

# Coastal Climate Impact Analysis and Sanitation Hazard Assessment Framework



## Institute for Sustainable Futures Team

Professor Pierre Mukheibir  
Dr Jeremy Kohlitz  
Professor Juliet Willetts

## Universitas Indonesia Team

Dr Cindy Rianti Priadi  
Osha Ombasta  
Iftita Rahmatika  
Sri Rachmawati H. Siregar

## Habitat for Humanity Fiji Team

Alisia Evans  
Bulou Naivale  
Taraiasi Wara  
Tevita Senico

## Citation

UTS-ISF, Universitas Indonesia and Habitat for Humanity Fiji (2023) Coastal Climate Impact Analysis and Sanitation Hazard Assessment Framework. Prepared for the Bill and Melinda Gates Foundation. Published by University of Technology Sydney - Institute for Sustainable Futures.



## Acknowledgements

We thank the municipal governments of Banjarmasin and Mataram and the provincial governments of West Nusa Tenggara and South Kalimantan Indonesia, and the city government of Suva, Fiji for their participation in pilots of this handbook. We also thank Arina Priyanka, Universitas Muhammadiyah Banjarmasin and Universitas Muhammadiyah Mataram for facilitating and supporting the workshops in Indonesia. Thanks to the Bill and Melinda Gates Foundation for funding support and engagement throughout this work.

Graphic design and layout by Jo Yuen: [www.joyuendesign.com.au](http://www.joyuendesign.com.au)

# Contents

<b>Introduction</b>	<b>3</b>
Abbreviations	4
<b>Phase 1: Data and information collection</b>	<b>7</b>
Framework overview	7
1a Understand the context	8
1b Map the institutional landscape	9
1c Map the waste flows and sanitation infrastructure	11
1d Research climate change scenarios	13
1e Overlay impact maps	14
<b>Phase 2: Situational analysis</b>	<b>16</b>
Framework overview	17
2a The institutional landscape	18
2b Climate change scenarios	20
2c City wastewater management flows	21
2d Hot spot mapping	23
<b>Phase 3: Understanding and monitoring the impacts</b>	<b>25</b>
Framework overview	26
3a Cause and effect mapping	27
3b Indicators of change	28
<b>Phase 4: Planning the adaptive responses</b>	<b>29</b>
Framework overview	30
4a Intervention points and adaptation options	31
4b Prioritised adaptation options	32
4c Adaptive planning	34
4d Action plan	36
<b>Annexes</b>	<b>40</b>
Annex 1: Types of data for understanding the context	41
Annex 2: Example adaptation options	42
Annex 3: Worksheet tables and tools	44
<b>Contact</b>	<b>55</b>

