options are then applied and their benefit-cost ratio together with the reduction in impact are assessed. The options are then ranked on a curve to indicate their cost-effectiveness. In the case of Barbados, the analysis indicates that reef revival, mangrove revival and coastal zoning can together avert ~$10 million in losses for a much lower cost making them attractive options. On the other hand mobile barriers, coastal stilts and breakwaters are more costly than the losses they would avert making them less attractive.

Although this assessment provides adaptation options for 2030, it would also be interesting to see a cost curve for the current climate risks. This would help identify those measures which are currently attractive and compare these with future adaptation options to identify changes in cost benefit ratio in the future. This could be used to make the case for actions to be undertaken regardless of climate change projections.

Source: CCRIF. 2010. Enhancing the Climate Risk and Adaptation Fact Base for the Caribbean: An informational brochure highlighting the preliminary results of the Economics of Climate Adaptation (ECA) Study. Available at www.ccrif.org

The study was implemented by CCRIF and regional partners including Caribbean Community Climate Change Centre and UN Economic Commission for Latin America and the Caribbean, with analytical support provided by McKinsey & Company and by Swiss Re, who developed the loss assessment model. It is based on the ECA framework developed by the ECA Working Group

While these decision making tools attempt to give an objective analytical framework for decision making, the realities and practicalities of decision making should always be borne in mind. Ways of ensuring solutions work on paper and succeed in practice include the following (based on GWP, 2006a):

- Making sure that the formulation team includes people with a broad range of practical experience
- Ensuring adequate stakeholder consultation and input
- Striving for transparent decision making processes
- Being aware of and linking into existing policy formulation and budgeting processes
- Keeping in mind the diverse, complex, and not always logical influences on human decision making and behaviour

Ask yourself...

Do these sources of adaptation options provide you with innovative ideas for options in your own context?

7.4. Specialised decision making techniques

In addition to the widely used decision making techniques discussed above, a growing range of more specialised techniques are being utilised for adaptation planning. These include Robust Decision Making, Real Options Analysis, Portfolio Analysis, Analytic Hierarchy Process, Social Network Analysis and Adaptation Turning Points (Watkiss and Hunt, 2013). These techniques can be used to assist in the identification of adaptation options, their prioritisation and the packaging of options into coherent strategies. However, they remain specialist tools which require an in-depth knowledge and may require substantial analytical work and supporting data. For this reason, this section introduces the key concepts behind some of these techniques which may be applicable in the Caribbean context and identifies sources of further information.

One cross cutting recommendation on the use of these techniques is to ensure their use is proportional to the risks under consideration. For example, Real Options Analysis was undertaken for a strategic planning study of managing flood risk to London from the Thames Estuary. This study was addressing a population within the floodplain of 1.25 million people and £200 billion in assets (Environment Agency, 2012) hence it warranted a highly technical and rigorous plan. In the Caribbean context, where populations, assets and resources are more limited the use of techniques such as Real Options Analysis may still be appropriate but thought must be given to the data and resource constraints being faced. Many of the principles of these specialised techniques can be adapted to make them appropriate for more rapid and less resource intensive applications.

Table 7.2 provides a summary of the 'traditional' decision making techniques of BCA, CEA and MCA as well as the more specialised techniques. Box 7.5 provides a reference to further material which gives background and examples of their application.

Box 7.5 – Further resources on specialised prioritisation techniques for climate change adaptation

European Union (EU) MEDIATION project Summary of Methods and Case Study Examples from the MEDIATION Project

The MEDIATION project guides researchers, policy advisors and experts to suitable climate change adaptation methods and tools for a wide range of questions and from various disciplines and perspectives.

Further information on the MEDIATION methodology, Adaptation Platform and training materials, which were developed for experts with basic technical or scientific knowledge rather than the general public, is available at *http://www.mediation-project.eu*

The MEDIATION Adaptation Platform contains a Toolbox of methods for decision making as well as a large number of other tools and techniques of relevance to climate change adaptation planning such as impacts assessment and scenario analysis. The Toolbox is available at *http://www.mediation-project.eu/platform/*

Table 7.2 - Summary of traditional and specialised decision making techniques (reproduced from Swart and Singh, 2013)

Decision support tool	Brief description	Usefulness and limitations in climate adaptation context
Social benefit - cost (BCA)	Evaluates all relevant costs and benefits to society of all options and estimates the net benefits/costs in monetary terms. BCA aims to directly compare costs and benefits allowing comparisons within and across sectors.	Most useful when: • climate risk probabilities are known • climate sensitivity is likely to be small compared to total costs/benefits • good-quality data exist for major cost/benefit components
Social cost-effectiveness analysis (CEA)	Compares relative costs of different options and can assess alternative ways of producing same or similar outputs, identifying least-cost outcomes using cost curves. Used extensively in climate change mitigation.	Most useful when: • as for BCA, but also applicable to non-monetary metrics (e.g. health) • agreement exists on sectoral social objective (e.g. acceptable risks of flooding
Multi-criteria analysis (MCA)	Allows consideration of quantitative and qualitative data using multiple indicators for integrating broad objectives (and related decision criteria) in a quantitative analysis. It provides systematic methods for comparing these criteria, some of which are expressed in monetary terms, some in other units.	Most useful when: • there are broad objectives and qualitative data (including non-monetary metrics) • there is opportunity/need for stakeholder input towards agreement
Real options analysis (ROA)	Extends principles of BCA to allow economic analysis of learning, delay and future option values providing context for decisions under uncertainty. Can also provide an economic analysis of benefits of flexibility and value of information on climate risks and actions.	Most useful for: • large, irreversible capital-intensive investment, with potential for learning (especially in case of long decision/construction lifetime) • climate risk probabilities are known or the range is within bounds
Portfolio analysis (PA)	Allows an explicit trade-off to be made between the return (measured, e.g., in net benefit terms from the BCA) and the uncertainty of that return (measured by the variance) of alternative combinations (portfolios) of adaptation options under alternative climate change projections.	Most useful when: • a number of adaptation actions are likely to be complementary in reducing climate risks
Robust decision making (RDM)	Aims to assess robust rather than optimal decisions and stress testing options against large numbers of future scenarios. Can work with climate uncertainty or in formal approach full system uncertainty. Can trade off economic efficiency against other criteria.	Most useful when: • there is deep uncertainty • scenarios for alternative climate, socio-economic and vulnerability futures can be constructed and data for their characterisation are available
Economic iterative risk management (adaptive management)	Iterative risk management (adaptive management) is an established approach that uses a monitoring, research, evaluation and learning process (cycle) to improve future management strategies extended to capture economic appraisal using conventional or alternative decision tools.	Most useful when: • climate risk probabilities are not well established or do not exist • there are threshold levels for risks (benefits expressed in quantitative or economic terms)

Taking options forward for implementation

8

Key messages

- Project preparation facilities help to ensure good project ideas and concepts are translated into bankable investment projects and programmes
- Integrating investments into existing development planning mechanisms and processes as a mechanism for carrying investments forward to implementation is more efficient and effective than having parallel streams of activity for climate resilience
- Ultimately, the aim is mainstreaming water security and climate resilience into development planning processes

Sample tasks and activities

- Review project preparation opportunities for taking adaptation options forward and working these up into bankable investment projects and programmes
- Integrate investments into organisational budgets, plans and work programmes at all levels
- Explore opportunities to mainstream climate resilience including internalising risk assessment and adaptation planning into national development planning process

Implementation requires working up adaptation options into bankable investment projects and programmes. Project preparation is often a part of a wider package of grant or loan financing which can assist national planners in translating ideas and concepts into bankable projects and programmes. Integrating options into existing plans and work programmes can also provide a modality for implementation. The latter is particularly well aligned to core elements of the Regional Framework for Development Resilient to Climate Change (CCCCC, 2009) including to *"Mainstream climate change adaptation strategies into the sustainable development agendas of the CARICOM Member States"*

This section provides insights into project preparation and the integration of investments into development planning processes. It also discusses the mainstreaming of climate resilience, and the role of tools such as CCORAL in supporting mainstreaming.

8.1. Preparing bankable investment projects and programmes

Implementation requires working adaptation options up into bankable investment projects and programmes. Adaptation options may vary considerably in their scale and the nature of the interventions required and this will determine how best to develop bankable investment options. They may include 'soft' options such as capacity development, technical studies, revising legislation and regulations or 'hard' options such as climate proofing infrastructure, restoring watersheds or other physical measures.

Ask yourself...

In your experience what are the barriers to preparing projects from ideas into bankable investments?

Options such as small scale technical studies to inform a regulatory review process will require less effort to prepare than a large scale programme of infrastructure development or renovation. The former may only require the development of a terms of reference and a logical framework setting out how the results will be utilised for positive benefits. The latter may require a much more involved process of prefeasibility, feasibility and detailed design. Support is available for these types of studies through multilateral channels such as the IDB (see Box 8.1).

Project preparation is closely linked to financing which is covered in Section 9. A supportive development partner or multilateral agency may offer project preparation resources as part of a wider package of grant or loan financing which will assist national planners in translating ideas and concepts into bankable projects and programmes.

Box 8.1 – Inter-American Development Bank (IDB)
Technical Cooperation Fields of Activity

The IDB provides support through its Technical Cooperation activities either as grants or loans to assist in project preparation, institutional strengthening, project implementation, planning and resources mobilisation. These are closely aligned with many of the tools and methods in the Sourcebook and are discussed in more detail below.

Preinvestment. The Bank provides technical assistance for the countries in the field of pre-investment helping them at various stages in the preparation of specific investment projects.

- **Basic Studies.** Economic and social studies to identify priority areas and studies of sectors, subsectors, and geographic areas to identify potential projects
- **Prefeasibility Studies**. Studies designed to examine viable project alternatives from the technical and economic standpoints
- **Feasibility Studies.** In-depth studies of the viable alternative that emerged from the prefeasibility study. If the alternative is found to be acceptable steps are taken to prepare the final design of the project
- **Final Design**. The orderly presentation of data relating to the project, duly adjusted. The design should also contain all the details relating to the feasibility, design, organization, and execution of a project in its technical, financial and legal aspects

Institution Strengthening. The Bank provides technical assistance for the creation, organization, and strengthening of institutions involved in the economic and social development process particularly those with responsibility for executing development plans and projects and those with responsibility for pre-investment activities. Technical assistance for institution building mainly bears on matters related to the creation or modification of institutions, organization, the design of systems and procedures, staff training and the adoption of new technology.

Investing Execution. The Bank provides technical assistance for institutions in charge of carrying out projects financed through Bank loans to ensure that:

- the techniques best suited to the management of financial and human resources are adopted;
- the technical and economic objectives of projects are attained

Development Planning. Technical cooperation in this field comprises activities that contribute to the improvement of:

- Institutional capacity to prepare general, sector, subsector and regional development plans.
- Coordination of institutions that work in the field of planning.
- Formulation of development policies and criteria for identifying high priority projects.
- Formulation of national pre-investment programs and preparation of specific technical cooperation requests.

Mobilization Of Resources. The Bank provides technical assistance for studies and measures related to the mobilization and management of domestic resources in general, fiscal policy and management and programming the use of external financial resources.

Source: IDB Basic guidelines General Operational Policies (policy 401). Available at http://www.iadb.org/en/about-us/basic-guidelines,6247.html

Project preparation will involve the development of a project or programme concept note by the proponent. This is a simple tool which communicates the main elements of the project including its scope and objectives as well as the intended impact and justification (in social, economic and/or environmental terms). This initial step results in a document which can be circulated to potential funding agencies or integrated into upcoming work plans or strategies within the proponent's organisation. Ideally the objectives of the project should be aligned with the proponent organisations strategic objectives and with the objectives of the potential financing agencies being targeted.

Project concept notes form a first step in getting the process of preparation off the ground. Subsequent steps vary depending on the institutional processes of proponents and financing agencies. Box 8.2 gives an example of the project preparation process which the IDB follows. This is intended as an illustration of the type of project preparation activities which are required by a lending organisation, each development partner and national government will have its own project preparation requirements.

Ask yourself...

In your experience what resources have been available internally and from the development community to develop project concepts?

Box 8.2 – Inter-American Development Bank Project Preparation process

The flow chart below summarises the project preparation process used by the IDB to develop initial project concepts (the project profile) into a bankable project which can be approved for financing. Further detail on each stage is available on the IDB website.

The Inter-American Development Bank has several facilities that support project preparation: the Project Preparation Facility (PPF), the Project Preparation and Execution Facility (PROPEF), the Infrastructure Fund (InfraFund), the Fund for Integration Infrastructure (FIRII), and the Fund for Financing Disaster Prevention (FDP).

Source: IDB Project Cycle: Preparation. Available at http://www.iadb.org/en/projects/preparation,1270.html

8.2. Integrating adaptation options into development planning processes

Once adaptation options have been identified and prioritised for implementation they will require integrating into existing plans and work programmes to provide a modality for implementation. Options which are clearly part of a coherent sector strategy or expenditure framework will be more likely to gain support from development partners as well as leveraging domestic sources of finance. The Implementation Plan for the Regional Framework (CCCCC, 2012) is clear in defining the lead implementation agencies for high priority actions, this section goes one step further in considering the planning mechanisms in which such actions can be integrated.

Adaptation options will often be additional components bolted onto planned development activities to ensure that climate variability and change is considered during development. For example, a programme of water supply improvements may have an adaptation option bolted on to carry out capacity development in drought management planning including the development of climate change scenarios. In such a case the adaptation option should be integrated into the implementation programme for the main project to ensure that objectives are aligned between the two.

Integration of adaptation options into organisations development planning processes will require a consideration of the following principal actions:

- **Ensure high level political support** for integrating options into relevant planning bodies and detailed planning processes. This provides a driver for planning authorities to carry through investments to the implementation phase
- **Understand the planning process** and find entry points to influence it at whichever planning level the adaptation option is most relevant. A summary of potential entry points is provided in Table 8.1
- **Identify 'windows of opportunity'** for detailed planning and implementation of options within existing plans and strategies (e.g. alongside the planned upgrading of existing infrastructure) or integrating longer-term adaptation options in strategies under review (e.g. strategic water resources planning)
- **Maintaining support** to planners through partnerships and capacity building to catalyse integration and capitalise on new skills and partnerships

Table 8.1 - Potential entry points to integrate adaptation options into planning processes

Planning level	Potential entry points
Regional	• Regional work programmes and projects
National	• National Adaptation Plans (NAPs) • National development plans and annual / medium term budgetary processes • Donor and Multilateral Development Bank country investment strategies • Sector strategies, policies and plans • Sector budgets and expenditure frameworks
Sub-national	• Municipal development plans and budgets • District and community plans and programmes of action • Watershed management plans

National and sector-level strategies and action plans are key tools for aligning resources with policy implementation. Strategy formation has its own 3–5-year cycles and each strategy will be at a different stage in different countries. The inclusion of already identified adaptation options to influence those strategies that are due for revision in the near future and focusing on priority sectors (which vary from country to country) will help to ensure resources are targeted towards water security and climate resilience.

Ask yourself...

What strategies, plans and budgetary instruments could provide entry points for adaptation options as a route to implementation?

Central ministries (e.g. economic planning and finance and/or the office of the prime minister) play a key role in allocations and arbitration among sectors. This includes the budget process which determines how much funding is received by sectors affected by water security and climate change. Presenting a well argued and economically justified case for sector investments in adaptation options which support national development goals is essential.

The national budget process is an important tool for promoting water security and climate resilience. While the national development strategy provides broad guidance, the national budget process is where the hard decisions over resource allocation – both recurrent and development spending – take place. Claiming climate resilience benefits in promoting sector or cross-sector strategies should provide opportunities to influence budgeting if the ministry of finance is fully engaged in the process.

8.3. Mainstreaming climate resilience

Mainstreaming is at the heart of the objectives of the Regional Framework for Development Resilient to Climate Change (CCCCC, 2009) in which Strategic Element 1 is to *"Mainstream climate change adaptation strategies into the sustainable development agendas of the CARICOM Member States"*

Mainstreaming is the desirable end point at which climate risk management including climate change adaptation is undertaken through existing development planning systems and processes. This avoids the tendency for climate change adaptation and climate risk management to be viewed almost as a separate sector rather than being of specific concern to development planners.

Ask yourself...

What are the successful examples of mainstreaming climate resilience in your context?

Mainstreaming involves making changes to existing systems of planning and decision making such that climate risks are managed as part of the day to day business of water management. The Caribbean Climate Online Risk and Adaptation TooL (CCORAL) provides an ideal entry point for mainstreaming as it works with existing processes to evaluate the adjustments required to enhance resilience.

Table 8.2 provides an illustration of mainstreaming in each case mainstreaming seeks to rationalise options for resilience into the existing decision making setting.

