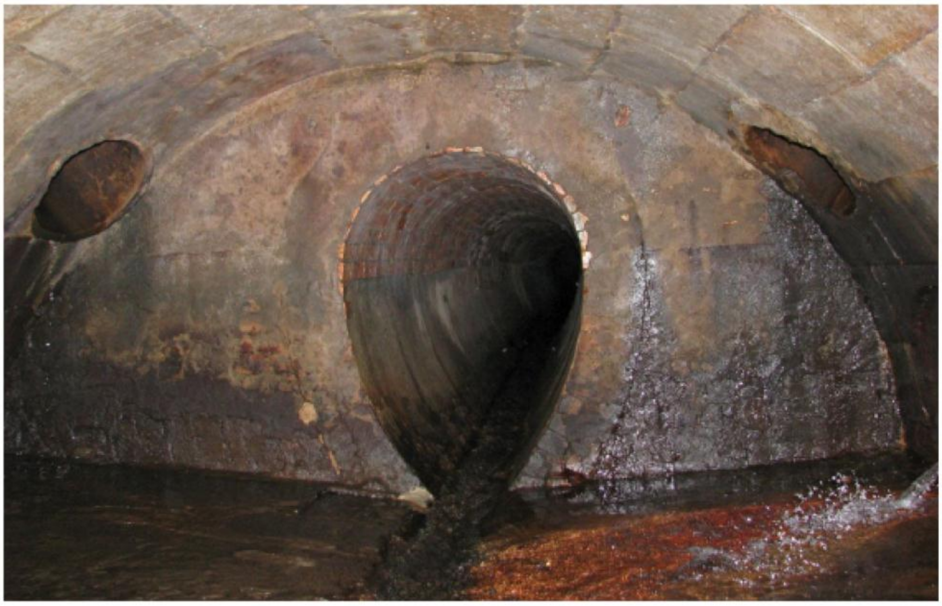
Demonstrating Climate Change Adaptation of Interconnected Water Infrastructure.



2012

Synthesis Report

Part 1 - Overview

SYDNEY COASTAL COUNCILS GROUP

NSW GOVERNMENT Office of Environment & Heritage

Sydney WATER

Coastal Adaptation Decision Pathways Project **(CAP)**

Contents

Glossary

ABCB	Australian Building Codes Board.
Adaptation	Action taken to avoid actual or anticipated impacts from climate change, or to attain potential benefits arising from climate change [IPCC, 2007a].
Adaptive Capacity	The emergent property of a system to adjust its characteristics or behaviour to better cope with existing climate variability or future climate conditions. Adaptive capacity is expressed as actions that lead to adaption that serve to enhance a system's coping capacity and increase its coping range, thereby reducing its vulnerability to climate hazards. Adaptive capacity also refers to the set of resources available for adaptation, and the ability of a system to deploy resources effectively in pursuit of adaption (UNDP 2005).
Annual average damage (AAD)	AAD is the average damage per year that would occur from flooding over an extended period of time.
Average Recurrence Interval (ARI)	"The average or expected value of the periods between exceedances of a given rainfall total accumulated over a given duration. It is implicit in this definition that the periods between exceedances are generally random" (BOM).
Barriers	An obstacle that prevents the implementation of an adaptation strategy.
Base case	Refers to a future scenario without adapting to climate change.
Business as usual	Refers to a future scenario where existing practices and spending is maintained without proactive adaptation.
CBA	Cost Benefit Analysis.
CBD	Central business district.
Climate	Average weather (or, more specifically, the mean and variability of variables such as temperature, precipitation and winds) over a time period ranging from months to thousands of years to millions of years.
Climate Change	A statistically significant variation in either the mean state of the climate or in its variability, persisting for an extended period (typically decades or longer). Climate change may be due to natural internal processes or external forcings, or to persistent anthropogenic changes in the composition of the atmosphere or in land use.