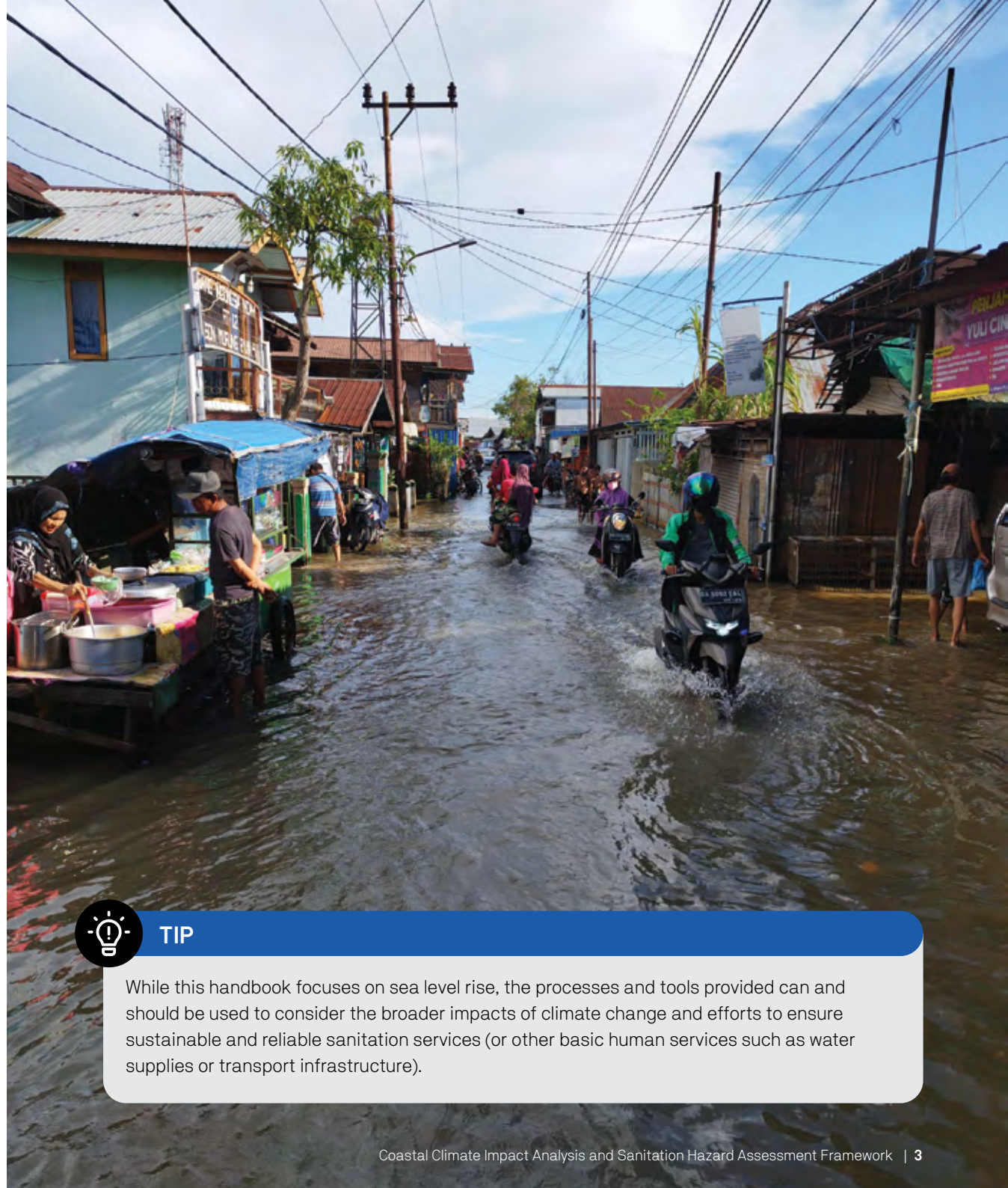
# Introduction

Many of the world's cities are sited along coasts. Storm surges currently create flooding of low-lying parts of many of these cities, which impacts the health and safety of those living in these areas—in low-income settings, it is most notably the poor and marginalised. Sea level rise due to climate change is projected to exacerbate these disruptive events, making them more frequent and more damaging.

In low- and middle-income countries (LMICs), current urban sanitation services often struggle to safely contain and treat human waste for a variety of reasons. Sea level rise and the associated increase in storm surges will add further complexity to urban sanitation service planning in these settings. Planning for sea level rise is needed to ensure the future reliability of these services and can be a catalyst for upgrading neglected sanitation services.

This handbook provides stepwise guidance for facilitating authorities responsible for citywide sanitation services to develop an adaptive action plan for ensuring the resilience of their city's sanitation services to the impacts of sea level rise. It has been designed to:

- 1 provide the user with the processes and tools to facilitate others to understand the impacts of sea level rise on sanitation services and develop an adaptive plan in response; and
- 2 guide someone (or a planning team) in the process of assessing the impacts of sea level rise on the existing sanitation infrastructure or when planning new infrastructure.



## TIP

While this handbook focuses on sea level rise, the processes and tools provided can and should be used to consider the broader impacts of climate change and efforts to ensure sustainable and reliable sanitation services (or other basic human services such as water supplies or transport infrastructure).

# How to use this guide

This document lays out the process whereby urban sanitation stakeholders use available data and their tacit knowledge to systematically identify sea level risks and ultimately generate an action plan for managing the risks. The handbook accommodates data-scarce settings and does not require sophisticated modelling techniques. It is intended for government authorities involved in city sanitation planning and implementation, and international agencies and non-government organisations (NGOs) who may provide the resources to support governments in developing resilient sanitation services.

The handbook is structured as a sequence of steps to be carried out by a facilitation team with the relevant city stakeholders as participants. It can also be used by a planning team to step through the activities as they collect information and progress their sanitation servicing plans. The first phase is a set of preparation tasks, followed by three phases that could be facilitated in a larger workshop with representatives from a range of organisations.