Table 8.2 - Examples of adaptation options and the mainstreaming required to ensure long term sustainability

Option for enhancing climate resilience	Mainstreaming activity
Developing national level flood risk mapping and spatial zoning policy	Ensuring planning application system requires the use of flood mapping and enforces the spatial zoning policy
Developing a drought management plan	Ensuring that the necessary triggers, responsibilities and resources are in place to activate the drought plan
Enhancing data collection from rivers and aquifers to support hydrological modelling	Legislating ring-fenced funding for long term monitoring, data management and modelling activities
Using CCORAL to screen decision making to identify climate risks	Embedding CCORAL in standard project appraisal processes

Mainstreaming will require adjustments to a range of decision making processes which should be considered together as a pathway to achieve the desired objective. This may encompass changes to policy and strategy, legislation and regulation, planning processes, budgeting processes and project preparation. Box 8.3 provides a high level resource for understanding more on the process of mainstreaming climate resilience.

A practical example of mainstreaming is exemplified in the water supply planning system used in the UK. This process requires water service providers to submit plans on a 5-year basis which set out how they plan to ensure water supplies are maintained over the next 30 years. The guidelines for developing these plans have been amended to require the use of climate change scenarios for water availability and water demand. Now when water service providers prepare their plans, climate change is a standard part of the planning process entirely integrated within the normal work programmes of water service providers and their consultants.

Box 8.3 – Further resources on mainstreaming climate resilience

The Organisation for Economic Co-operation and Development (OECD) has produced a policy guidance document that is the benchmark for confronting the challenge of mainstreaming adaptation within core development activities.

Source: OECD. 2009. Integrating Climate Change Adaptation into Development Co-operation: Policy Guidance. OECD Publishing, Paris, France. Available at www.oecd.org/dac/43652123.pdf

9

Identifying sources of finance to implement adaptation options

Key messages

- Global climate funds already represent a strategic source of funding for water sector planners working in CARICOM countries
- International climate finance has provided more funding to the Caribbean water sector than official development assistance self-labelled by donors as climate change-related.
- These global climate funds make strong contribution to water sector strategy development and technical studies
- Five global climate funds have disbursed over USD 14 million to the Caribbean water sector over the 3-year period 2010-2012.
- There are a number of other funds that may be relevant to water sector planners, including funds focussed on mitigation strategies through clean energy provision and forest conservation

Sample tasks and activities

- Use the Climate Finance Options website to identify potential funding opportunities for adaptation priorities and align these with the aims of the main climate funds
- Assess how these climate finance options compare with established bilateral sources of finance
- Hold a financing round table with Ministry of finance representatives and development partners including multilateral development banks, bilateral partners and climate change fund administrators to catalyse finance for priority adaptation options and programmes

International climate funds are of growing importance to the financing mix available to the Caribbean water sector. An understanding of the types of funds available, what they can be used for and how to access these funds is therefore important in developing appropriate financing strategies for climate resilient development options.

This section provides an overview of the financing options for water related investments and then looks in more detail at specialist climate change funds. It provides an overview of the scale and aims of these financing streams, as well as some of the main considerations in accessing climate finance.

Annex C provides further supplementary information on the trends in development and climate financing in the Caribbean region.

9.1. 'Traditional' financing sources

A financing principle for water service provision that has traditionally gained favour is that of the '3Ts' namely tariffs, taxes and transfers. If the basic revenues from the 3Ts are inadequate then other sources – loans, bonds and equity – which have to be serviced and repaid are not feasible. Such repayable sources are required for large capital investments such as infrastructure upgrades.

- **Tariff revenue** is the foundation of future cash flows and is normally the main source of funding for recurrent operations and maintenance expenses
- **Tax-funded subsidies** are widely used to supplement tariff revenues especially for rural services and public irrigation schemes
- **Transfers** originate from ODA provided by foreign governments and also from NGOs

Ask yourself...

How is water resources management funded in your context and how sustainable is this source of funding?

How can this sustainability be improved?

Water resources management performs a crucial function acting as the interface between the natural watershed and the various users who abstract and discharge water into it. Water resources management can be viewed as a public good and as such may be funded through taxes and transfers. However, the polluter pays and beneficiary pays principles are also valid in water resources management. These principles can use levies on users who discharge or abstract water through licences or consents to fund the management of the resources at least in part. In the Caribbean context the practicalities of financing and enforcing these principles remains challenging.

Box 9.1 – Further resources on financing investments for water security and climate resilience

Financing for Water and Sanitation A Primer for Practitioners and Students in Developing Countries

The EU Water Initiative Finance Working Group (EUWI-FWG) has produced a primer on conventional principles for water financing including tariffs, taxes, transfers and repayable funding sources. It includes a discussion on the application of each funding source and a discussion on leveraging finance.

Source: EU Water Initiative Finance Working Group - Financing for Water and Sanitation A Primer for Practitioners and Students in Developing Countries (EUWI-FWG, 2011). Available at http://www.euwi.net/wg/finance

Unlike water service provision, financing for flood risk management typically arises from tax funded subsidies and transfers rather than tariffs/user charges as it is considered a public good. In addition, flood risk against which it is uneconomic to offer publically funded protection can be offset using insurance (at the individual or national level) which itself may be subject to a level of public subsidy. The Caribbean Catastrophe Risk Insurance Facility (CCRIF) is an example of a regional level insurance mechanism which provides cover for hazards for which countries cannot finance protection domestically.

Box 9.2 – Further resources on financing for water resources management

OECD A Framework for Financing Water Resources Management (OECD, 2012)

Financing for water resources management presents particular challenges relating to the blurred lines between the public and private beneficiaries of water resources management related to the provision of water services, flood risk management, ecosystems preservation and pollution management. This OECD resource provides useful background guidance on the different approaches taken across OECD countries to finance water resources management.

Source: OECD. 2012. A Framework for Financing Water Resources Management, OECD Studies on Water, OECD Publishing. Available at http://dx.doi.org/10.1787/9789264179820-en

9.2. Appreciating the growing importance of climate finance

In recent years, global climate finance has provided more funding to the Caribbean water sector than Official Development Assistance (ODA) self-labelled by donors as climate change related.

Ask yourself...

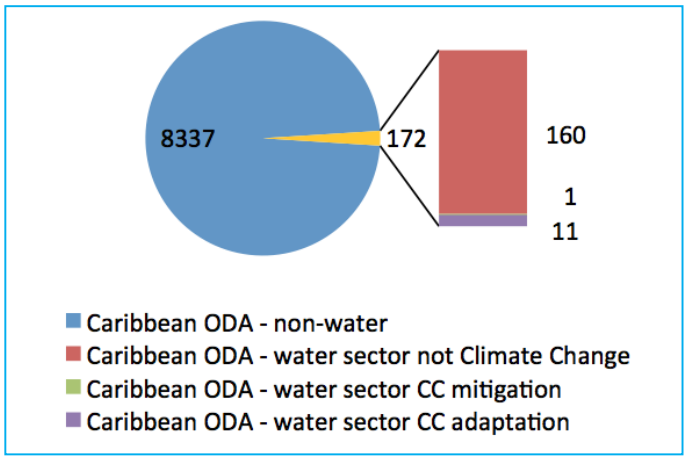
What is your experience with accessing ODA and specialist climate change finance?

What are the main barriers to accessing finance?

Over the 3-year period 2010-2012, the 15 members of CARICOM received a total of approximately USD 8.5 billion in external public funding as ODA[1]. Of that amount, USD 172 million went to the water sector (2%) defined as spending for water and sanitation, hydro-electricity and agricultural water resources (Figure 9.1). Of this total USD 12 million was reported as being climate change-related.

Adaptation dominated this climate change related spending, with USD 10 million (82%) targeting adaptation options, compared to USD 1 million for mitigation actions and USD 1 million for activities that had both adaptation and mitigation objectives.

Figure 9.1 - ODA disbursed to the Caribbean between 2010-2012 (USD million)

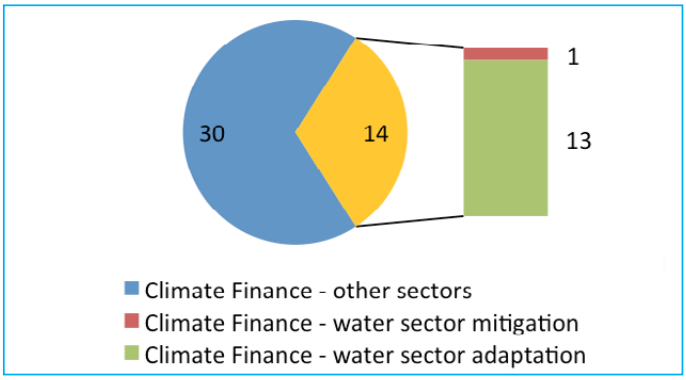


[1] The selection of this 3-year period is based on data availability of the most recent funding flows. The use of the Rio Marker for Climate Change Adaptation began in 2010 and the latest data available from the OECD CRS database is 2012.

Over the same period, support disbursed from global climate funds was approximately USD 44 million, from five funds to countries in the Caribbean. Of this amount, USD 14 million was targeted at the water sector (32%). Significantly, international funding from global climate funds disbursed a slightly higher amount over the period to the water sector than climate change-related ODA: USD 14 million compared to USD 12 million. It can therefore be seen that global climate funds already represent a strategic source of funding for water sector planners.

The global climate funds also made a stronger contribution to water sector strategy development and technical studies whereas the funding channelled through traditional ODA channels was focused primarily on infrastructure development.

Figure 9.2 - Climate finance disbursed to the Caribbean between 2010-2012 (USD million)



Examples of climate financed activities in the region are given in Box 9.3.

Box 9.3 - Examples of climate financed activities

Climate financing funded a range of activities in the region during the period 2010-2012 including:

- The Global Climate Change Alliance (GCCA) programme in Belize aims to increase the resilience of the water sector to potential climate change impacts and has as one of its expected results the institutionalization of the National Integrated Water Resources Authority within the Ministry of Natural Resources and the Environment.
- The Adaptation Fund (AF) intervention in Jamaica is aligned with the country's water sector policy. Although primarily focused on adaptation practices in the agricultural sector, the programme involves improved water management associated with small-scale irrigation schemes and the construction of a micro-dam.
- The Pilot Program for Climate Resilience (PPCR) has supported a number of eastern Caribbean states to improve their resilience to the impacts of climate change. Activities that have been supported include the development of water resource management plans (Dominica); water resource assessments (Grenada); and water resources conservation (St Vincent & Grenadines).
- Expenditure from the Least Developed Countries Fund (LDCF) project follows a similar approach to the AF intervention in Jamaica. The agricultural sector in Haiti is the main focus of the project that aims to improve watershed management practices.
- One Global Environment Facility (GEF) project was identified in Haiti that aims to support the development of small scale hydro power by removing current institutional, regulatory and information barriers.

9.3. Seeking opportunities to fund climate change related actions

Information on specialist climate change funding is available through online portals such as the Climate Finance Options website (see Box 9.4).

Box 9.4 - Further information on specialist climate change finance

Climate Finance Options website

Online platforms specialised in climate finance should be used by water sector planners as a primary search tool to evaluate different funding opportunities. Climate Finance Options is one such online platform that provides information on different sources of funding and provides access to tools that can assist water sector project developers in designing climate change projects.

Source: Climate finance options website available at http://climatefinanceoptions.org/cfo/index.php

Climate Fund aims and objectives

This section summarises the aims and objectives of global climate funds that have been recently been active in the Caribbean region.

Five global climate funds disbursed funding to the Caribbean water sector over the 3-year period 2010-2012. All these funds support countries in their efforts to increase resilience to climate variability and change. The Funds (in decreasing level of disbursements) are:

- The Global Climate Change Alliance
- The Adaptation Fund
- The Pilot Program for Climate Resilience
- The Least Developed Countries Fund
- The GEF Trust Fund – climate change focal area

Each Fund has specific aims and objectives which are outlined in the following paragraphs.

The Global Climate Change Alliance[2]
The Global Climate Change Alliance (GCCA) is a European Union (EU) initiative that became operational in 2008 to strengthen dialogue and cooperation on climate change between the EU and countries vulnerable to climate change in particular Least Developed Countries and Small Island Developing States (which includes all CARICOM countries). Rather than pooling contributions into a single fund, the GCCA uses the European Commission's established development cooperation channels to distribute funds to recipient countries.

The five GCCA priority areas are: (i) mainstreaming climate change into poverty reduction and development strategies; (ii) adaptation, building on National Adaptation Programmes of Action and other national plans; (iii) disaster risk reduction; (iv) reducing emissions from deforestation and forest degradation; and (v) enhancing participation in the global carbon market and Clean Development Mechanism.

Since 2008, the GCCA has supported 16 interventions in the water sector globally including one project in the Caribbean region in Belize. The GCCA is therefore an important source of funding to be considered by Caribbean water sector project planners as it directs a considerable volume of finance to the water sector and explicitly focuses on Small Island Developing States (SIDS).

[2] http://www.gcca.eu/

The Adaptation Fund[3]

The Adaptation Fund (AF) was established in 2001 to finance adaptation projects and programmes in developing countries that are Parties to the Kyoto Protocol (which includes all CARICOM countries). The stated objective of the Adaptation Fund is to reduce vulnerability and increase adaptive capacity to respond to the impacts of climate change including variability at the local and national levels. It seeks to achieve this objective by funding 'concrete' adaptation projects defined as 'a set of activities aimed at addressing the adverse impacts of and risks posed by climate change'. Funded activities need to produce visible and tangible results on the ground by reducing vulnerability and increasing the adaptive capacity of human and natural systems to respond to the impacts of climate change including climate variability. Activities supported by the Fund include water resources management which is a prioritised sector making up 32% of the present Fund portfolio. There is one Adaptation Fund project in the Caribbean at the present time in Jamaica.

The Pilot Program for Climate Resilience[4]

The Pilot Program for Climate Resilience (PPCR) became operational in 2008 and is a program of the Strategic Climate Fund. Moreover it is one of two funds within the Climate Investment Funds framework administered by the World Bank. The PPCR aims to pilot and demonstrate ways in which climate risk and resilience can be integrated into core development planning and implementation by incentivising scaled-up action and initiating transformational change.

Approximately 20% of PPCR approved funding globally has been directed to the water sector with water resources management ranking as the second highest sector in terms of approved funding coming second to agriculture and landscape management. However, Latin America and the Caribbean has received only 8% of the total amount approved and an even smaller share of this (as shown in Table 2) has gone to CARICOM countries. This will soon change as PPCR pilot countries each of which are expected to receive up to USD 5 million now include Dominica; Grenada; Haiti; Jamaica; Saint Lucia; and Saint Vincent and the Grenadines. This suggests that the PPCR fund managers are starting to diversify the geographic scope of their projects to include CARICOM countries.

The GEF Trust Fund[5]

The Global Environment Facility (GEF) Trust Fund is the longest standing climate change fund and since 1994 it has been an operating entity of the financial mechanism of the United Nations Framework Convention on Climate Change (UNFCCC). It is replenished every four years and is now in its fifth cycle (GEF5) with a budget of more than USD 1 billion for climate change projects. The main objectives of the current replenishment are to support the demonstration, deployment and transfer of innovative low carbon technologies; investment in renewable energy technologies; and the conservation and enhancement of carbon stocks through sustainable management of land use, land-use change, and forestry.

It can therefore be seen that GEF5 focuses mainly on mitigation activities. Funding to the water sector in the Caribbean has been limited to one small-scale hydro development project in Haiti which is expected to incorporate sustainable watershed management practices.

The Least Developed Country Fund[6]

The GEF also administers the Least Developed Country Fund (LDCF) established in 2002 with the aim of meeting the adaptation needs of least developed countries. Specifically, the LDCF has financed the preparation and implementation of National Adaptation Programs of Action to identify priority adaptation actions. As this Fund is restricted to LDCs and as Haiti is the only LDC within CARICOM support from this Fund to the region has been limited. However, with approximately 13% of the LDCF portfolio focusing on water resources management the water sector is an important area of the funds' interventions.

[3] https://www.adaptation-fund.org/
[4] https://www.climateinvestmentfunds.org/cif/node/4
[5] http://www.thegef.org/gef/trust_funds
[6] http://www.thegef.org/gef/LDCF

Other global climate funds not yet active in the Caribbean region

In addition to these five global climate funds that have a history of recent fund disbursement in the Caribbean region there are a number of additional Funds that may be relevant to water sector planners. These additional funds principally focus on mitigation strategies either through clean energy provision or forest conservation.

Clean Energy Provision Funds

The Clean Technology Fund[7]
The Clean Technology Fund seeks to promote scaled up financing for demonstration, deployment and transfer of low carbon technologies with significant potential for long-term greenhouse gas emission savings. Amongst its objectives, it aims to provide positive incentives through public and private sector investments for the demonstration of low carbon development and mitigation of greenhouse gas emissions; and fund low carbon programs and projects that are embedded in national plans and strategies, scaling up development and accelerating the diffusion and transfer of clean technologies.

The Scaling-Up Renewable Energy Program[8]
The Scaling-Up Renewable Energy Program in Low Income Countries (SREP) is designed to demonstrate the economic, social and environmental viability of low carbon development pathways in the energy sector in low-income countries. It aims to achieve a number of objectives including assisting low income countries foster transformational change to low carbon pathways by exploiting renewable energy potential; and to highlight economic, social and environmental co-benefits of renewable energy programs.