CMA	Catchment Management Authority.
CoS	City of Sydney.
Direct impacts	Climate impacts which affect the performance of the physical, social or environmental condition of the system being considered.
ESD	Ecologically Sustainable Development.
Exposure	The degree to which a system or sector is exposed to climate factors, including in terms of the duration, frequency, and magnitude of changes in average climate and extremes.
Flexible Adaptation Pathway (FAP)	An adaptation plan which identifies a range of potential adaptation options which may be implemented depending on when or if certain climate thresholds are reached. The Flexible Adaptation Pathway is dynamic and can incorporate new science as it emerges and supports iterative decisions in context of long-term view of change.
GIS	Geographical Information System.
GRCCC	Georges River Combined Councils' Committee.
Impacts (climate) Integration	Consequences of climate change on natural and human systems. The process by which separately produced components or assessments are combined, and incongruities in their interactions are considered and addressed.
Indirect impacts	Climate impacts which do not directly affect the performance of the physical, social or environmental condition of the system being considered but may result from flow on effect as a result of direct impacts to other systems.
Interconnected water infrastructure	Stormwater, wastewater and water supply infrastructure, where management is shared between agencies or different tiers of government, or where there is physical interconnectedness or shared financial or asset management due to overlapping governance.
Low regrets	An adaptation options which is highly like to increase resilience to climate change no matter what the extent of climate change that occurs and if it does not increase resilience, very little resource or capital is lost.
Maladaptation	Any changes in natural or human systems that inadvertently increase vulnerability to climate variables; an adaptation that does not succeed in reducing vulnerability but increases it instead.

MCA	Multi-criteria Assessment.
Mitigation (emissions)	An anthropogenic intervention to reduce the sources or enhance the sinks of greenhouse gases.
Mitigation (natural disasters)	Measures to contain or reduce the severity of human and material damage caused by extreme weather events and natural hazards.
No regrets	An adaptation option which increases resilience to climate change no matter what the extent of climate change that occurs.
NRM	National Resource Management.
OSD	On-site Stormwater Detention.
Real options	Real options are adaptation options which include flexibility over time to avoid inefficient maladaption. Real options are 'fitted with' flexibility to adapt to future changes, rather than be fitted for the projected change.
Region	The planning regions of NSW as depicted in *NSW2021 – A plan to make NSW Number 1.*
Resilience	Ability of a system to undergo change without changing state.
Risk appetite	The level of risk that an individual or organisation is willing to accept and tolerate before they require action to take place to mitigate the risk.
Robust options	Options that provide the best risk mitigation solution.
Scenarios	Scientifically based projection of one plausible future climate and likely biophysical impacts for a region based on knowledge of human impact on climate.
Sector	A part or division, as of the economy (e.g. the manufacturing sector, the services sector) or the environment (e.g. water resources, forestry).
Sensitivity	The degree to which a system is affected by a change.
SLR	Sea Level Rise.
SWC	Sydney Water Corporation.
System	A population or ecosystem; or a grouping of natural resources, species, infrastructure or other assets.

Threshold	Point expressed in terms of a climate variable beyond which risks become unacceptable.
Trigger point	Point (expressed either in terms of climate parameters or as a point in time) at which action must occur to avoid unacceptable impacts.
Viable options	Options that are technically possible and produce financial or economic returns in reducing climate risk.
Vulnerability	The degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude and rate of climate change and variation to which a system is exposed, its sensitivity and its adaptive capacity.
Water infrastructure managers	Persons who has a responsibility for the design or ongoing maintenance and performance of water infrastructure assets such as but not limited to pumping stations, pipes, channels.
Weather	Atmospheric conditions at a particular time, such as hours or days, as defined by variables such as temperature, precipitation and winds.
Weather extremes	Weather phenomena that are at the extremes of the historical distribution, especially severe or unseasonal weather.
Wicked problem	A difficult problem due to incomplete, contradictory and changing requirements that are often difficult to recognise.
WRL	Water Research Laboratory.