## There are four distinct phases:

- 1 data and information collection
- 2 situation analysis
- 3 understanding and monitoring the impacts
- 4 planning the adaptive response.

The timing of all the steps in Phases 2–4 allows for the content to be covered and activities completed over two days (6 hours of activities each day: phases 2–3, followed by phase 4); however, this may not be practical, in which case the process can be undertaken over a number of days. This might be the case if an individual person or planning team is stepping through the process.

Each phase has several steps, as illustrated in the diagram overleaf. Each step has its own section that describes its purpose, time and resources needed, expected outcomes and outputs, and instructions for carrying out activities. By the end of the process, workshop participants should understand the key risks sea level rise poses for urban sanitation services in priority areas of the city, and list of near-, middle- and long-term actions that can be taken to strengthen the resilience of sanitation to sea level rise.

Additional tips have been provided under the steps where helpful. Case study examples of how the steps were considered in Banjarmasin and Mataram (Indonesia) and Suva (Fiji), are included throughout to illustrate their real-life applications. Some activities contain worksheets that can be found in Annex 3.



## Abbreviations

- GIS:** Geographic information system
- LMIC:** Low- and middle-income country
- NGO:** Non-governmental organisation
- SFD:** Shit flow diagram
- SPCZ:** South Pacific Convergence Zone




## TIP


If this process is being undertaken by a smaller planning team within an organisation, then the team leader should be considered the facilitator for the 'workshop' phases and guide the team through the activities. It is likely this process will be undertaken over a period of time, in which case it would be good to communicate the findings at the end of each phase to relevant stakeholders and the affected communities.


# Framework overview


## 1 DATA AND INFORMATION COLLECTION

1a   
Understand the context

1b   
Map the institutional landscape


1c   
Map sanitation infrastructure

1d   
Research climate change projections


1e   
Overlay impact maps

## 2 SITUATION ANALYSIS


2a   
Institutional landscape


2b   
Climate change scenarios

2c   
City wastewater management flows


2d   
Hot spot mapping


## 3 UNDERSTANDING AND MONITORING THE IMPACTS


3a   
Cause and effect mapping


3b   
Indicators of change

## 4 PLANNING THE ADAPTIVE RESPONSES

4a   
Intervention points and adaptation options

4b   
Prioritised adaptation options

4c   
Adaptation plan

4d   
Action plan

PHASE 1:

# Data and information collection

1a




Understand the context

1b



Map the institutional landscape

1c




Map sanitation infrastructure

1d





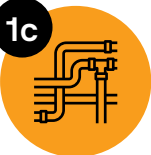


Research climate change projections

1e



Overlay impact maps

# Framework overview

Phase 1: Data and information collection			
	Step title	What does it involve?	Expected outcome
	<b>Understand the context</b>	Meeting with city sanitation stakeholders to learn about key issues and concerns, and to collect data useful for the workshop, such as sanitation coverage, the types of sanitation being used, the current challenges being encountered, etc.	The users and facilitators will have an improved understanding of the city sanitation context and will collect secondary data useful for supporting the activities described in this handbook.
	<b>Map the institutional landscape</b>	Identifying/mapping key stakeholders for policy, regulation, investment, implementation and ongoing management and operations in regard to urban sanitation.	An understanding of who the key stakeholders are, and who is responsible for what aspects of the city wastewater and faecal sludge management.  A list of who should be invited to participate in the planning workshop.
	<b>Map sanitation infrastructure</b>	Using primary and secondary data to map faecal waste flows in the city using the Shit Flow Diagram (SFD), and geospatially locate sanitation infrastructure on a Geographic Information System (GIS) map for both sewer and non-sewered sanitation.	A completed SFD and GIS map of sanitation infrastructure system (both sewer and non-sewered).
	<b>Research climate change scenarios</b>	Researching and preparing a set of slides to demonstrate the range of sea level rise projections under slow and rapid onset scenarios.	An indicative range for sea level rise and rainfall changes for the slow and rapid onset scenarios.
	<b>Overlay impact maps</b>	Using GIS software, overlaying maps of where current and projected flooding connected with sea levels occurs on top of the sanitation infrastructure map.	Flood maps that provide useful information for identifying high-risk priority areas.

1a



## PHASE 1: DATA AND INFORMATION COLLECTION

# Understand the context

**Purpose:** To properly develop robust strategies for responding to the impacts of sea level rise on sanitation infrastructure and services, the context and situation on the ground should be fully understood. Locally based organisations are best placed to provide insights into the issues and key challenges currently faced in providing sanitation services.