The Global Energy Efficiency and Renewable Energy Fund[9]
The Global Energy Efficiency and Renewable Energy Fund (GEEREF) aims to obtain benefits from the accelerated deployment of energy efficiency and renewable energy technologies. Specifically, it aims to achieve high leverage of public finance by offering preferential returns to private funds.

Forest Conservation Funds

The Forest Carbon Partnership Facility[10]
The Forest Carbon Partnership Facility aims to provide financial and technical assistance to assist countries in achieving emission reductions from deforestation and/or forest degradation; and build recipient country capacity for benefiting from possible future systems with positive incentives for REDD.

The Forest Investment Program[11]
The Forest Investment Program is designed to support developing countries' REDD efforts and promote sustainable forest management by initiating and facilitating transformational change in national forest related policies and practices.

The UN-REDD Programme[12]
The UN-REDD Programme aims are to generate the necessary flow of resources to significantly reduce global emissions from deforestation and forest degradation in developing countries.

Bilateral Funds

Three bilateral Funds that have been established by the UK, Germany and Norway respectively may also offer relevant funding opportunities to water sector planners in the Caribbean.

The UK International Climate Fund[13]
The International Climate Fund (ICF) is the primary channel of UK climate change finance. It aims to drive urgent action to tackle climate change by supporting low carbon growth and adaptation in developing countries.

[7] https://www.climateinvestmentfunds.org/cif/node/2
[8] https://www.climateinvestmentfunds.org/cif/node/67
[9] http://geeref.com/
[10] https://www.forestcarbonpartnership.org/
[11] https://www.climateinvestmentfunds.org/cif/node/5
[12] http://www.un-redd.org/
[13] https://www.gov.uk/government/policies/taking-international-action-to-mitigate-climate-change/supporting-pages/international-climate-fund-icf

Germany's International Climate Initiative[14]
Germany's International Climate Initiative finances and supports climate change mitigation, adaptation and biodiversity projects with climate relevance to help trigger private investments of a greater magnitude.

Norway's International Climate and Forest Initiative[15]
Norway's International Climate and Forest Initiative, aims to work towards the inclusion of emissions from deforestation and forest degradation in a new international climate regime. It supports the promotion of the conservation of natural forests to maintain carbon storage capacity.

A New Global Fund

The Green Climate Fund[16]
Finally, much international attention is now focused on the Green Climate Fund (GCF). This Fund was adopted as an operating entity of the financial mechanism of the UN Framework Convention on Climate Change (UNFCCC) at the end of 2011. Over time, it is expected to become a major multilateral financing mechanism to support climate action in developing countries.

Once operationalised the GCF is expected to contribute to the achievement of the objectives of the United Nations Framework Convention on Climate Change (UNFCCC). In the context of sustainable development the Fund aims to promote a paradigm shift towards low-emission and climate-resilient development pathways by providing support to developing countries to limit or reduce their greenhouse gas emissions and to adapt to the impacts of climate change. However, at the present time it is not clear when funding may become available from this new Fund.

9.4. Pragmatic considerations to be aware of when seeking funding

Each Climate Fund has specific funding allocation criteria which provide guidance as to the type of activity likely to be supported. The following paragraphs highlight considerations that should be taken into account by water sector planners when seeking funding for project proposals from the each of the five global climate funds already active in the Caribbean region.

Global Climate Change Alliance

The GCCA provides support to developing countries considered most vulnerable to climate change particularly the Least Developed Countries (LDCs) and the SIDS. The following eligibility criteria are used to guide funding decisions:

- The country must be a LDC or SIDS
- The country must exhibit vulnerability to climate change in particular a heightened risk related to floods, droughts, storms and sea level rise. The importance of the agricultural sector being one of the most sensitive sectors to climate change is also taken into account
- The country should have national and/or sector climate change policies in place or expressed its intention of preparing them to ensure the integration of climate change into development strategies, plans and budgets
- The government should be willing to enhance policy dialogue and cooperation on climate change with the EU and donors more widely
- The country should preferably be involved with and be politically active in the negotiations under the United Nations Framework Convention on Climate Change and in this sense serve as a model for other countries in its group/region

[14] http://www.international-climate-initiative.com/en/
[15] http://http://www.norad.no/en/thematic-areas/climate-change-and-the-environment/norways-international-climate-and-forest-initiative
[16] http://www.gcfund.org/home.html

There is also the possibility of supporting a regional approach when deemed more appropriate (e.g. due to the small size of the countries) and if the absorptive capacities of regional organisations allow for it (something for which the Caribbean countries would be well suited). Funding levels are then decided on a case by case basis.

Adaptation Fund

Decisions on the allocation of resources of the Adaptation Fund take into account the criteria outlined in the published Strategic Priorities, Policies and Guidelines of the Adaptation Fund (Adaptation Fund Board, undated), specifically:

- Level of vulnerability
- Level of urgency and risks arising from delay
- Lessons learned in project and programme design and implementation to be captured
- Securing regional co-benefits to the extent possible, where applicable
- Maximizing multi-sectoral or cross-sectoral benefits
- Adaptive capacity to the adverse effects of climate change

However, in practice the funding allocation has proven a difficult process as there are insufficient resources available to support programmes in all eligible countries. While efforts have been made to agree to a set of criteria to ensure a focus on the needs of the most vulnerable such as low lying coastal and other small island countries and countries with fragile mountainous ecosystems these have proved politically contentious and intractable in the absence of a global agreement on what factors make countries vulnerable.

The main drawback of the Adaptation Fund at the present time about which water sector planners need to be aware, is that there is a moratorium in place on access to the Adaptation Fund through multilateral organisations. This means that for the foreseeable future to secure funding from the Adaptation Fund countries will have to have an accredited national implementing entity of which there are only two in the Caribbean region, Jamaica and Belize. This suggests that funding from the Adaptation Fund is unlikely to be available for most Caribbean countries at least over the short-term.

Pilot Program for Climate Resilience

The PPCR does not have an established application process: recipients express an interest and an Expert Group selects country proposals according to pre-defined criteria. Country eligibility criteria include:

- ODA-eligible (as per the OECD-DAC guidelines)
- Presence of an active multilateral development bank country programme
- Extent to which country can be considered vulnerable to one or multiple climate risks; has relevant special needs as guided by agreed international processes and conventions. In looking at country vulnerability the Expert Group is also expected to consider country exposure, sensitivity (as a function of dependence of GDP on climate sensitive sectors), and adaptive capacity (being partly a combination of the country's human development index rating and governance factors)
- Extent to which the list of recommended pilot country is regionally representative so as to benefit from a pilot program
- Extent to which the group of recommended countries reflects the range of representative climate hazards (in terms of droughts, floods, tropical storms and storm surges) as appropriate to a pilot program

The number of Caribbean countries already selected as pilot countries suggests that many of these criteria are well demonstrated within the region.

GEF Trust Fund

A country is an eligible recipient of GEF grants if it is eligible to borrow from the World Bank or if it is an eligible recipient of UNDP technical assistance. Any eligible individual or group may propose a project that meets the following criteria:

- Consistent with national priorities and programs in an eligible country and endorsed by the government
- Addresses one or more GEF Focal Areas improving the global environment or advancing the prospect of reducing risks
- Consistent with the GEF operational strategy
- Seeks GEF financing only for the agreed incremental costs on measures to achieve global environmental benefits
- Involves the public in project design and implementation

The GEF has also established the System for Transparent Allocation of Resources (STAR) with specific rules and procedures for the financial allocations of the fund.

Common considerations

All the global funds share the following selection criteria:

- Vulnerability to specific risks (typically floods, droughts, and storms)
- Integration with development benefits and/or cross sectorial benefits
- Adaptive capacity of the country

This combination of criteria shows that these global funds allocate funding to countries that are vulnerable to the impacts of climate change but at the same time these countries need to show or have records of good governance systems in order to prove adaptive capacity. Another aspect prioritised in the funding allocation criteria is that the climate objectives of the activities supported have to be complementary to and well integrated with development ones and or promote cross sector outcomes. These three criteria are the main pragmatic considerations that should be taken into account by planners when seeking financing for their concepts.

Benefiting from results based monitoring and evaluation

10

Key messages

- Results-based planning methods are an effective means of laying the foundation for future monitoring and evaluation
- To be effective, monitoring and evaluation must be considered throughout the project cycle from design to completion and beyond into the long term impacts of the project
- Indicators for tracking progress should be SMART indicators (specific, measurable, attainable, relevant and timely)
- The aim should be to strengthen and adapt existing national monitoring systems to integrate climate change rather than developing a standalone system, thereby reinforcing mainstreaming
- Good baseline data are essential for effective monitoring
- Benchmarking is an effective tool to compare and contrast performance of water utilities and agencies

Sample tasks and activities

- Develop results-based frameworks for project implementation and ensure monitoring and evaluation are considered at the earliest stages of project and programme design
- Review existing monitoring indicators and data collection systems to identify how these can be utilised and adapted for monitoring water security and climate resilience impacts and outcomes
- Develop SMART indicators where possible building on existing indicators and data collection systems
- Establish good baseline data as a basis on which to monitor future progress and impacts
- Work with utilities and water management agencies to develop performance indicators which are appropriate to organisation's mission, national objectives and relevant multilateral environmental agreements

Sustainability should be a key consideration from the outset of any project and is an important factor for obtaining financing. Monitoring and evaluation provides a tool to set and measure outputs, outcomes and impacts of projects and programmes, supporting long term sustainability. A range of different results framework models are available for use for development planning and these provide a foundation for monitoring and evaluation throughout the project cycle.

This section introduces methods and concepts for effective monitoring and evaluation, with a focus on processes throughout the whole project cycle and a reinforcement of mainstreaming water security and climate resilient development.

10.1. Results-based monitoring and evaluation

Results-based frameworks link cause and effect to describe the flow of resources through an activity and how this leads to the desirable impact resulting from the activity. A range of different results framework models are available for use and as an example this section focuses on the Logical Framework approach which is widely used within development planning. A Logical Framework approach establishes a hierarchy of impacts, outcomes and outputs alongside verifiable indicators, means of verification and assumptions to track progress. They also provide a framework for monitoring and evaluation.

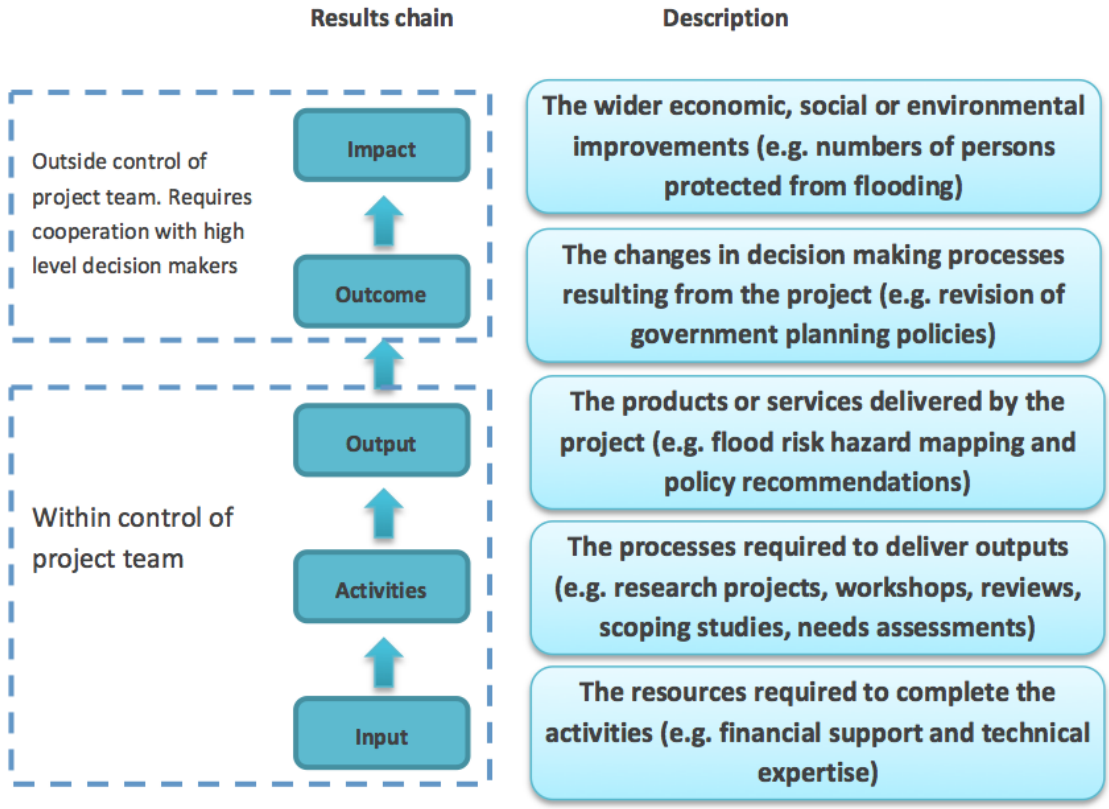
Ask yourself...

What are your positive and negative experiences of monitoring and evaluation systems?

Results-based planning methods

A high level conceptualisation of a results framework is presented in Figure 10.1. It provides a simple logical flow from the inputs to the desired impacts and can be used to clearly frame and discuss the various steps and challenges required to work back from the impact to the required inputs. Working back from impacts and outcomes means that projects are focussed from the outset on the strategic benefits which are desired, rather than considering only the shorter term outputs. Such approaches may struggle to capture the nuances and complexities of implementation, but they do provide a point of reference for all stakeholders.

Figure 10.1 - Conceptual results framework (adapted from UNDP, 2011)



One key aspect of the conceptual framework presented in Figure 10.1 is the difference in ownership between impacts and outcomes compared to outputs, activities and inputs. Inputs, activities and outputs are relatively straightforward to achieve and often form the basis of contracts with consultants and contractors who are given the responsibility for these near term outputs. Outcomes and impacts are subject to a much wider range of influences and uncertainties. For example, the revision of a policy may require a level of political leadership and high level consensus which is dependent on a range of factors which are outside the control of any one organisation.

Making the link into impacts is therefore a perpetual challenge and should be actively planned for from the outset. Obtaining national level demand and ownership of project activities and outputs as well as understanding the needs and drivers of policymakers is important.

Impacts and outcomes are key to the process of monitoring and evaluation as they form the starting point for considering what activities and outputs are needed in the first place. Impacts can be drawn from high level indicators such as national visions or sectoral strategies. It is therefore important that water security and climate resilience are reflected in these high level strategies to drive the demand for impacts and outcomes and thus for the outputs, activities and inputs which contribute to delivering the overall impacts. This links back into the alignment of adaptation options with high level strategies and objectives (see Section 3).

Ask yourself...

How do the outputs of your activities translate into positive outcome and impacts?

Monitoring and evaluation throughout the project cycle

To be effective, monitoring and evaluation (M&E) must be considered throughout the project cycle from design to completion. A solid plan for monitoring and evaluation must be completed in the design phase of a project whereby the M&E concern is to design a project that can be evaluated later. Throughout subsequent project cycle stages M&E continues to play a beneficial role as demonstrated in Table 10.1.

Table 10.1 - The benefits of effective M&E throughout the project cycle (reproduced from IDB, 1997)

The Stage	The Benefits - M & E
Project Design and Approval	• enables projects to build on experiences and lessons learned • helps projects incorporate best practices and suitable approaches • ensures collection of baseline data essential for monitoring progress • suggests measurable project indicators of success • provides a foundation for future efforts to monitor and evaluate performance
Project Start-Up	• ensures that approved loans become active while project design still valid
Project Implementation	• tracks ongoing project performance • provides early warnings of problems • encourages timely corrections • supports improvement and redesign • protects the investment
Project Completion	• provides data on the effectiveness of the original design • reports on results obtained • compares outcomes to baseline • yields lessons and best practices for future designs
Throughout the Cycle	Monitoring and evaluation provide opportunities for learning throughout the project cycle. Planning to learn and then using the lessons of experience to improve future performance are important aspects of building a learning organization.

The UNDP 'Handbook on Planning, Monitoring and Evaluating for Development Results' provides further background on monitoring and evaluation which is widely applicable, see Box 10.1.

Box 10.1 – Handbook on Planning, Monitoring and Evaluating for Development Results

The UNDP 'Handbook on Planning, Monitoring and Evaluating for Development Results' provides readers with a basic understanding of the purposes, processes, norms, standards and guiding principles for planning, monitoring and evaluation. Although specific to the UNDP development context, much of the content is generic good practice. The Handbook provides:

- an overview of the integrated nature of planning, monitoring and evaluation and describes the critical role they play in managing for development results
- an overview of the conceptual foundations of planning and specific guidance on planning techniques and the preparation of results frameworks that guide monitoring and evaluation
- guidance on how to plan for monitoring and evaluation before implementing a plan
- a focus on issues related to monitoring, reporting and review and key elements of evaluation design and tools and describes practical steps in managing the evaluation process
- practical steps and examples in using knowledge from monitoring and evaluation in managing for development results

The Handbook is not designed to be read cover-to-cover. Rather, it is intended to be used as a reference throughout the programme cycle.