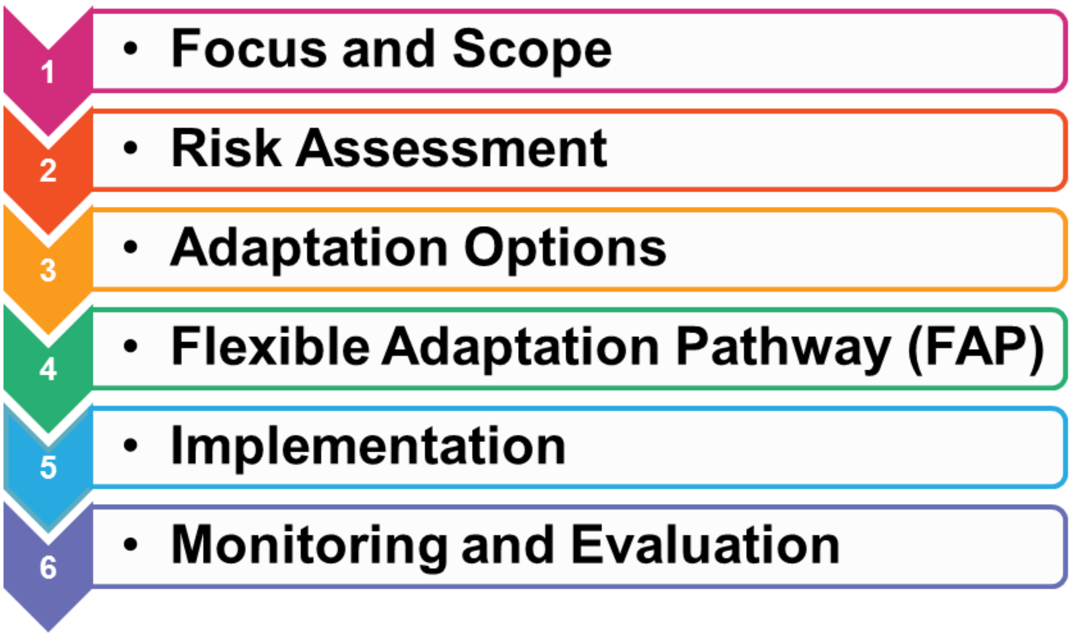
Overview

The Australian Government has invested $4.5 million to demonstrate effective approaches to adaptation in the coastal zone. This project is one of thirteen Coastal Adaptation Pathway (CAP) projects which has received funding to develop leading practice approaches to better manage future climate risk to coastal assets and communities. This CAP project demonstrates a process for climate change adaptation of interconnected water infrastructure. The project partners for the study are Sydney Coastal Councils Group (SCCG), Sydney Water and NSW Office of Environment and Heritage (OEH), with CAP funding from the Department of Climate Change and Energy Efficiency (DCCEE).

Interconnected water infrastructure is infrastructure where management is shared between agencies or different tiers of government. This can be as a result of physical interconnectedness or shared financial or asset management due to overlapping governance. Climate change will require water infrastructure managers to adapt their asset management and investment programs going forward.

Climate change is sometimes considered as a ‘wicked’ problem because it is characterised by incomplete, contradictory, and changing requirements that are often difficult to recognise. In addition, such as in the case of interconnected systems, a range of stakeholders who may have different and sometimes competing objectives are involved. In such an environment, decision making becomes difficult and decision making paralysis can occur. This is where structured decision making frameworks become paramount.

This study takes a case study approach to explore the adaptation decision making process through a six stage process.



Report structure

The report presents a decision making framework for climate change adaptation for interconnected water infrastructure as follows:

Part 1 – Overview: This section provides an overview of the study, the general objectives and the issues and challenges facing interconnected water infrastructure managers in the context of climate change. It also provides a summary of key findings.

Part 2 – User Guide: Provides a summary of each stage of the framework including what the stage involves, why it is important and a brief explanation as to how it is to be completed.

Part 3 – Interactive PDF (iPDF): The report is also accompanied by an interactive PDF which provides a greater level of detail as to 'how' each stage is to be completed including links to relevant tools.

Part 4 – Case Studies: Provides details of how the approach was adopted on each of the five case studies and highlights lessons learnt.

Part 5 – Background Information: The section provides a greater level of technical detail on how the framework was adopted and why it is relevant for interconnected water infrastructure. In addition, case study learnings and global practice examples are provided.

Why is the framework needed?

Sydney's complex interconnected water infrastructure systems provide the city with quality and reliable water supply and wastewater services and protect the city against damages during flooding and storm events. The effective functioning of these systems is therefore paramount to Sydney's:

- Productivity, economic stability and growth.
- Public health, safety and security.
- Local environment and ecosystem health.