### Expected outcomes/ outputs:

Facilitators will have an improved understanding of the city sanitation context and will collect secondary data useful for supporting workshop activities.

### Activity:

- ✓ Identify organisations that have knowledge of or responsibility for aspects of sanitation service delivery (this can be done in conjunction with Step 1b). These may include:
  - service providers (both formal and informal, public and private)
  - government agencies, such as those responsible for public works, health, environment and housing
  - regulators
  - local city councils
  - NGOs
  - community groups
  - agencies involved in investing in or planning new sanitation infrastructure and services (e.g., development banks, bilateral donors).
- ✓ Discuss the objectives of the upcoming workshop and what the organisations see as the key issues confronting sanitation. This will provide workshop facilitators with useful context as they prepare for the workshop activities. Organisations may also identify other agencies that should be invited to the workshop.
- ✓ Ask the organisations if they have any data that might contribute to the pre-workshop activities to map the waste flow and existing and planned sanitation infrastructure (Step 1c) and overlay impact maps (Step 1e). See Annex 1 for examples of what kinds of data might be useful.
- ✓ It is also useful to tour local areas to get a true appreciation of the situation on the ground, observe the types of sanitation technologies and practices, and witness where previous climate-related impacts have disrupted sanitation services.



1b



## PHASE 1: DATA AND INFORMATION COLLECTION

# Map the institutional landscape

**Purpose:** To properly develop robust strategies for responding to the impacts of sea level rise on sanitation infrastructure and services, the stakeholders and those responsible for the different aspects of the sanitation system need to work through this framework together.

This activity could be done collaboratively by the agency leading the process (or in collaboration with others) to ensure no important stakeholders are left out of the process.

### Expected outcomes/outputs:

An understanding of the various players in the sanitation servicing sector, their roles and functions.

### Resources needed:

Flip chart paper, sticky notes, A3 printout of Worksheet Table 1.



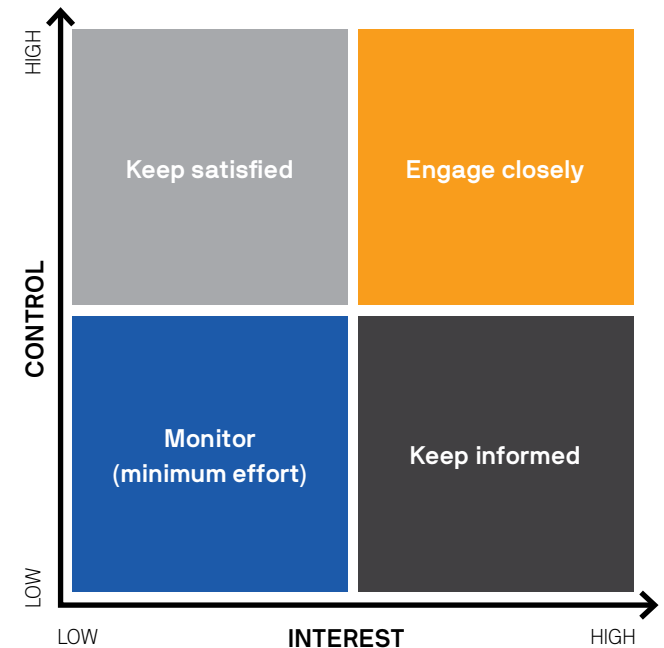
### TIP

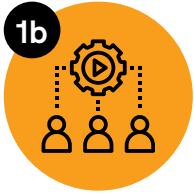
Engaging more deeply with the political economy at play within the city, region and country will reveal what is going on and provide an improved understanding of the drivers for change and potential investment in sanitation, so the adaptation planning developed through the process described in this handbook can take this into account. It may require a dedicated piece of work to research this and document it for sharing with those involved in this planning process.

### Activity part 1:

- ✓ The first step is to map out all the relevant institutions and stakeholders on the matrix according to their relationship to sanitation services in terms of their level of control over parts of the system (including their access to financial resources and their political power), and their level of interest in the outcome of the impact and hazard assessment and response strategy to be developed. This will provide some insight into which stakeholders matter and why you should involve them in this process.
- ✓ Based on the mapping, an engagement plan should be prepared that details the targeted stakeholders and affected parties specifically falling into the top right-hand quadrant, the process for engaging and consulting with each of them, and the level of engagement required for each; that is, which of the stakeholders should be directly involved in the assessment and strategy development.
- ✓ Invitations should be sent out to those required in future workshops and data collection and analysis.