Source: UNDP. 2009. Handbook on planning, monitoring and evaluating for development results. Available at http://web.undp.org/evaluation/handbook/

Defining SMART indicators

Indicators are required in monitoring and evaluation to determine whether activities, outputs, outcomes and impacts in projects and programmes of work have been realised. The selection of indicators is often critical and has potential implications for data collection systems. Indicators should be SMART (Specific, Measurable, Attainable, Relevant and Timely). Quantitative indicators are usually preferred but a narrative that draws together quantitative and qualitative findings can also be informative to high level decision makers. A range of assumptions will need to be met to secure the outcomes and outputs and these should be clearly identified. In addition to the routine monitoring, improved evaluation should also provide a focus on improved water security and climate resilient development. Examples of the use of indicators and assumptions can be found in the IDB monitoring and evaluation guidance, see Box 10.2.

Ask yourself...

What types of indicator are used to monitor performance in your context and are these 'SMART'?

Box 10.2 – Tools for evaluation and project preparation

The IDB has developed guidance on *Tools for evaluation and project preparation* which explain how evaluation can improve project design and planning, and can set the stage for evaluation activities throughout the project cycle. It begins by reviewing the steps to ensure that the project is addressing the relevant development problem and that it has a clearly defined purpose, as these two attributes are important for enhancing project performance and facilitating evaluation activities. The section also describes the evaluation products that are generated at the design stage of the project. It must be emphasized that at the project design stage some of the more vital aspects are:

- Establishing a clear understanding of the development problem
- Building into the project design lessons from previous operations
- Setting the stage within the project design for effective evaluation both during the monitoring and ex-post stages

Source: IDB. 1997. Evaluation: A Management Tool for Improving Project Performance, Inter-American Development Bank, Evaluation Office (EVO), March 1997. Available at http://www.iadb.org/ove/EngBook/engbook.htm

Tracking progress requires a baseline to be set which is normally the status of the indicator at the onset of the intervention. Good baselines are needed for effective monitoring and it is very difficult to track the progress/ success of interventions without reference to baseline data. This in turn may raise difficulties for funding agencies in terms of being able to demonstrate effectiveness of financing. The development of simple, measurable logical frameworks at an appropriate level of detail is an effective means of laying the foundation for future monitoring and evaluation.

10.2. Incorporating climate change in existing monitoring and evaluation systems

The impact of programmes on water security and climate resilient development should be monitored using the existing monitoring mechanisms in national planning systems to the greatest extent possible thereby reinforcing the mainstreaming of water security and climate resilient development. Existing systems vary greatly from country to country but most Caribbean countries already have high order monitoring frameworks and indicators associated with their national strategies (e.g. poverty reduction strategy papers) that provide a foundation for monitoring strategic goals and objectives. Results based budgeting systems in which government department declare a few key indicators against which progress will be monitored are desirable.

Ask yourself...

What are the national or sectoral reporting mechanisms and how might climate resilience be incorporated into these mechanisms?

This section gives two examples of monitoring and evaluation systems which can be used support climate resilience. The Sustainable Development Goals (SDGs) represent a high level monitoring framework, while utility benchmarking is much more focussed on the function of a single agency.

Aligning with the emerging Sustainable Development Goals (SDGs)

The Millennium Development Goals (MDGs) agreed by world leaders in 2000 have served as a shared framework for global action and cooperation on international development. As the 2015 target date for achieving the MDGs approaches the UN is working with governments, civil society and other partners to build on the momentum generated by the MDGs and shape a new development framework beyond 2015 that not only builds on the MDGs but also addresses weaknesses. These include: reflecting on previously omitted issues and developing a set of Sustainable Development Goals (SDGs) that would address in a balanced way all three dimensions of sustainable development – economic, social and environmental. There has been overwhelming support to ensure water issues are prioritised in the post-2015 development agenda and underpinned by appropriate quantifiable targets, see Box 10.3.

Box 10.3 - Proposals for the post-2015 development agenda - UN-Water

A broad goal to capture the fundamental importance of water for both humans and the environment is proposed. The proposed goal builds on and extends existing commitments such as the Millennium Development Goals and the priorities agreed at Rio+20. The goal provides an overall framework that is universally applicable, but also responds to particular national circumstances and addresses account costs, benefits and means of implementation. The framework, with a clear set of targets and indicators, can be tailored to the context and priorities of each country.

UN-Water proposals for a global goal of 'securing sustainable water for all' aims to reflect the multiple functions water plays in society and would be underpinned by five key targets as follows:

- Achieve universal access to safe drinking water, sanitation and hygiene
- Improve by (x%) the sustainable use and development of water resources in all countries
- All countries strengthen equitable, participatory and accountable water governance
- Reduce untreated wastewater by (x%), nutrient pollution by (y%) and increase wastewater reuse by (z%)
- Reduce mortality by (x%) and economic loss by (y%) from natural and human induced water related disasters

The suggested goals aim to promote: Universal access to safe drinking water, sanitation and hygiene, improving water quality and raising service standards; The sustainable use and development of water resources, increasing and sharing the available benefits; Robust and effective water governance with more effective institutions and administrative systems; Improved water quality and wastewater management taking account of environmental limits; and Reduced risk of water related disasters to protect vulnerable groups and minimize economic losses.

Source: UN-Water website. Available at http://www.unwater.org/topics/water-in-the-post-2015-development-agenda/en/

10.3. Benchmarking and performance measurement

The primary objective of benchmarking is to improve performance of water utilities by comparing with and learning from each other. Performance monitoring can also contribute significantly towards improved information and decision making in water utilities identifying performance shortfalls and effecting improvements through sharing of information and best practices. Ultimately, benchmarking will contribute to better water services and therefore make a valuable contribution to improved and sustainable water management.

Benchmarking indicators can be used to compare performance of water utilities and agencies over time. They also provide a common view of what the important objectives of these agencies should be. Examples of benchmarking indicators are given in Box 10.4

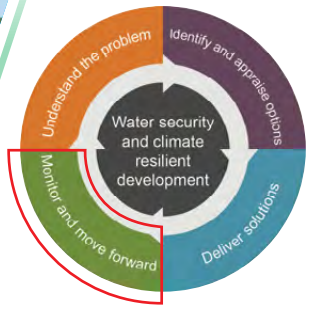
Box 10.4 - Practical water security indicators – an example from the United Kingdom

In the United Kingdom, the privatisation of water utilities has led to close scrutiny by regulatory authorities to ensure supplies are sustainable and affordable. Water utilities are required to report performance against a number of simple high level indicators which allows the regulator and customers to compare performance of utilities across the country and over time. Table 10.2 summarises these indicators and performance of the utilities as a whole across the period. While this level of detail may not be appropriate in the Caribbean context the indicators do provide a useful basis for measuring water security in social and environmental terms and could be adapted within the region. One aspect which is of interest from a climate resilience viewpoint is the water supply interruption indicator which shows a large jump from 120,000 to 700,000. This was primarily due to an unusually cold winter which damaged infrastructure interrupting supplies. This clearly demonstrates the impact of climate hazards on the UK water supply systems.

Table 10.2 - UK Water Company sustainability indicator summary for 2010-2011, (reproduced from Water UK, 2011)

Industry priority	Indicator	Measure	Units	Result 2010/11	Result 2009/10	Progress
Protect and promote public health	Drinking water (DW) quality	Compliance with DW standards, England & Wales	percentage	99.96	99.95	↑
		Compliance with DW standards, Scotland	percentage	99.83	99.78	↑
		Compliance with DW standards, Northern Ireland	percentage	99.79	99.74	↑
	Incidents of sewer flooding	Properties actually affected by sewer flooding	count	7,295	6,476	↓
	Reported accidents	Major/fatal accidents to employees arising whilst undertaking water company related activities	count per 1000 employees	1.20	1.20	Stable
Provide a high quality, reliable, and value for money service	**Water supply interruptions**	Properties with interruptions to supply (in excess of 6 hours in duration)	count	700,255	119,880	↓
	Water into supply	Total volume of water put into supply	Megalitre/day	17,395	17,261	↓
	Domestic water demand	Domestic water demand (measured)	litres/person/day	129.0	-	N/A
		Domestic water demand (unmeasured)	litres/person/day	159.2	-	N/A
	Cash interest cover	Sector cash interest cover ratio	Ratio	4.4	4.9	↓
Respond to climate change	Total energy use	Total energy used (annual)	Gigawatt Hour	9,016	9,012	Stable
	Renewable energy generation	Renewable energy generated by water and wastewater companies	Gigawatt Hour	877	665.0	↑
	Greenhouse Gas (GHG) emissions	Total GHG (from water supply, wastewater treatment, offices and transport)	Million tonnes CO_2 equivalent	5.01	4.95	↓
Reduce our impacts on the environment	Sludge management	Total waste water sludge	thousand tonnes of dried solids	1,464	1,698	↑
	Sludge use	Waste water sludge sent for recycling (agriculture, land reclamation, other)	percentage	80.3	70.8	↑
	Non-sludge waste	Other waste recycled	percentage	80.1	67.3	↑
	Total loss of water from the Supply Network	Total leakage	Megalitre/day	3,908	4,251	↑
	Status of Sites of Special Scientific Interest (SSSIs)	SSSIs in target condition (England only)	percentage	98.5	96.0	↑
		SSSIs in target condition (Scotland only)	percentage	69.3	70.3	↓
Earn the trust of the Community	**Convictions for environmental and public health offences**	Number of convictions (sector total)	count	47	42	↓
	Community investment	Total value of financial contributions to community during reporting year	£ thousands	8,359	8,742	↓

Source: Water UK. 2011. Sustainability indicators. Available at http://www.water.org.uk/home/news/press-releases/indicators2010-11



Learning lessons and communicating findings

11

Key messages

- Building resilience and adapting to climate change is an iterative process that benefits from continual learning and self-improvement
- Planning to learn and using lessons learned to improve future performance are important aspects of building a learning organisation
- Learning reviews support systems for self-improvement by identifying what has been done, what worked well and what could be improved upon
- Lessons from implementation should consider internal and external factors including strengths, weaknesses, opportunities and threats
- A critical aspect of any review process is to widely disseminate findings, thereby reinforcing regional learning and knowledge sharing

Sample tasks and activities

- Establish a learning review process including identification of an independent review team and the methodology and approach to be adopted
- Review of all sources of literature, project reports and other external sources to identify what went well and what could be improved
- Instigate a series of consultations and/or one-to-one review meetings with key stakeholders including high level advisors, senior officials, implementing agencies, funding bodies, target beneficiaries, NGOs and other key stakeholders
- Disseminate the findings of learning reviews widely and set-up mechanisms to monitor response and change as a result of the findings

Building resilience and adapting to climate change is an iterative learning process. Taking lessons from implementation both on the strengths and weaknesses encountered provides the basis for future improvements. This is especially true in the Caribbean context where regional sharing of experiences is essential given the relatively small size of the organisations involved.

This section provides guidance on preparing for learning reviews, application of assessment tools such as Strengths, Weaknesses, Opportunities, and Threats (SWOT) analyses and approaches for disseminating findings.

11.1. Benefiting from learning reviews

Planning to learn and then using the lessons of experience to improve future performance are important aspects of building a learning organisation and culture. Monitoring and evaluation provide opportunities for learning throughout the project cycle but dedicated learning reviews can also provide systems for self-improvement. Learning reviews aim to identify what has been done, what worked well and what could be improved upon. The quality and relevance of work undertaken including the effectiveness, accomplishments and potential impacts of past activities can be assessed from not only a technical viewpoint but also from governance and institutional perspectives. Typical activities for a learning review are highlighted in Box 11.1.

Ask yourself...

How does your organisation integrate lessons learned into future work?

Box 11.1 – Learning Review activities (example from GWP-Caribbean)

The GWP has established a system of Learning Reviews to provide a mechanism to help strengthen overall impact, assure quality and to enhance transparency and accountability of GWP's support to IWRM processes. Activities undertaken as part of their learning review process include:

- Review Team meeting to discuss and agree the review methodology and approach
- Review of documents, including a web-based reviews and collation of information
- SWOT analysis with a focus on:
    - value added to IWRM processes at regional and country level
    - main achievements and specific outcomes
    - long-term benefits of the support received
    - main governance issues and concerns
    - key challenges and opportunities to redress these
- High level consultation and feedback from Ministers and senior officials
- Group and one-to-one consultation and review meetings with key implementing agencies, funding bodies, target beneficiaries, NGOs and other key stakeholders
- Tele-conference and email communications with other key stakeholders in order to obtain a wide a range of opinions
- Consultations with relevant international and bilateral organizations /agencies
- Learning Review team de-brief
- Preparation and submission of the Draft and Final Learning Review reports
- Dissemination of findings

SWOT analysis is another useful analytical method to evaluate the strengths, weaknesses, opportunities and threats involved in a project, programme or other initiative. It helps to identify the internal and external factors that are favorable and unfavorable to achieving the project or programme objectives. The four quadrants of the analysis can be broadly defined as:

- Strengths: characteristics of the project that give it an advantage over others
- Weaknesses: characteristics that place the project at a disadvantage relative to others
- Opportunities: elements that the project could exploit to its advantage
- Threats: elements in the enabling environment that could cause trouble for the project

11.2. Disseminating findings and regional learning

A critical aspect of any review process is to ensure the findings are shared and disseminated widely thereby reinforcing regional learning and knowledge sharing. One of the best means to disseminate real experiences is through the use of case studies.

Cases submitted by practitioners and professionals from both the Caribbean or elsewhere can offer realistic lessons for others by giving examples of how methods, tools and approaches have worked in a given situation and context. A growing body of peer reviewed knowledge on water security and climate resilience including for the Caribbean is available through the GWP IWRM Toolbox, see Box 11.2.

Other channels for disseminating best practice to planners and decision makers could include:

- Regional meetings, conferences, workshops and other fora which allow presentation and interactive discussion of case examples
- Technical publications and mailing lists which target water professionals
- Communication of best practices to the next generation of decision makers can be undertaken through including case studies in higher education curricula
- A wide range of media can be used to target messages on success stories to the public at large, see CANARI (2009)

Ask yourself...

What are the best opportunities for sharing good practices regionally?

Box 11.2 – The Global Water Partnership (GWP) IWRM ToolBox, disseminating good practice

The IWRM ToolBox comprises an organized collection of case studies, reference documents, reader lists, external web sites and other supporting materials in water resources management, which have been submitted by various contributors and are peer reviewed including from the Caribbean.

The IWRM ToolBox is intended to be an information exchange platform where experiences are shared to help develop the body of knowledge which can enable all those engaged in water issues to work together to build water security and sustainable water for all. GWP has developed the ToolBox as a free access source of knowledge.

The ToolBox allows water related practitioners and professionals to discuss and analyse the various elements of the IWRM process and facilitates the prioritization of actions aimed at improving water governance and management. It aims to facilitate those professionals and specialists to engage with a broader community for the solution of (water related) problems.

The IWRM ToolBox is a free and open database with a library of background papers, policy briefs, technical briefs and perspective papers as well as huge sections of case studies and references.

The ToolBox also contains a wealth of tools for water management which support climate change adaptation and is a primary resource for those involved in water security and climate resilient development activities.

Source: GWP toolbox. Available at http://www.gwp.org/ToolBox/

Disseminating experiences within organisations and/or across programmes is also an effective means to share emerging best practice. In support of this many donors and International Funding Institutions (IFI's) have dedicated and independent evaluation units that aim to promote institutional learning and improve development effectiveness, see Box 11.3.

Box 11.3 – Sharing experiences and lessons learned

GEF and its partners have been proactive in coming together to share experiences and lessons learnt in the execution of GEF projects. The aim has been to disseminate this information for use in the development and implementation of future GEF projects, both in the Caribbean and elsewhere. Based on their review processes, a number of valuable experiences, lessons learnt, and best practices have emerged and these were subsequently developed into individual case studies or GEF experience notes. Topics have included participatory watershed management, indicators template development, design and implementation of a coastal monitoring programme, counterpart contributions, project implementation by a nongovernmental organization, selection of demonstration sites, and improving sustainability of project outcomes. The lessons learnt include those from the GEF-IWCAM project.

Source: See the report GEF IWCAM. 2012. Capture and Demonstration of Good Practice and Lessons Learned: Common Threads and Trends in IWCAM Demonstration projects. Available at http://www.iwcam.org/

The Office of Evaluation and Oversight is an independent body responsible for externally evaluating the Inter-American Development Bank's (IDB's) projects and performance. The evaluations are aimed at promoting institutional learning and improving IDB's development effectiveness. Evaluations are undertaken at a range of levels including evaluations of country programmes, sector and thematic programmes, and project impact levels. Project Evaluations evaluate performance and assess sustainability. They provide information to evaluate models underlying project design and can help determine whether to replicate interventions in other contexts or countries. Impact Evaluations contribute to institutional learning and expand the knowledge frontier regarding the real impact of interventions.