However, Sydney's interconnected water infrastructure systems are under threat. Urban growth over recent decades combined with ongoing deterioration of ageing infrastructure is causing stress to the system. Consequently, parts of the system are currently struggling to provide the level of service or protection for which they were originally designed. There is already a need for infrastructure to adapt to these existing threats.

Into the future, climate change is likely to exacerbate the current exposure of interconnected water infrastructure to climate impacts, and possibly result in new risks from climate.

There is high certainty that the climate is changing, and in many cases there is a high degree of confidence in the direction of the changes. However, the precise timing and magnitude of climate change is still uncertain and thus the extent of adaptation required is still largely uncertain. Climate change projections for a range of future emissions scenarios are provided by the Intergovernmental Panel on Climate Change (IPCC) however no information is provided on the likelihood of each of the emissions scenarios.

Current exposure and climate change mean further public investment in water infrastructure will be required, however funds are not unlimited. Therefore, infrastructure managers will be increasingly required to prioritise and optimise spending and potentially be willing to accept reduced levels of service and higher exposure to risk. A greater understanding of these trade-offs is required.

Lack of certainty is acting as a constraint on effective decision making in response to climate change, leading either to inaction, or inappropriate responses. One solution is to follow a flexible process, allowing certain decisions to be progressed while in parallel gathering information to reduce uncertainty and support more complex decisions. However, due to the interconnectedness of the water infrastructure system, there is the potential for this individual business approach to result in maladaptation. This could occur where:

- Individual stakeholders implement their own adaptation options in isolation resulting in an overall over investment and a higher level of protection than required
- Individual stakeholders have different attitudes to risk resulting in one stakeholder exposing another to a level of risk beyond what they consider acceptable
- The potential benefits of adaptation measures being adopted by individual stakeholders are poorly understood or based on incorrect assumptions.

Current governance arrangements within the water infrastructure sector represent a significant barrier to a coordinated approach to adaptation. Where multiple ownership structures are present there are often competing objectives which may impede decision making. Notwithstanding, where these barriers can be overcome there is the potential to optimise investment in climate change adaptation to both reduce overall expenditure on capital and maintenance and minimise exposure to risk.

What does this study do?

This study takes a case study approach to explore the climate change issues facing Sydney's interconnected water infrastructure, the adaptation imperative and the range of challenges and barriers to adaptation facing infrastructure managers.

The study seeks to apply a step-wise framework for adaptation decision making using principles of risk management, 'real options' and probability weighted cost benefit analysis. The study also introduces the concept of a Flexible Adaptation Pathway (FAP) as a way to manage climate change uncertainty.

This study recognises that some of Sydney's water infrastructure managers have sophisticated climate change adaptation strategies while others are just beginning to develop these. The study further recognises that even the most sophisticated of managers still have some way to go in determining the most effective response in the context of uncertainty.

Guidance on adapting interconnected water infrastructure to climate change will be relevant to all councils and water infrastructure managers within the Sydney coastal region. However, the project deliberately adopts a case study approach to test this guidance, and any assumptions 'on the ground' in real-world scenarios.

The case studies selected differ in terms of the climate problems faced as well as the governance structures and political social context through which decision making must occur. The case studies are also in different stages in terms of the progress that has already been made in establishing adaptation pathways.

The study attempts to progress each case study through the framework through the use of a range of tools referenced throughout this document. The case study narrative provides a valuable insight into the challenges faced in identifying and responding to climate change adaptation issues.

The five case studies are:

- City of Sydney CBD: Understanding the implications of sea level rise and tidal locking in an existing area of high value assets.
- Green Square: New development accommodating the impact of sea level rise on the drainage network.
- Cooks River: Improving governance arrangements to address existing and future flooding impacts.
- Wollongong: A systems approach for interconnected coastal asset owners to adapt to coastal recession.
- Berry Creek: Valuing community and ecological assets in the adaptation of interconnected water networks under multiple ownership.

Most importantly, this study aims to provide simple, practical guidance to water infrastructure managers no matter how far they have progressed in the consideration of climate change implications on their assets and the services they provide. Too often actions and decisions are delayed due to lack of data, lack of resources and the complex, uncertain and interconnected problem of climate change. In this sense, the guidance will allow water infrastructure managers to overcome these barriers and 'make a start' by beginning with focussed and manageable initial assessments. Moreover, the guidance will allow more advanced water infrastructure managers to understand the next steps and further build upon work already undertaken.