### Worksheet Tool 1: Institutional mapping





# Map the institutional landscape continued

## Activity part 2:

- ✓ The next step is to document what role the various institutions play in the delivery of sanitation services.
- ✓ Consider who is responsible for regulating sanitation services, master planning, infrastructure planning, and ongoing operations and maintenance.
- ✓ Consider who is responsible for backlog servicing areas and who is responsible for ensuring informal settlements have adequate sanitation services.

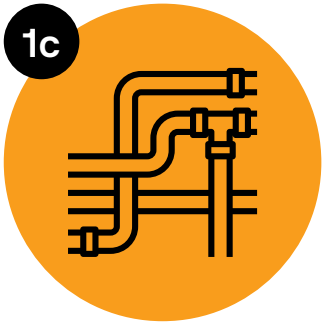


### TIP

Where there is no responsible institution for a specific function, or it is not known, then this should be noted for future follow-up and engagement with policy and governance practitioners.

Worksheet Table 1: Institutional landscape

Urban sanitation service	Who is responsible for:			
	Regulations	Planning	Approvals	Operations
e.g., sewerage services				
e.g., septic tanks and pit latrines				
e.g., emptying/ desludging services				
e.g., treatment/ disposal services				



PHASE 1: DATA AND INFORMATION COLLECTION

# Map the waste flows and sanitation infrastructure

**Purpose:** To understand what infrastructural components of the sanitation system (both sewered and non-sewered) exist in the city and where they are located. To understand the management of faecal sludge and wastewater in the city, which helps provide insights into issues to be dealt with as sea levels rise.

**Expected outcomes/ outputs:**

A completed SFD and a map of the sanitation infrastructure system (both sewered and non-sewered).

**Resources needed:**

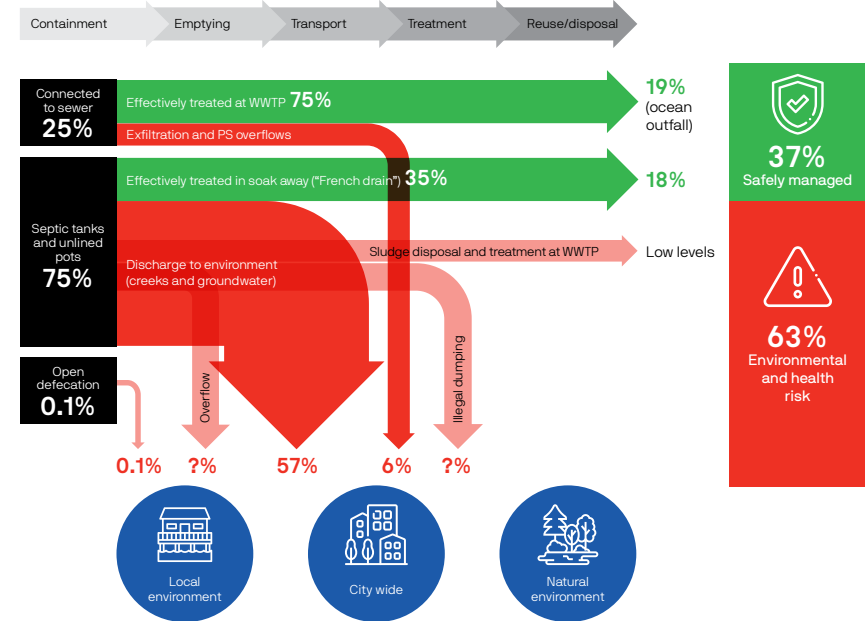
Secondary data on proportions of faecal sludge and wastewater contained, emptied, transported and treated in the city; GIS maps or secondary data on the locations of sanitation infrastructure in the city.