Source: IDB impact reviews. Available at http://www.iadb.org/en/office-of-evaluation-and-oversight/project-and-impact-evaluations,7093.html

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13

Acronyms

ACCC	Adaptation to Climate Change in the Caribbean
AF	Adaptation Fund
AMCOW	African Ministers' Council on Water
BCA	Benefit Cost Analysis
CANARI	Caribbean Natural Resources Institute
CARDI	Caribbean Agricultural Research and Development Institute
CARICOM	Caribbean Community
CARIRI	Caribbean Industrial Research Institute
CARIWIG	Caribbean Weather Impacts Group
CARIWIN	Caribbean Water Initiative
CAWASA	Caribbean Water and Sewerage Association Inc.
CCCCC	Caribbean Community Climate Change Centre
CCIC	Caribbean Climate Innovation Centre
CCORAL	Caribbean Climate Online Risk and Adaptation TooL
CCRIF	Caribbean Catastrophic Risk Insurance Facility
CDB	Caribbean Development Bank
CDEMA	Caribbean Disaster Emergency Management Agency
CDKN	Climate and Development Knowledge Network
CEA	Cost Effectiveness Analysis
CEHI / CARPHA	Caribbean Environmental Health Institute now the Environmental Health Unit of the Caribbean Public Health Agency
CERMES	Centre for Resource Management and Environmental Studies
CIMH	Caribbean Institute of Meteorology and Hydrology
CPACC	Caribbean Planning for Adaptation to Climate Change
CROSQ	CARICOM Regional Organization for Standards and Quality

CSGM	Climate Studies Group of the UWI, Mona
CTF	Clean Technology Fund
CWWA	Caribbean Water and Wastewater Association
EBP	Evidence-Based Policymaking
ECLAC	Economic Commission for Latin America and the Caribbean
EUWI-FWG	European Union Water Initiative Finance Working Group
FAO	Food and Agriculture Organization of the UN
GCCA	Global Climate Change Alliance
GCF	Green Climate Fund
GCM	General Circulation Model
GDP	Gross Domestic Product
GEEREF	Global Energy Efficiency and Renewable Energy Fund
GEF	Global Environment Facility
GEF-CReW	Caribbean Regional Fund for Wastewater Management
GEF-IWCAM	Integrating Watershed & Coastal Areas Management in Caribbean SIDS
GWP-C	Global Water Partnership Caribbean
ICF	UK International Climate Fund
IDB	Inter-American Development Bank
IFIs	International Financial Institutions
IISD	International Institute for Sustainable Development
INSMET	Instituto de Meteorologico de Cuba
IP	Implementation Plan
IPCC	Intergovernmental Panel on Climate Change
IWRM	Integrated Water Resources Management
LDCF	Least Developed Countries Fund
M&E	Monitoring and Evaluation
MACC	Mainstreaming Adaptation to Climate Change
MCA	Multi Criteria Analysis
MDGs	Millennium Development Goals
NAP	National Adaptation Plans
NCSP	National Communication Support Program
NGOs	Non-Governmental Organizations
NWC	National Water Commission, Jamaica
ODA	Official Development Assistance

ODI	Overseas Development Institute
OECD	Organization for Economic Cooperation and Development
OECS	Organisation of Eastern Caribbean States
PA	Portfolio Analysis
PPCR	Pilot Program for Climate Resilience
PRECIS	Providing Regional Climates for Impacts Studies
RCM	Regional Climate Model
RDM	Robust Decision Making
ROA	Real Options Analysis
SDGs	Sustainable Development Goals
SIDS	Small Island Developing States
SMART	Specific, Measurable, Attainable, Relevant and Timely
SOPAC	Pacific Islands Applied Geo-science Commission
SPACC	Special Programme on Adaptation to Climate Change
SPCR	Caribbean Regional Strategic Program for Climate Resilience
SRC	Scientific Research Council, Jamaica
SREP	Scaling-Up Renewable Energy Program in Low Income Countries
SST	Sea Surface Temperature
SWOT	Strengths, Weakness, Opportunities and Threats analysis
UKCIP	United Kingdom Climate Impacts Program
UNDP	United Nations Development Program
UNEP	United Nations Environment Program
UNESCO-IHE	United Nations Educational, Scientific and Cultural Organization - Institute for Water Education
UNFCCC	United Nations Framework Convention on Climate Change
UN-Water	United Nations inter-agency coordination mechanism for all freshwater and sanitation related matters
WACDEP	GWP-C Caribbean Water, Climate and Development programme
WB	World Bank
WHO	World Health Organization

14

Glossary of key terms

This section provides definitions for the terminology central to the sourcebook. The following additional resources are recommended for a detailed examination of climate change related terminology and are freely available online.

Box 14.1 – Further Resources on key climate change terminology

The IPCC provides an internationally consistent set of terminology related to climate change science, impacts and adaptation. Although these definitions may be adapted to local contexts, the overarching principles are transferrable and provide a common language for communicating climate change issues.

IPCC Fifth Assessment report Working Group 1 glossary of terms

This provides definitions addressing the physical science of climate change

Source: IPCC. 2013. Annex III: Glossary [Planton, S. (ed.)]. In: Climate Change. 2013. The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. Available at https://www.ipcc.ch

IPCC Fifth Assessment report Working Group 2 glossary of terms

This provides definitions regarding the impacts, vulnerabilities and adaptation associated with climate change

Source: IPCC. 2014. WGII AR5 Glossary. (note citation may be subject to change pending final copy edits of Fifth Assessment report, formal citation not available at time of writing) Available at https://www.ipcc.ch

IPCC SREX Glossary of terms

This provides information on terms associated with disaster risk management and climate change

Source: IPCC. 2012. Glossary of terms. In: Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation [Field, C.B., V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi, M.D. Mastrandrea, K.J. Mach, G.-K. Plattner, S.K. Allen, M. Tignor, and P.M. Midgley (eds.)]. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change (IPCC). Cambridge University Press, Cambridge, UK, and New York, NY, USA, pp. 555-564. Available at http://ipcc-wg2.gov/SREX/report/full-report/

Adaptation (to climate variability or change): Adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects which moderates harm or exploits beneficial opportunities. An adaptation assessment combines elements of impact and vulnerability assessments by examining the potential impacts of climate change on systems together with the system's vulnerability or capacity to adapt to changing conditions or added stresses.

Adaptive capacity: Ability of a human or natural system to: adapt, i.e., to adjust to climate change including to climate variability and extremes; prevent or moderate potential damages; take advantage of opportunities; or cope with the consequences. The adaptive capacity inherent in a human system represents the set of resources available for adaptation (information, technology, economic resources, institutions and so on) as well as the ability or capacity of that system to use the resources effectively in pursuit of adaptation.

Adaptation deficit: Failure to adapt adequately to existing climate risks largely accounts for the adaptation deficit. Controlling and eliminating this deficit in the course of development is a necessary but not sufficient step in the longer-term project of adapting to climate change. Development decisions that do not properly consider current climate risks add to the costs and increase the deficit. As climate change accelerates the adaptation deficit has the potential to rise much higher unless a serious adaptation program is implemented. Adaptation option: This term is loosely defined as any discrete action or initiative which supports adaptation to current climate variability or future climate change. Adaptation options can enhance the resilience and / or reduce the vulnerability of systems to climate variability and change or enhance the capacity of the system to adapt to future climate change.

Climate: The characteristics of weather (temperature, precipitation and wind patterns) which occur annually or seasonally usually averaged over a 30-year time period for planning purposes.

Climate change: This refers to a statistically significant change in either the mean state of the climate or in its variability persisting for an extended period (typically decades or longer).

Climate hazard: A climate hazard is a potentially damaging physical manifestation of climatic variability or change such as droughts; floods; storms; episodes of heavy rainfall, long-term changes in the mean values of climatic variables; and potential future shifts in climatic regimes.

Climate resilient development: Development activities that will deliver benefits under all potential future climate scenarios and can cope with uncertainties over future conditions. It differs from business-as-usual development in actively considering and addressing potential existing and future climate risks.

Climate risk screening: A process of rapidly assessing existing and future climate risks relating to a system such as a proposed investment option. It can be used to identify risks and resilient options for prioritisation. CCORAL is an example of a risk screening tool.

Climate variability: The departure of climate from long-term average values or changing characteristics of extremes for example, extended rainfall deficits which cause droughts or the prevalence of a greater than average rainfall depth occurring over a season.

Exposure (to climate hazards): The presence of people; livelihoods; environmental services and resources; infrastructure; or economic, social, or cultural assets in places that could be adversely affected.

Extensive risk: The widespread risk associated with the exposure of dispersed populations to repeated or persistent hazard conditions of low or moderate intensity often of a highly localized nature which can lead to debilitating cumulative disaster impacts. Extensive risk is mainly a characteristic of rural areas and urban margins where communities are exposed to and vulnerable to recurring localised floods, landslides storms or drought. Extensive risk is often associated with poverty, urbanization and environmental degradation.

'Hard' and 'Soft' adaptation: 'Hard' adaptation measures usually imply the use of specific technologies and actions involving capital goods such as dikes, seawalls and reinforced buildings whereas 'Soft' adaptation measures focus on information, capacity building, policy and strategy development and institutional arrangements.

Impact (of climate hazard): The effect of climate variability or long-term change on the functioning of a system. For example, an intense rainfall event may impact on agriculture negatively through crop damage. An impact assessment is the practice of identifying and evaluating in monetary and/or non-monetary terms, the effects of climate change on natural and human systems.

Integrated water resources management (IWRM): A process which promotes the coordinated development and management of water, land and related resources in order to maximise the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital eco-systems.

Integrating climate resilience: Refers to the near term inclusion of climate resilient investment opportunities in existing planning processes such as national or sector strategies, programmes and budgets.

Likelihood (of a hazard occurring): A probabilistic estimate of the occurrence of a single event or of an outcome for example, a climate parameter, observed trend or projected change lying in a given range. Likelihood may be based on statistical or modelling analyses, elicitation of expert views or other quantitative analyses.

Mainstreaming climate resilience: Refers to the long-term adjustment of decision making processes to include climate resilience concerns. This results in a pervasive improvement of the resilience of strategies, programmes, budgets and individual investments.

Maladaptation: An action or process that increases vulnerability to climate change-related hazards. Maladaptive actions and processes often include planned development policies and measures that lead to increased vulnerability in the medium to long-term for example, constructing new houses on a flood plain.
Mitigation: Refers to implementing policies to reduce greenhouse gas emissions and to enhance the capture and storage of greenhouse gasses.

No/Low-regret investments: No regrets investments will be unaffected by climate change and will deliver benefits under the full range of potential future climate change scenarios. Low-regrets investments are those which may be negatively impacted by climate change to some degree but will still deliver acceptable net benefits under the full range of potential future climate change scenarios.

Projection: A projection is a potential future evolution of a quantity or set of quantities often computed with the aid of a model. Projections are distinguished from predictions in order to emphasize that projections involve assumptions concerning for example, future socioeconomic and technological developments that may or may not be realized and are therefore subject to substantial uncertainty.

Resilience: The ability of a social or ecological system to resist, absorb, accommodate and recover from the effects of a (climate) hazard in a timely and efficient manner while retaining the same basic structure and ways of functioning. It reflects the amount of change a system can undergo; the degree to which it can re-organise; and the extent to which it can build capacity to learn and adapt.

Risk assessment: Risk is often defined as the combined probability and severity of an event occurring. For example, a highly likely severely hazardous event is considered high risk whereas a highly likely mild event (or unlikely but severe event) is considered medium or low risk. A risk assessment seeks to quantify the level of risk either quantitatively such as in monetary terms or qualitatively such as high, medium or low.

Robust decision making: Robust decisions are those made with consideration of uncertainty in this case, climate uncertainty. A robust decision will deliver the desired benefits under all potential future climate scenarios but will not necessarily be the optimal decision for any one single climate scenario.

Scenario: A plausible and often simplified description of how the future may develop based on a coherent and internally consistent set of assumptions about driving forces and key relationships. Scenarios may be derived from projections but are often based on additional information from other sources which are sometimes combined with a narrative storyline.

Sensitivity: This is the degree to which a system is affected, either adversely or beneficially, by climate related stimuli. The effect may be direct (e.g., a change in crop yield in response to a change in the mean, range, or variability of temperature) or indirect (e.g., damages caused by an increase in the frequency of coastal flooding due to sea level rise). A sensitivity analysis typically involves gaining an understanding of how varying climate to different extents (e.g., a 20% increase in annual rainfall) affects human or biophysical systems (for example hydropower production).

Uncertainty: An expression of the degree to which a value (e.g. the future state of the climate system) is unknown. Uncertainty can result from lack of information or from disagreement about what is known or even knowable. It may have many types of sources from quantifiable errors in the data to ambiguously defined concepts or terminology or uncertain projections of human behaviour. Uncertainty can therefore be represented by quantitative measures for example, a range of values calculated by various models or by qualitative statements for example, reflecting the judgement of a team of experts.

Vulnerability: The propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts including sensitivity or susceptibility to harm and lack of capacity to cope and adapt.. Note that this is the definition used in the IPCC Fifth Assessment Report (IPCC, 2014) which harmonises the definition of vulnerability used by the disaster risk and climate change adaptation communities.

Water security: Water security is defined as the capacity of a population to safeguard sustainable access to adequate quantities of acceptable quality water for sustaining livelihoods; human well-being and socio-economic development; for ensuring protection against water-borne pollution and water related disasters; and for preserving ecosystems in a climate of peace and political stability.

Annex

ANNEX A
Overview of climate change in the Caribbean

This section provides a synthesis of climate change projections across the Caribbean region based on International Panel on Climate Change (IPCC) reports and the results of regional studies. Four main types of change are discussed:

- Sea level rise
- Changing temperatures
- Changing seasonal rainfall characteristics
- Changing climate extremes

The implications of these changes for the Caribbean water sector are then outlined. However, detailed local knowledge of catchments and water systems is required to understand how these projections will impact at a local level.

Climate change will in many cases exacerbate current hazards and highlight the requirement for the Caribbean to consider, over the longer term, strategies to address changes in climate. The IPCC has released the first component of its Fifth Assessment report (AR5) which is the international benchmark for climate change science. This first report, referred to as the Physical Science Basis (IPCC, 2013a), deals with the physical science behind climate change while subsequent reports deal with the wider impacts, adaptation and mitigation issues.

The AR5 Physical Science Basis report provides updated projections of climate change building on the Fourth Assessment Reports (AR4) released in 2007. The climate change modelling behind the AR5 has been updated to reflect recent developments in climate change science.

This section presents some of the main climate change projections provided by the IPCC AR5 and other regional specific studies.

A.1 Rising sea levels

> *Sea level rise poses one of the most widely recognized climate change threats to low-lying coastal areas on islands and atolls (high confidence, robust evidence and high agreement)*
>
> ***(IPCC, 2014c)***

Global sea levels have been observed to rise by around 1.8mm per year over the period 1961-2003 (Bindoff et al., 2007) and the Caribbean is broadly in line with this trend (Simpson et al, 2012). The rate of rise has increased recently with the IPCC stating that it is very likely that the mean rate of global averaged sea level rise was 3.2 (2.8 to 3.6) mm per year between 1993 and 2010 (IPCC, 2013a).

Projections for future sea level rise derived from climate change modelling vary considerably depending on the assumptions on the volume of polar ice melt which contributes to ocean volume. The IPCC projections on sea level rise in the 2007 AR4 Report have been considered to be too low by recent authors, notably Rahmstorf (2007). The CARIBSAVE Climate Change Risk Atlas provides a useful synthesis of sea level rise projections for the Caribbean (Simpson et al. 2012) which are reproduced in Table A.1.

Table A.1 also provides the more recent IPCC AR5 sea level rise projections (IPCC, 2013a). Note that these are based on a slightly later reference period. The results indicate that IPCC projects of sea level rise have not only increased from AR4 but are not as extreme as those projected by Rahmstorf (2007). The projections provided in these tables illustrate the range of projections which should be considered rather than providing precise values. For example the CARIBSAVE Risk Atlas uses a simplified set of sea level rise projections (0.5m, 1m and 2m) to cover the uncertainty range.

Another consideration is the local land level changes which can either exacerbate or reduce the impact of sea level rise; this can occur as a result of tectonic uplift or subsidence of land masses and other local effects such as hydrocarbon or groundwater extraction. Such local effects should be considered when developing national level projections of sea level rise to assess the localised impacts of sea level rise.