What does this study NOT do?

This study does not develop its own climate change projections or provide a review of climate change science. Instead, it adopts projections published or endorsed by the NSW Government and acknowledges that these are not certain and are subject to change.

This study does not solve the adaptation problem for the individual case studies. Instead, it demonstrates how the decision making process can work using the best available information and data available at the time of writing. In many cases, assumptions are overly simplified and proxy data from international examples has been adopted in order to demonstrate the process. However, the case studies explore the next steps required to refine the degree of accuracy before any given adaptation option could be implemented.

Key Findings

There are a range of key findings which have been drawn out of the case study process and review of global practice. The key findings can be divided into case study specific findings which are discussed in detail in the appendices, and general findings which are:

- Using existing guidance: There is a range of existing guidance developed to assist businesses and government in developing adaptation pathways in the context of climate change uncertainty. The framework seeks to build upon these guidelines and adapt them to specifically address the issues facing interconnected water infrastructure managers. It provides guidance on which tools may be appropriate in the specific context on interconnected water infrastructure.
- Importance of focus and scope: Project scoping takes real time and significant engagement with the stakeholders to get a detailed understanding of potential issues relating to climate change. The case studies demonstrated a need to understand how climate change was likely to affect existing assets. The case studies also demonstrated the real need to get all stakeholders to work together to move beyond current perceptions of the problem and to identify the root causes.
- Value of risk assessment: The risk assessment process is an important step in understanding the extent of the problem. In one case study the perceived problem of sea level rise was found not to be a critical issue. This early result from a very simplified risk assessment would allow the water infrastructure managers to focus on more significant threats including existing issues related to stormwater capture. This demonstrated that simple assessment or modelling can be effective as a screening tool in excluding potential issues, but that more detailed modelling is needed where issues are identified.
- Iteration leading to greater understanding: The project found that all the case studies were at different stages in the framework. Where existing studies were already available, iteration and expansion of the risks considered can lead to better outcomes. For one case study the consideration of frequent but less intense events revealed that impacts are not limited to major events. Within the case study groups there were often differing opinions from the participants on where the case study was in the process. This difference of opinion generally reflected the different priorities of the stakeholders.
- Governance as a critical barrier to resolve: Stakeholder engagement was fundamental to all case studies at all the stages within the framework. The case studies highlighted the need for long term collaboration to develop coordinated model data from which to develop flexible adaptation options for the catchments. Another case study demonstrated that greater economic efficiencies may be available when stakeholders work together.
- Accessing project funding through a robust economic analysis: Grant funding is unlikely to be a significant source of funding for climate change adaptation. Moreover, access to investment for adaptation will more likely be carried out as part of conventional business case analysis by individual businesses to justify the investment and its timing. Both individual businesses and financial regulators will require a robust economic analysis supported by a quantitative risk assessment process to approve such increases.

- Existing climate threats require action as well as future threats: Almost all of the case studies identified that current climate, combined with urban development and an ageing asset base, are already impacting the performance of interconnected water infrastructure systems. However the uncertainty surrounding climate change is impeding the decision making process in responding to these existing threats. For the most part, the case studies focussed on interconnected water infrastructure systems which are already impacted by the existing climate and for which immediate action is required. The consideration of climate change in the response is critical, but the optimum point at which adaptation should occur, from an economic analysis perspective, may have already passed.

Beyond these case studies, there are a range of issues facing water infrastructure managers operating within the Sydney Coastal Councils region. This study recognises that some of these water infrastructure managers have sophisticated climate change adaptation strategies while others are just beginning. The study further recognises that even the most sophisticated of managers still have some way to go in determining the most effective response in the context of uncertainty.

It is intended that the guidance developed within this study will apply to all water infrastructure managers no matter how far they have progressed in the consideration of climate change implications on their assets and the services they provide. The guidance will allow more advanced water infrastructure managers to understand the next steps and further build upon work already undertaken and perhaps more importantly will allow other water infrastructure managers to overcome barriers and ‘make a start’ by beginning with focussed and manageable initial assessments.

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