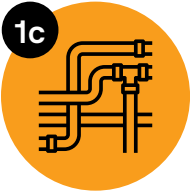
**Activity: Preparing the SFD**

- ✓ As an initial step (and before the workshop), you will need to develop a Shit Flow Diagram (SFD) using the best data available to you. You may use the [SFD Graphic Generator](#) to create an SFD for your city. However, this tool only focuses on sludge management. It may be easier to generate a similar diagram using PowerPoint drawing tools or to do it on paper by hand (possibly interactively in the workshop). A combined flow diagram (see Suva example) might be more useful to understand where wastewater and sludge ends up.
- ✓ Use secondary data provided by the agencies you consulted (Step 1a) to create the SFD.
- ✓ If data availability is poor, you may need to make educated guesses based on your consultations with local experts.
- ✓ Print the SFD out on sheets of A4 paper so workshop participants can work with the SFD in small groups (see Step 3c).
- ✓ You may consider uploading your completed SFD to the SFD database.

**TIP**

If data is available, an SFD could be prepared for precincts that are known to have poor sanitation outcomes and existing flooding events.





## Map the waste flows and sanitation infrastructure continued

### Activity: Preparing the GIS maps of the sanitation infrastructure

- ✓ If digitised drawings or maps of the sanitation system are available, they should be loaded into the local or online GIS platform, together with elevation contour maps.
- ✓ The GIS maps should clearly indicate the significant sewerage infrastructure and non-sewered systems (such as pit latrines and septic tanks systems), especially those located along the coastline (see image of important infrastructure asset locations in two sub-districts in Banjarmasin, Indonesia, right).



#### CASE STUDY: FIJI AND INDONESIA

In Suva, Fiji, little data was available for mapping waste flows in the city. Some of the figures used for the SFD above were based on the expert opinions of the workshop participants. In Banjarmasin, Indonesia, city government officials had a GIS map of public sanitation infrastructure that was used to create a spatial map of their locations in the city.



#### TIP

QGIS is a free GIS software package that can be downloaded from the internet:

<https://www.qgis.org/en/site/forusers/download.html>



1d



## PHASE 1: DATA AND INFORMATION COLLECTION

# Research climate change scenarios

**Purpose:** To understand the projected climate change impacts on the area under investigation, specifically sea level rise and rainfall.

### Expected outcomes/ outputs:

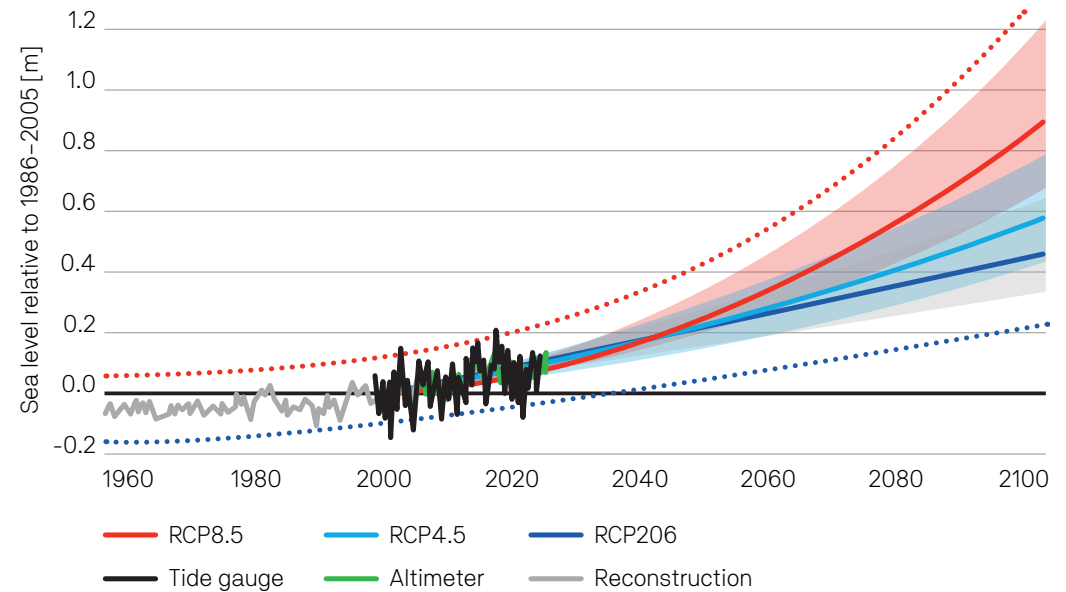
An indicative range for sea level rise and rainfall changes for the slow and rapid onset scenarios.

### Resources needed:

Published sea level rise, rainfall and temperature projections under high and low regional downscaled climate change modelled scenarios (see the [World Bank Climate Change Knowledge Portal](#) for country-specific resources).