Table A.1 - Summary of Caribbean and Global sea level rise projections from the Caribsave Risk Atlas (Simpson et al., 2012) and The IPCC AR5 report (IPCC, 2013a)

Source of projection	Mean Sea Level Rise (m)			Notes	Source
	0.5m	1m	1.5m		
IPCC Fourth Assessment Report range across B1 / A1B and A2 emissions scenarios	→ 0.13 - 0.56 m			Caribbean Mean Sea Level Rise (m) by 2100 relative to 1980-1999 (+0.05m relative to global mean)	Simpson et al. (2012)
Rahmstorf, 2007 (assumes a large volume of polar melt water)	- - → Up to 1.45m			Caribbean Mean Sea Level Rise (m) by 2100 relative to 1980-1999 (+0.05m relative to global mean)	Simpson et al. (2012)
IPCC Fifth Assessment Report range across RCP 2.5 (very strong climate change mitigation), RCP 4.5 (similar to AR4 B1 scenario), RCP 6.0 (approximately similar to AR4 A1B scenario) and RCP 8.5 (similar to AR4 A1F scenario)	→ 0.26 - 0.82 m			Global Mean Sea Level Rise (m) by 2081-2100 relative to 1986-2005	IPCC (2013)

In the context of water resources and water services, sea level rise could lead to the following impacts:

- Increased coastal erosion and flooding resulting in damage and loss of water related assets such as drainage infrastructure, outfalls and other assets located in coastal areas. Damage to infrastructure which supports water services such as power supplies and transport links could indirectly impact on water services
- Saline intrusion into coastal aquifers coupled with over abstraction of groundwater leading to reduced output or abandonment of water sources and the provision of alternative supplies
- Increased flooding of sanitation systems and of other pollutants leading to drinking water treatment problems and health problems

A.2 Increasing temperatures

> *Global surface temperature change for the end of the 21st century is likely to exceed 1.5°C relative to 1850 to 1900 for all RCP scenarios[1] except RCP2.6. It is likely to exceed 2°C for RCP6.0 and RCP8.5, and more likely than not to exceed 2°C for RCP4.5.*
>
> ***(IPCC, 2013b)***

Temperature is one of the climate change variables with the highest level of confidence in the direction of change. It is virtually certain that observations over the past century indicate globally rising temperatures (IPCC, 2013a). In addition, increases in global temperatures by the end of the 21st century projected by climate models are considered virtually certain (IPCC, 2013a). In this context, the question is not 'Is the Caribbean warming?' but rather 'How much warmer will the Caribbean become?'

A range of climate change experiments have been undertaken at the global and regional levels. The most recent IPCC AR5 projections are only available from broad scale global models whereas the AR4 data has been downscaled for the Caribbean at a higher resolution. Table A.2 provides a summary of the temperature projections available for the Caribbean as a whole. More detailed national level projections are also available for the AR4 group of global climate models through the CARIBSAVE Climate Change Risk Atlas.

Broadly, the projections indicate warming by the end of the 21st century of between 0.3 and 5 °C. This wide range of uncertainty encompasses climate modelling uncertainties and uncertainties in future emissions of Greenhouse gases.

Caribbean islands present an additional challenge in climate change modelling as their small size means they are poorly represented in the models. Since ocean surfaces are projected to warm less than land surface global projections which represent small islands as ocean surface may underestimate the local warming of the land surface.

Table A.2 - Summary of global and Caribbean regional temperature projections for 2100

Scenario description	Degrees warming	Baseline period	Source
	1°C 2°C 3°C 4°C 5°C		
Global AR5 (5% to 95% uncertainty)	0.3°C- 1.7°C RCEP 2.6 1.1°C- 2.6°C RCEP 4.5 1.4°C- 3.1°C RCEP 6.0 2.6°C- 4.8°C RCEP 8.5	1986-2005	IPCC (2013)
Caribbean (land and sea) AR5 (minimum to maximum range) (IPCC, 2013)	0.7°C to 2.4°C RCEP 4.5	1986-2005	IPCC (2013) (see Table 14.1)
Caribbean AR4 (minimum to maximum range)	1.4°C to 3.2°C A1B	1980-1999	Christensen et al (2007)
Caribbean regional modelling driven by AR4 global models (land only)	2°C to 4°C B2 2°C to 5°C A2	1980-1999	Campbell et al (2010)

[1] Representative Concentration Pathways (RCP) are the global emissions scenarios used by the International Panel on Climate Change (IPCC) in their Fifth Assessment Report. They range from major mitigation efforts (RCP2.6) to a high emissions scenario (RCP8.5)

In the context of water resources and water services rising temperatures could lead to the following impacts:

- Increasing demand for water for agricultural and domestic purposes (coupled with increased demand arising from population growth and changing consumption patterns)
- Reduction in water quality through increased algal and bacterial growth in surface watercourses
- Reduction in groundwater recharge and river flows due to higher evaporation rates leading to drier soil conditions exacerbating drought conditions
- Reduction in the dilution of pollutants and wastes in watercourses and aquifers which could contribute to environmental degradation, health risks and the need for more intensive water treatment

A.3 Changing seasonal rainfall

> *There is strong evidence that under most climate change scenarios water resources in small islands are likely to be seriously compromised (very high confidence)*
> ***(Mimura at al. 2007)***

Changes in rainfall are less consistent than temperature changes geographically and seasonally. This makes global or even regional projections of rainfall less useful than national level projections. However, this section can still usefully provide the high level information for the Caribbean as a whole. The other aspect to consider is the increased uncertainty in rainfall projections as compared to temperature. For instance, the IPCC rates increases in temperature globally as 'virtually certain' whereas its projection of reduced rainfall over the Caribbean is 'likely' (IPCC, 2013a). However, compared to many other world regions the IPCC is relatively confident in reduced rainfall over the Caribbean and many world regions do not show a clear trend in either direction.

Table A.3 provides a summary of the regional projections which are available based on the IPCC and regional downscaling. Note that more detailed national level projections are available through the CARIBSAVE Climate Change Risk Atlas.

Regional projections (Campbell et al. 2010) indicate the more severe reductions in rainfall will be experienced in the central and southern Caribbean while the northern Caribbean may experience increased precipitation overall.

Table A.3 - Summary of global and Caribbean regional precipitation projections for 2100 expressed as a percentage change

Scenario description	Annual average rainfall change (note that seasonal rainfall changes may be more extreme)				Baseline period	Source
	-50% Much drier	-25% Drier	+25% Wetter	+50% Much wetter		
Caribbean (land and sea) AR5 (25% to 75% uncertainty range)		-10% to -1% RCP 4.5			1986-2005	IPCC (2013, see Table 14.1)
Caribbean AR4 (25% to 75% uncertainty range)		-19% to -3% A1B			1980-1999	Christensen et al (2007)
Caribbean regional modelling driven by AR4 global models (land only)		-10% (-50% to +25%) B2 -20% (-50% to +25%) A2			1980-1999	Campbell et al (2010)

Note: For AR4 modelling large reductions were projected in the central Caribbean and increases in the north Caribbean. The triangular symbol ▲ indicates the regional average and the bar the range of results reported.

In the context of water resources and water services, changing rainfall patterns could lead to the following impacts:

- Reduced rainfall will also reduce groundwater recharge (coupled with higher temperatures and evaporation rates) as well as surface water flows, reducing the water available for human and environmental systems
- Projections of reduced rainfall would increase the frequency and severity of droughts (coupled with increased demand arising from population growth and changing consumption patterns). This would in turn impact on water dependent users resulting in economic, social and environmental effects
- Reduced rainfall will reduce the dilution of pollutants and wastes in watercourses and aquifers which could contribute to environmental degradation, health risks and the need for more intensive water treatment. This will be coupled with population growth and potentially increased or reduced environmental pollution depending on Caribbean countries policy choices with respect to water quality management

A.4 Changing storm characteristics

Projections for the 21st century indicate that it is likely that the global frequency of tropical cyclones will either decrease or remain essentially unchanged concurrent with a likely increase in both global mean tropical cyclone maximum wind speed and rain rates

(IPCC, 2013a) (note the Caribbean is agreement with this global trend)

Hurricanes and extreme rainfall already cause substantial disruption to Caribbean economies, societies and environments. The most recent IPCC AR5 projections for Caribbean and Central America broadly indicate a 'projected reduction in mean precipitation and increase in extreme precipitation with more extreme precipitation in tropical cyclones making landfall along the eastern and western coasts' (IPCC, 2013a). There are two key aspects to consider in terms of future hurricanes and extreme rainfall; the frequency of occurrence and the severity of the events when they do occur. The IPCC AR5 report concludes that the frequency of smaller storms (Category 1) may decrease and it is more likely than not that the frequency of Category 4 and 5 storms will increase. In addition, the maximum storm intensity and rainfall rate is projected to increase.

In the context of water resources and water services changing storm characteristics could lead to the following impacts:

- Increased coastal flooding and erosion (coupled with sea level rise) which could damage water related infrastructure such as drainage infrastructure, outfalls, treatment works and other assets located in coastal areas as well as auxiliary services such as power supplies
- Increased inland flooding and erosion of watercourses coupled with land degradation which could damage water related infrastructure such as dams, intakes, treatment works and pipelines as well as auxiliary services such as power supplies
- Increased occurrence of landslides which could damage infrastructure and contributing to sediment laden runoff; this is also linked to land degradation and inappropriate development
- Increased sediment in runoff and surface water which could lead to water system sedimentation and problems with water treatment and water quality. This is coupled with land degradation leading to erosion of top soils during heavy rainfall
- Increased wash off of wastewater from flooded sanitation systems and of other pollutants leading to drinking water treatment problems and wider environmental health issues

A.5 Conclusions

Water resources and water services are impacted by current climate variability through floods, droughts, hurricanes and other related climate hazards. Because water resources and services both rely on other sectors (such as energy) as well as support other sectors (such as tourism) the impacts are complex and interlinked. Impacts extend beyond the sphere of influence of the water sector and require cooperation between sectors in order to manage these interdependencies.

Climate change presents an additional challenge which is overlaid onto existing hazards. Broad trends for the Caribbean can be drawn out from the climate models such as warmer temperatures, higher sea levels, reduced rainfall and increased storm intensity but the uncertainty associated with some of these projections remains high. Given these uncertainties strategies are required which bring benefits under a wide range of future scenarios (referred to as no and low regret options) and which remain flexible to adapt to changes over time which are at present not well constrained.

Box A.1 – Further background information on the implications of climate change in the Caribbean

National level impacts of climate change - CARIBSAVE Climate Change Risk Atlas

The Risk Atlas provides valuable contextual information on the broad range of climate risks facing the Caribbean including those posed to water resources and water services. It also provides national level projections of climate change which are a valuable resource for decision makers to understand the broad range of risks at a national level.

Source: http://intasave-caribsave.org/resources/reports/

Box A.1 – Further background information on the implications of climate change in the Caribbean - cont'd

Impacts of climate change on water management in the Caribbean

This article presents a concise overview of the risks facing water management in the Caribbean. It evaluates the existing availability of water resources; the implications of the most recent climate change modelling for the Caribbean region; and the impact of climate change on existing service provision strategies.

Source: Cashman A., Nurse L., and Charlery J. 2009. "Climate Change in the Caribbean: The Water Management Implications," Journal of Environment and Development 19 (2009): 42–67.

Managing Climate Extremes and Disasters in the Water Sector: Lessons from the IPCC SREX Report

Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation (SREX) was commissioned by the Inter-governmental Panel on Climate Change (IPCC) in response to a recognised need to provide specific advice on climate change, extreme weather and climate events ('climate extremes'). This summary presents lessons from the SREX report digested for the water sector and is global in scope.

Source: Climate and Development Knowledge Network. 2012. Managing Climate Extremes and Disasters in the Water Sector: Lessons from the IPCC SREX Report. Available at www.cdkn.org/srex

ANNEX B
Key concepts on water security and climate resilient development

This annex supports users of the Sourcebook to gain a common understanding of the concepts and terminology used throughout the Sourcebook. It unpacks the concepts of water security and climate resilient development and what they mean in the context of the Caribbean water sector.

B.1. Defining water security for the Caribbean

Water security acknowledges the importance of water in sustaining social, environmental and economic growth and development as defined by UN-Water (see Box B.1) rather than as a narrow sectoral interest.

Water security is on the agenda for development partners and multilateral agencies such as the UN system. Caribbean countries should consider what water security objectives should be and how these align with current strategic objectives for the water sector.

Box B.1 The UN-Water definition of water security (UN-Water, 2010)

Water security is defined as "the capacity of a population to safeguard sustainable access to adequate quantities of acceptable quality water for sustaining livelihoods, human well-being and socio-economic development for ensuring protection against water-borne pollution and water related disasters and for preserving ecosystems in a climate of peace and political stability"

Source: For further information on water security see UN-Water and the Global Water Partnership (GWP)

In the context of the Caribbean, water security implies a range of objectives including:

- The management and allocation of water between users including the environment to balance social needs, economic development and environmental sustainability
- The provision of clean, reliable and sustainable rural and municipal water services to support the social wellbeing of the population and economic activities including business, tourism and industry
- The efficient and effective use of water for agricultural purposes which supports economic growth and livelihoods while maintaining the natural environment
- The protection of water supplies against disasters including hurricane damage, flooding and drought through design, preparedness and response to disaster events
- The sustainable management of watersheds to preserve the quality and quantity of water available for human and environmental use against human degradation and natural disasters
- The prevention and treatment of wastes and pollutants entering watersheds to preserve the quality of water supplies for human and environmental needs and the protection of the marine environment

Water security describes a high level objective for water management but it does not acknowledge how this is to be achieved. The principles and tools of Integrated Water Resources Management (IWRM) can be used to move towards water security without requiring an additional set of processes.

B.2. Defining climate resilient development in the Caribbean context

Climate resilience is a relatively well established concept in the Caribbean being the central theme of the Regional Framework for Achieving Development Resilient to Climate Change (CCCCC, 2009) and the accompanying Implementation Plan (CCCCC, 2012). The strategic vision of the regional framework is "a regional society and economy which is resilient to a changing climate". It is centred around the actions required to reduce vulnerability and ensure that economic, social and environmental development in the Caribbean is safeguarded from the adverse impacts of climate variability and change. Climate resilience encompasses both actions which help adapt to future climate change (adaptation) as well as managing existing climate hazards.

In the Caribbean context management of the immediate climate hazards is a high priority. However, the longer term trends in climate and resulting incremental impacts on the Caribbean cannot be overlooked. Therefore the identification of no and low regrets actions are recommended; these offer both short term benefits in reducing current risks while also helping to adapt to longer term changes in climate.

A climate resilient water sector in the Caribbean could imply the following objectives:

- Water resources planning and allocation systems which include processes to manage the impacts of droughts and consider long term climate change risks
- Water infrastructure which is resilient to climate related hazards such as flooding, landslides, storm surge and sea level rise amongst others
- Water service providers which provide a reliable and agreed level of service to their customers through periods of drought and other climate extremes to safeguard the wider economies and societal needs which they support
- Water management institutions which can measure and manage resources across users, including the flexibility to manage resources during drought and other climate extremes

Box B.2 – Further background information on water security and climate resilience

Global Water Partnership - Climate Change Adaptation and Water Management

This technical background paper introduces some of the key concepts around how water management and climate change adaptation are related, providing useful background information for non-climate change specialists.

Source: Sadoff, C and Muller, M. 2009. Water Management, Water Security and Climate Change Adaptation: Early Impacts and Essential Responses, Global Water Partnership, TEC Background Papers no. 14. Available at http://www.gwp.org/en/ToolBox/PUBLICATIONS/Background-papers/

IDB - Water security and services in the Caribbean

This paper gives a useful overview of the status of water security in the Caribbean and some of the main climate change related and non-climate related challenges which the region is facing. It provides a useful entry point on water issues for non-specialists.

Source: Cashman, A. 2013. Water security and services in the Caribbean (IDB Technical Note; 514) Available at http://www.iadb.org/en/publications/publication-detail,7101.html?id=67809

UN-Water - Policy briefs on water security and climate change adaptation

These policy and analytical briefs provide high level information on the key concepts related to water security and climate resilience providing a framing of the main concepts and an overview on the international discussion on these subjects.

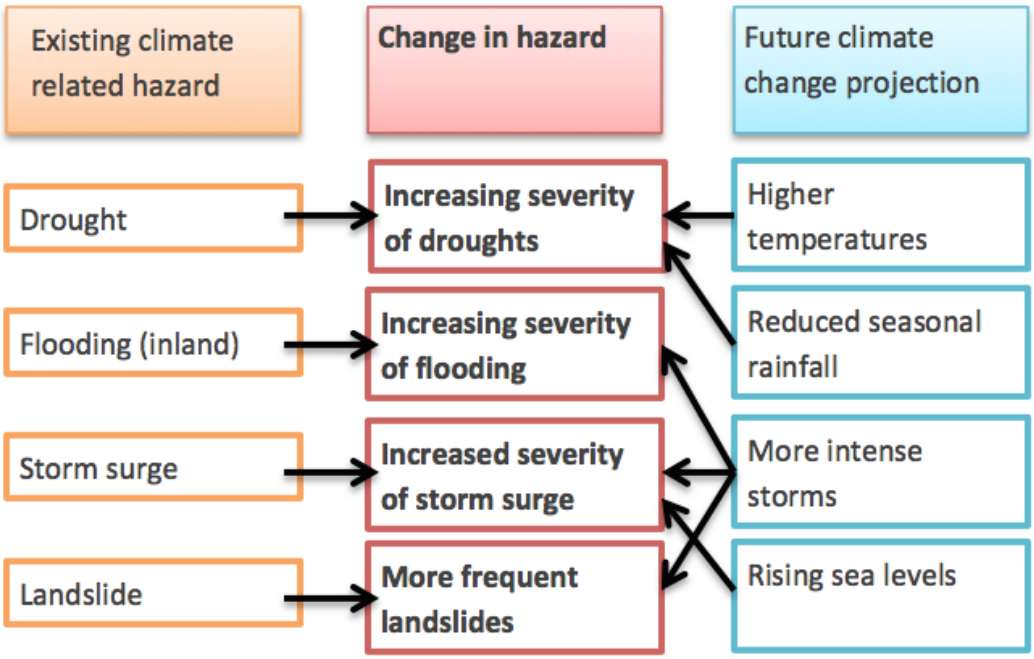
Source: UN-Water Policy and Analytical Briefs series. Available at http://www.unwater.org/publications/policy-and-analytical-briefs/en/

B.3. Relating current climate variability with future climate change

The Caribbean is exposed to both current climate variability as well as future climate changes. The economic, social and environmental impacts experienced during recent climate hazards such as hurricanes and droughts highlight the need for action to reduce these risks to acceptable levels.

Climate change must be considered in the context of existing levels of climate variability. For example, if drought is a hazard which frequently causes negative impacts, and climate change projects a reduction in rainfall, it is likely that the existing impacts will worsen in future. This means that disaster risk concerns should be integrated with climate change adaptation as the two are in practice closely linked. Figure B.1 provides an illustrative example of the links between existing hazards and how these are influenced by changes in climate. It highlights the importance of considering existing levels of risk first, before embarking on climate change adaptation.

Figure B.1 - Example of the links between existing climate related hazards (disaster risk) and climate change projections (climate change adaptation).



In addition, long term changes in average climate conditions could bring new problems for water management. Long term reductions in rainfall and aquifer recharge could reduce the average yield of boreholes. This means that strategic planning of water resource developments will need to take account of potential changes in climate.

The impacts of droughts, landslides and other climate related issues such as smaller scale flood events on society and environment are more difficult to quantify in such stark terms and are therefore less widely assessed. However, the impacts are likely to be most severe for poor and vulnerable communities which do not have the resources to prepare for such risks or manage their effects. This continued exposure to low levels of risk is a concept referred to as extensive risk[1] and is often underestimated because it is more pervasive than discrete events such as hurricanes.

Water is the primary medium through which climate change influences Earth's ecosystem and thus the livelihood and well-being of societies (UN-Water, 2010). Climate variability impacts directly on water resources and the water services for the many economic, social and environmental functions water supports. Therefore the impacts of drought for example, reach into many sectoral interests such as health, tourism, agriculture and industry. Flooding associated with storms and hurricanes can also impact these sectors through disrupting access to water supplies and through damage to water related infrastructure. This means that sustainable management of water requires input and cooperation from all water dependent sectors.

[1] Extensive risk: The widespread risk associated with the exposure of dispersed populations to repeated or persistent hazard conditions of low or moderate intensity often of a highly localized nature which can lead to debilitating cumulative disaster impacts. Extensive risk is mainly a characteristic of rural areas and urban margins where communities are exposed to and vulnerable to recurring localised floods, landslides storms or drought. Extensive risk is often associated with poverty, urbanization and environmental degradation. (UNISDR website http://www.unisdr.org/we/inform/terminology)

B.4. Vulnerability to climate change in the Caribbean

> *Given the inherent physical characteristics of small islands, the AR5 reconfirms the high level of vulnerability of small islands to multiple stressors, both climate and non-climate (high confidence, robust evidence, high agreement)*
>
> ***(IPCC, 2014c)***

Vulnerability describes the characteristics of a system which makes it susceptible to negative impacts due to climate hazards. The Caribbean water sector faces a number of vulnerabilities which are unique to Small Island Developing States (SIDS). In addition, the low lying mainland CARICOM countries possess a different set of vulnerabilities. These vulnerabilities specific to the Caribbean means that, tools and methods which may be appropriate in other world regions are not necessarily applicable in the Caribbean context. The Sourcebook attempts to identify and adapt methods which are useful to Caribbean decision makers.

Some of the Caribbean specific vulnerabilities and the broad actions to reduce these are highlighted below:

Relative impact of climate hazards: The small sizes of Caribbean countries means that when hurricanes and other hazards strike the proportional impact on economy, society and environment is much larger than for larger nations. The example of Hurricane Ivan resulting in damage equivalent to 227% of Grenada's GDP is a case in point. Working regionally is a key strength within the Caribbean and an important strategy for pool risks and resources through regional initiatives such as the Caribbean Climate Risk Insurance Facility (CCRIF) and the organs of CARICOM.

Land and water resource scarcity: The small size of many small island states and their topography limits the area of land for development which can put water resources into conflict with development and its attendant pollution and land degradation. The finite limit of water resource available on small islands also puts a constraint on the total volumes of resource available. The coordination of land and water management is essential in the Caribbean in order to ensure that urban and agricultural development; and water resources and coastal management are working together and not impacting negatively on one another.

Financial and technical resource constraints: Caribbean countries require the technical and financial resources to undertake water resources management, water services planning, flood risk management and climate change adaptation. In the Caribbean these activities are carried out in the context of limited financial resources to deploy specialists in these areas and small teams are required to undertake a wide range of responsibilities. Working regionally to pool expertise and harmonise tools and methods such as the use of CCORAL is an important strategy to ensure countries are making the most efficient use of limited resources.

Box B.3 – Further background information on the implicationsof climate change in the Caribbean

Surviving Climate Change in small islands: A guidebook

This guidebook provides an overview of the climate change risks and vulnerabilities posed to Small Island Developing States. It also outlines the processes for developing adaptation strategies and their implementation.

Source: Tompkins, E.L. et al. 2005. Surviving Climate Change in Small Islands - A guidebook, produced by the Tyndall Centre for Climate Change Research, United Kingdom. Available at www.tyndall.ac.uk/sites/default/files/surviving.pdf

Inter-governmental Panel on Climate Change Fifth Assessment Report, Chapter on Small Islands

This chapter of the IPCC Fifth Assessment report provides an overview of the climate vulnerabilities specific to small islands across all sectors. It also provides an overview of the observed and projected changes in climate, adaptation options to respond to climate change and the research gaps requiring action.

Source: IPCC. 2014c. Climate Change 2014: Impacts, Adaptation, and Vulnerability Chapter 29. Small Islands (note citation may be subject to change pending final copy edits of Fifth Assessment report, formal citation not available at time of writing). Available at http://www.ipcc.ch/

ANNEX C
Climate financing

C.1. 'Traditional' sources of financing for water services

Financing for water service provision for water services consisting of private companies generating their own revenues has brought about a financing principle that is gaining favour. This is the '3Ts' namely, tariffs, taxes and transfers. If the basic revenues from the 3Ts are inadequate then other sources – loans, bonds and equity – which have to be serviced and repaid are not feasible. Such repayable sources are required for large capital investments such as infrastructure upgrades.

- **Tariff revenue** is the foundation of future cash flows and is normally the main source of funding for recurrent operations and maintenance expenses. In well-managed services with a good revenue base (e.g. in most large urban areas) tariff revenues can contribute to capital investment costs too. An example of this is the K factor which is used by the National Water Commission of Jamaica. The relative importance of user charges varies between categories of water users. It tends to be high for urban household water supply, industry and commercial users and sales of hydropower; less for rural consumers; and low for farmers and wastewater services. With this qualification user charges are potentially the most sustainable, predictable and controllable part of the 3Ts.
- **Tax-funded subsidies** are widely used to supplement tariff revenues especially for rural services and public irrigation schemes. The effectiveness of subsidies can be increased and their cost to public finance reduced by targeting them to specific groups of deserving consumers or as part of a performance-related agreement between the government and the water utility.
- **Transfers** originating from ODA provided by foreign governments and also from NGOs. Budgetary transfers can normally only be programmed several years ahead as part of government Medium Term Expenditure Frameworks (MTEFs) although commitments can be rolled over. The same is true of ODA for which agreements tend to be made 3–5 years in advance in line with the budgets of donor agencies. This can make transfers an unreliable source of regular funding but well suited to one off projects such as technical assistance for feasibility studies or capacity development.

Box C.1 – Further resources on financing investments for water security and climate resilience

Financing for Water and Sanitation A Primer for Practitioners and Students in Developing Countries

The EU Water Initiative Finance Working Group (EUWI-FWG) has produced a primer on conventional principles for water financing including tariffs, taxes, transfers and repayable funding sources. It includes a discussion on the application of each funding source and a discussion on leveraging finance.

Source: EU Water Initiative Finance Working Group - Financing for Water and Sanitation A Primer for Practitioners and Students in Developing Countries (EUWI-FWG, 2011).
Available at http://www.euwi.net/wg/finance

C.1.1. Funding for flood risk management

Unlike water service provision, financing flood risk management typically arises from tax-funded subsidies and transfers rather than user charges as it is considered a public good. In addition, flood risk which is uneconomic to offer publically funded protection against can be offset using insurance (at the individual or national level) which itself may be subject to a level of public subsidy. The Caribbean Catastrophe Risk Insurance Facility (CCRIF) is an example of a regional level insurance mechanism which provides cover for hazards for which countries cannot finance protection domestically.

C.1.2. Funding for water resources management

Water resources management performs a crucial function as the interface between the natural watershed and the various users who abstract and discharge water into it. Water resources management can be viewed as a public good and as such be funded through taxes and transfers. However, the polluter pays and beneficiary pays principles are also be valid in water resources management. These can use levies on users who discharge or abstract water through licences or consents to fund the management of the resources at least in part.

Box C.2 – Further resources on financing for water resources management

OECD A Framework for Financing Water Resources Management (OECD, 2012)

Financing for water resources management presents particular challenges relating to the blurred lines between the public and private beneficiaries of water resources management related to the provision of water services, flood risk management, ecosystems preservation and pollution management. This OECD resource provides useful background guidance on the different approaches taken across OECD countries to finance water resources management.

Source: OECD. 2012. A Framework for Financing Water Resources Management, OECD Studies on Water, OECD Publishing. Available at http://dx.doi.org/10.1787/9789264179820-en

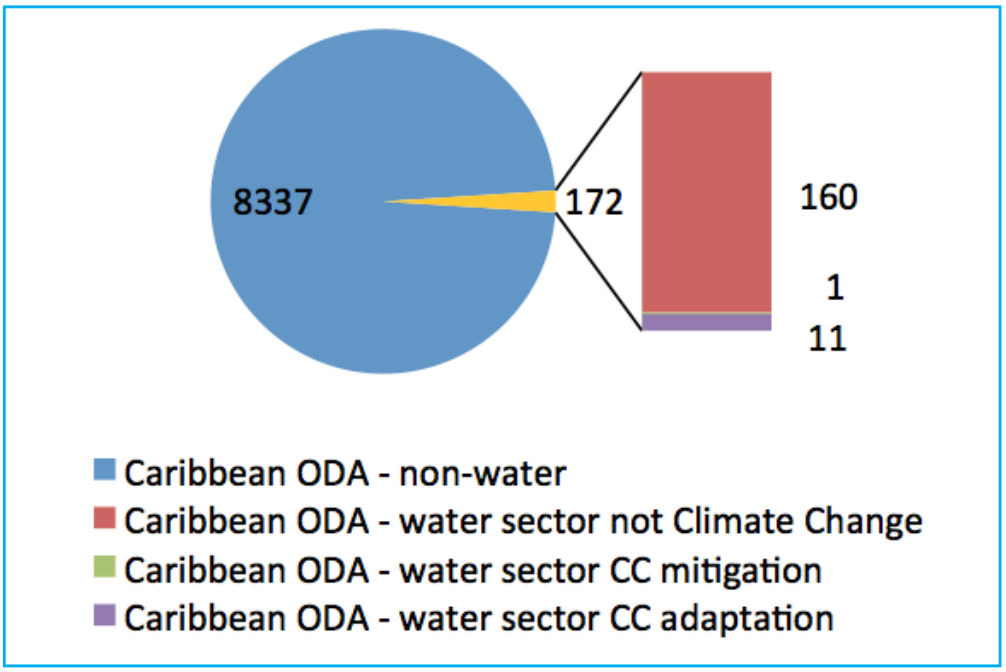
C.2. Summary of development assistance to the Caribbean Water Sector [1]

The OECD-DAC Creditor Reporting System on-line database records that the 15 Members of CARICOM received a total of approximately USD 8.3 billion in external public funding as Official Development Assistance (ODA) over the 3-year period, 2010-2012[2]. Of that amount, USD 172 million went to the water sector (2%), defined as spending for water and sanitation, hydro-electricity and agricultural water resources (Figure C.1).

[1] Contributions to climate funds have been excluded from this section of the analysis to avoid double counting when presenting the findings of the climate funds (section 1.3).

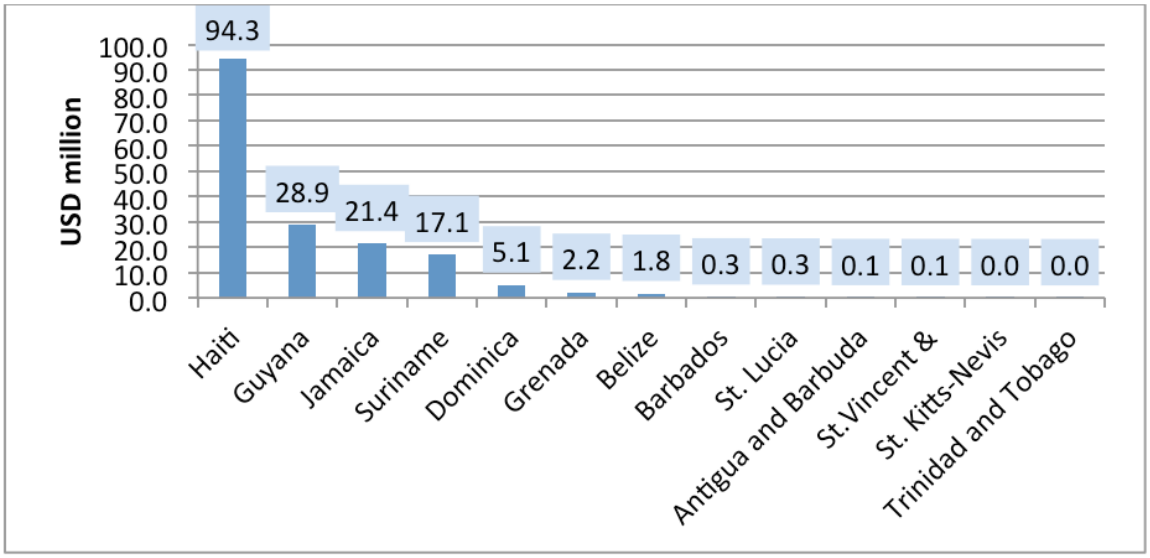
[2] The selection of this 3-year period is based on data availability of the most recent funding flows. The use of the Rio Marker for Climate Change Adaptation began in 2010 and the latest data available from the OECD CRS database is 2012.

Figure C.1 - ODA disbursed to the Caribbean between 2010-2012 (USD million)



Haiti was the top recipient of ODA finance to the water sector receiving three times more that than the next country Guyana. The six small island states of the eastern Caribbean received very small amounts of ODA in support of activities in the water sector (Figure C.2).

Figure C.2 - Total ODA flows disbursed to the water sector in the Caribbean, 2010-2012



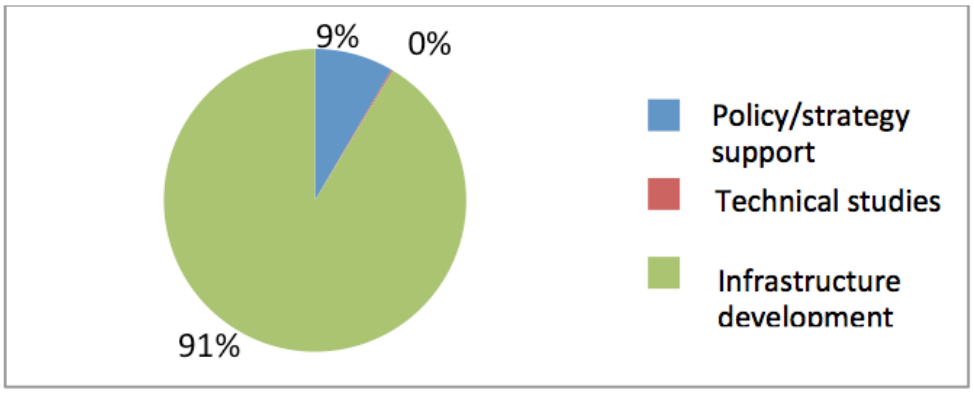
In terms of activities supported the main provision was for supply of water and other basic services clearly reflecting the international response following the 2010 Haiti earthquake disaster. Water resource protection received very little external support (Table C.1).

Table C.1 - ODA finance to water sector sub-themes in the Caribbean, 2010-2012

Water sector sub-themes (OECD classification)	Amount USD million
Water supply & sanitation - large systems	77.8
Water supply - large systems	24.6
Basic drinking water supply and basic sanitation	20.8
Water resources policy, administration and management	13.4
Basic drinking water supply	9.7
Waste management/disposal	9.5
Sanitation - large systems	6.9
River basin development	4.6
Basic sanitation	2.9
Education and training for water supply & sanitation	1.1
Water resources protection	0.3
Total	**171.6**

In terms of the type of assistance received the overiding amount went to infrastructure development (91%). There was some external support for policy devlopment and strategic planning but minimal funding for technical studies such as water resource assessments (Figure C.3).

Figure C.3 - Breakdown by type of intervention for water sector ODA in the Caribbean



C.3. Summary of international climate finance to the Caribbean Water Sector

In terms of support from global climate funds over the same period (2010-2012) approximately USD 44 million was disbursed from five Funds to countries in the Caribbean (Figure C.4). Of this amount, USD 14 million was targeted at the water sector (32%) (Table C.2). A range of activities were supported:

- The Global Climate Change Alliance (GCCA) programme in Belize aims to increase the resilience of the water sector to potential climate change impacts and has as one of its expected results the institutionalization of the National Integrated Water Resources Authority within the Ministry of Natural Resources and the Environment.
- The Adaptation Fund (AF) intervention in Jamaica is aligned with the country's water sector policy. Although primarily focused on adaptation practices in the agricultural sector, the programme involves improved water management associated with small-scale irrigation schemes and the construction of a micro-dam.
- The Pilot Program for Climate Resilience (PPCR) has supported a number of eastern Caribbean States to improve their resilience to the impacts of climate change. Activities that have been supported include the development of water resource management plans (Dominica); water resource assessments (Grenada); and water resources conservation (St Vincent & Grenadines).
- Expenditure from the Least Developed Countries Fund (LDCF) project follows a similar approach to the AF intervention in Jamaica. The agricultural sector in Haiti is the main focus of the project that aims to improve watershed management practices.
- One Global Environment Facility project was identified in Haiti that aims to support the development of small scale hydro power by removing current institutional, regulatory and information barriers.

Figure C.4 - Climate Finance Disbursed to the Caribbean for the period 2010-2012 (USD million)

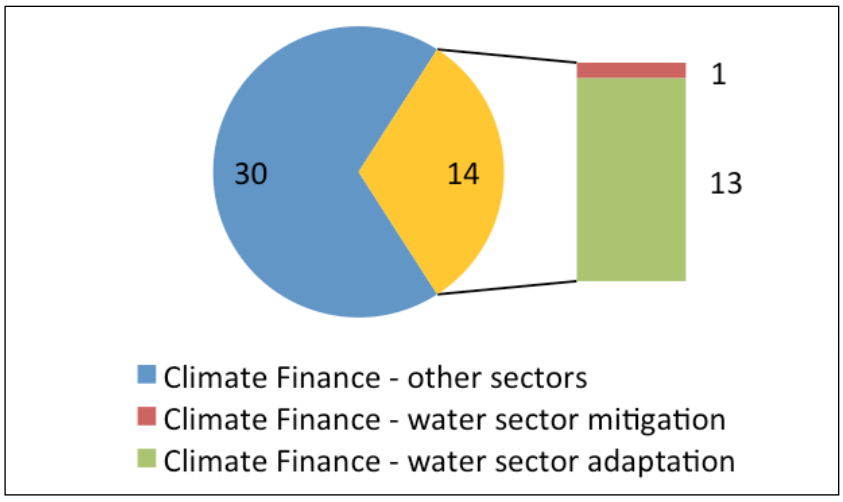


Table C.2 - Regional disbursements involving the water sector from global climate funds, 2010-2012

Fund name	Recipient countries	Amount disbursed (USD million)
Global Climate Change Alliance	Belize	3.9
Adaptation Fund	Jamaica	3.5
Pilot Program for Climate Resilience	Grenada, St Vincent, Jamaica, St Lucia, Dominica & Haiti	2.7
Least Developed Countries Fund	Haiti	2.7
GEF Trust Fund - climate change focal area	Haiti	1.0
TOTAL		**13.8**

C.4. The relative importance of global climate funds versus traditional donor priorities

For each of the three years 2010-2012, climate change-related funding represented a small percentage of total ODA flows self-reported by donor countries as going to the water sector in the Caribbean. A 3-year total of USD 12 million was reported as being climate change-related out of the total of USD 172 million (Figures C.5 and C.6). Following are the OECD definitions of adaptation and mitigation (Box C.3).

Box C.3 - Adaptation and Mitigation Climate Change OECD definitions

Adaptation: An activity should be classified as adaptation-related if it intends to reduce the vulnerability of human or natural systems to the impacts of climate change and climate related risks by maintaining or increasing adaptive capacity and resilience.

Mitigation: An activity should be classified as climate change mitigation related if it contributes to the objectives of stabilisation of greenhouse gas (GHG) concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system by promoting efforts to reduce or limit GHG emissions or to enhance GHG sequestration.

Source: OECD. 2011. Handbook on the OECD-DAC Climate Markers. OECD, Paris. Available at www.oecd.org/dac/stats/48785310.pdf

Figure C.5 - Total ODA disbursements going to the water sector in the Caribbean, 2010-2012

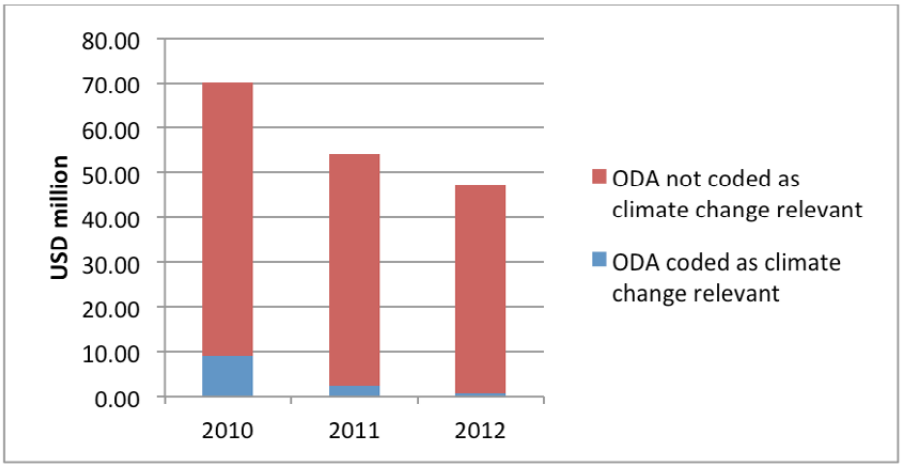
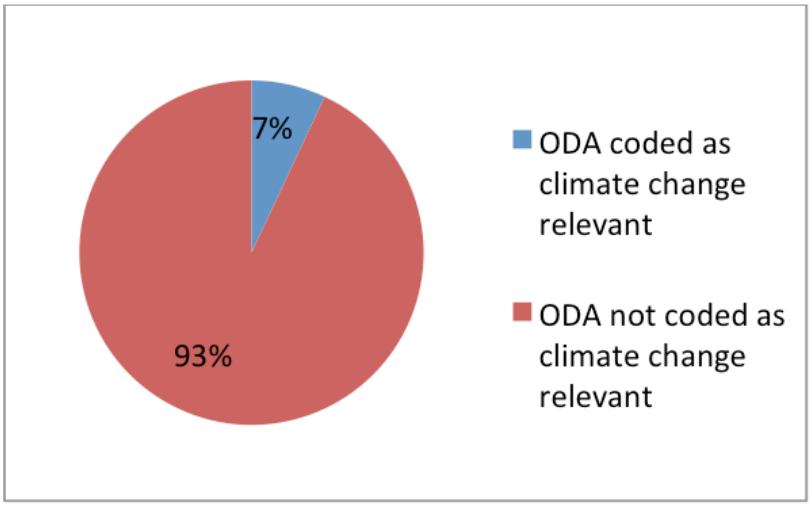


Figure C.6 - Proportion of climate change-relevant and non-relevant ODA disbursements to the water sector in the Caribbean, 2010-2012



For climate change-related ODA funding a year-on-year decrease was observed over the period. This reflects the broader downward trend in ODA disbursements to the water sector which may be explained by an atypically high level of disbursement in 2010 following the Haitian earthquake.

Significantly, international funding from global climate funds disbursed a slightly higher amount over the period to the water sector than climate change-related ODA: USD 14 million compared to USD 12 million. These funds also made a stronger contribution to water sector strategy development and technical studies whereas the funding channelled through traditional ODA channels was focused primarily on infrastructure development. It can therefore be seen that global climate funds already represent a strategic source of funding for water sector planners.

C.5. Spending on climate resilience across all sectors compared to the water sector

Using the ODA dataset that is self-reported by donor countries, ODA funding to Caribbean countries with climate change adaptation as a policy objective totalled USD 113 million for the three year period, 2010-2012, across all sectors. Water supply and sanitation received USD 11 million in adaptation-related funding (in three countries: Guyana, Haiti and Jamaica), including USD 1 million that had joint adaptation and mitigation objectives (Figure C.7). This represented approximately 10% of the regional total for adaptation (Figure C.8).

The water sector was the fourth highest funded sector after environmental protection, multi-sector actions and emergency repsonse. It received more funding than agriculture, another sector where adaptation finance receives a lot of attention (and where support from global climate funds has been noted). However, apart from support to Haiti as part of the post-earthquake response to provide basic drinking water and sanitation services ODA disbursements for project activity were at a very small scale (less than USD 0.5 million per project). The one exception was Japan's support to an urban water supply project in Guyana where just over USD 5 million was disbursed.

Figure C.7 - Total disbursements of ODA tagged as climate change adaptation actions, 2010-2012

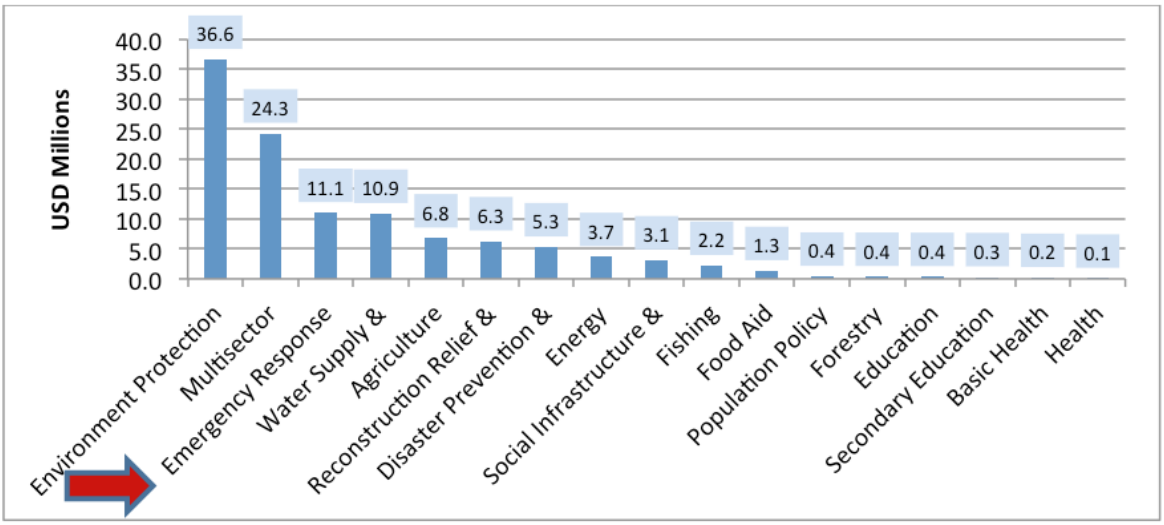
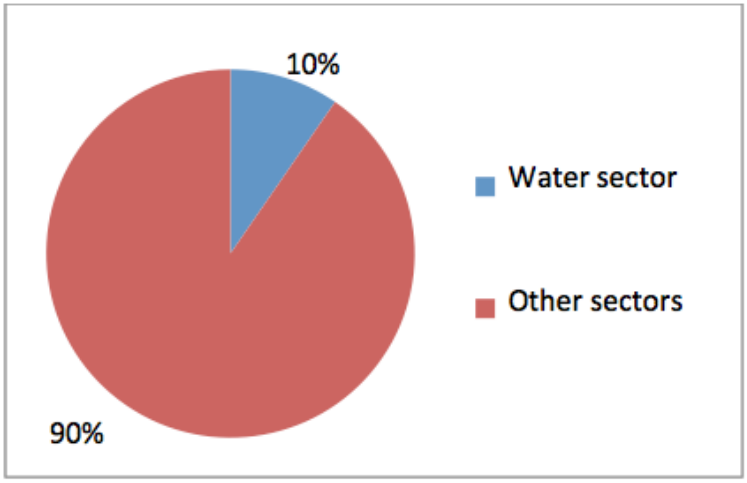


Figure C.8 - Proportion of ODA adaptation finance disbursed to the water sector in the Caribbean, 2010-2012



Significantly, of the USD 11 million investment for adaptation in the water sector USD 10 million went to projects where, although recognised in the project documentation adaptation was not the main objective of the expenditure (see Box C.4 for the definitional approach used by the OECD to distinguish between primary and secondary objectives of spending). This suggests that adaptation is being mainstreamed into traditional donor-supported development projects rather than being channelled through any new set of project interventions. As noted in the previous section, an additional USD 12 million was made available for adaptation actions in the Caribbean water sector from global climate funds.

Box C.4 - The OECD-DAC Climate Markers

The OECD Development Assistance Committee (DAC) gathers statistics on aid and other resource flows to developing countries from bilateral and multilateral donor agencies every year. The data are publicly available in the Creditor Reporting System (CRS) database. Since 1998 the DAC has monitored aid targeting the objectives of the Rio Conventions through the CRS using the so-called Rio markers. The **Rio marker on climate change mitigation** was established by the DAC in close collaboration with the Secretariat of the United Nations Framework Convention on Climate Change (UNFCCC). It tracks aid flows that support the implementation of the Convention.

In December 2009 the DAC approved a new marker to also track aid in support of **climate change adaptation**. This complements the climate change mitigation marker and thus allows the presentation of a more complete picture of climate change-related aid. The first data on the new marker relating to 2010 flows became available in 2011.

Each donor programme is classified as to whether it has climate change-related objectives or not and if so whether the primary policy objective of the action is related to mitigation and/or adaptation or these constitute secondary objectives:

> **Principal (primary) policy objectives (score 2)** are those which can be identified as being fundamental in the design of the activity and which are an explicit objective of the activity. They may be selected by answering the question "would the activity have been undertaken (or designed that way) without this objective?"
>
> **Significant (secondary) policy objectives (score 1)** are those which, although important, are not one of the principal reasons for undertaking the activity.

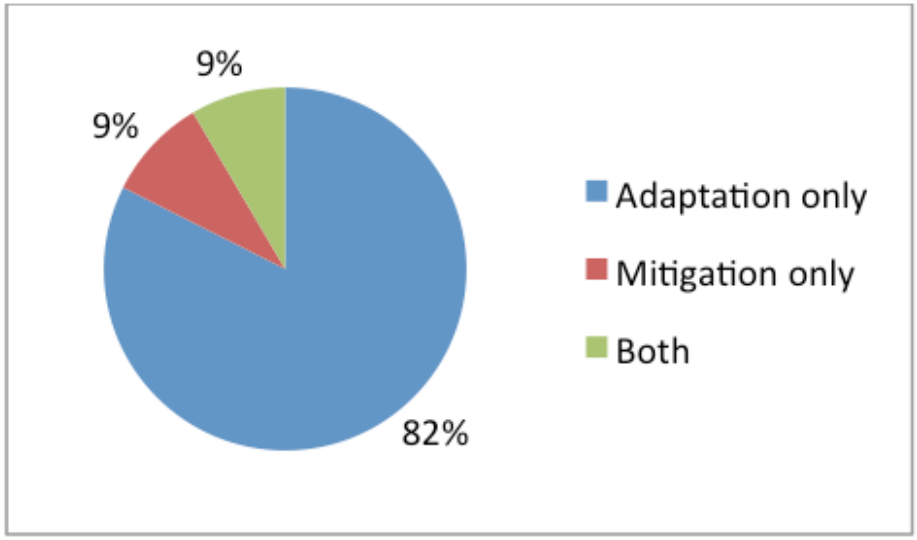
To qualify for a score principal or significant, the objective has to be explicitly promoted in project documentation.

Source: OECD. 2011. Handbook on the OECD-DAC Climate Markers. OECD, Paris. Available at www.oecd.org/dac/stats/48785310.pdf

C.6. Adaptation versus mitigation spending in the water sector

Adaptation spending dominated climate change funding in the water sector over the period 2010-2012 with USD 10 million (82%) disbursed compared to USD 1 million for mitigation actions and USD 1 million for activities that had both adaptation and mitigation objectives (Figure C.9).

Figure C.9 - Proportion of adaptation and mitigation spending in the Caribbean water sector from ODA sources, 2010-2012



As noted in section C.4, the vast majority of adaptation-related spending (93%) was within broader development projects where the main objective of spending was not climate change-related. A similar pattern applied to mitigation spending. So at least for traditional ODA spending it would appear that, climate change whilst a significant policy objective is rarely identified as the principal objective of the activity. This is in contrast to activities funded through global climate funds where responding to climate change is always the primary objective of the expenditure.


Global Water
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Caribbean Community
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