### Activity:

- ✓ Research the published literature on the climate change projects for this region.
- ✓ Contact representatives from the government agency responsible for meteorological services and climate projections, to obtain information on locally accepted country climate change projections.
- ✓ Prepare a set of slides to show to the participants to demonstrate the range of sea level rise projections under slow and rapid onset scenarios.



Source: CSIRO and SPREP (2021). 'NextGen' Projections for the Western Tropical Pacific: Current and Future Climate for Fiji. Final report to the Australia-Pacific Climate Partnership for the Next Generation Climate Projections for the Western Tropical Pacific project.

1e



## PHASE 1: DATA AND INFORMATION COLLECTION

# Overlay impact maps

**Purpose:** To identify geographic areas in the city that are known to be affected by flooding which could be further affected by sea level rise, and to highlight critical sanitation infrastructure (such as pump stations and treatment facilities), as well as areas of the city where vulnerable people live to prioritise efforts in these locations.

### Expected outcomes/ outputs:

Flooding maps and maps of where vulnerable people live overlaid on top of sanitation infrastructure maps (both sewer and non-sewer).

### Resources needed:

GIS maps or secondary data capturing areas in the city that are currently affected by flooding and could be further affected by sea level rise (e.g., river or coastal floods), and areas where vulnerable people live (e.g., low socioeconomic communities, informal settlements, low-lying areas) and areas that currently have a high prevalence of illnesses related to poor sanitation or contaminated waterways, especially those where children play in unsafe water bodies.

### Activity:

- ✓ Using the information you have collected on the location of sanitation infrastructure (sewer and non-sewer), together with existing flooding maps/data/information, create a composite map either using GIS tools or by hand on large printed or drawn map of the city (or specific areas known to be vulnerable). The existing flooding areas could be due to storm surges along the coast or rain-driven flooding of low-lying areas within the city. It is important to map these since it is highly likely that sea level rise will make these situations worse through more severe and/or frequent impacts. In the diagram provided on the right, areas in a city already affected by tidal flooding have been shown in blue.



### CASE STUDY: BANJARMASIN, INDONESIA

In December 2021, rivers burst their banks and flood parts of Banjarmasin, Indonesia, due to a very high tide. Sea level rise makes these tidal floods more likely to happen. City government officials had mapped the tidal flooding in GIS (as shown in the image), which was overlaid on top of the sanitation infrastructure map for this workshop. This helps highlight sanitation infrastructure that is especially exposed to flooding driven by sea level rise.



## Overlay impact maps continued

### Activity:

- ✓ If there are no existing flood maps, you can approximate the locations where flooding commonly occurs using the local knowledge of key informants in the city. This may be refined during the workshop.
- ✓ Identify locations in low-lying areas that could be affected (or further affected) by storm surge related flooding in future. This could be done using the GIS tools or by hand on a hard copy of the map. Where contour lines are not at a useful resolution (less than 1m), then a best guess of the low-lying areas can be made (based on historical flooding events).
- ✓ Overlay other GIS data layers/maps that might be useful for understanding risks and identifying priority areas. For example, you can map the locations of informal settlements or low-income housing to identify where vulnerable people live.



### TIP

There are online platforms that attempt to map the extent to which sea level rise will inundate coastal areas in the future. However, these platforms typically have low resolution at local levels (e.g., the city level) and are not as accurate as they seem. Over-relying on them might provide misleading estimates of sea level rise for city planning purposes.

Where there is little or no data on elevations or GIS available, Google Maps can be used to scroll along the city coastline and identify low-lying areas and possible areas of risk. <https://maps.google.com/>



PHASE 2:

# Situational analysis

2a



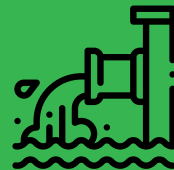
Institutional  
landscape

2b



Climate change  
scenarios

2c



City wastewater  
management  
flows



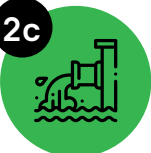

2d



Hot spot  
mapping



# Framework overview

Phase 2: Situation analysis			
	Step title	What does it involve?	Expected outcome
	<b>The institutional landscape</b>	<p>Asking participants to indicate their respective levels of interest in sanitation and climate change.</p> <p>Confirming and modifying with the participants their understanding of the institutional arrangements in the urban sanitation sector undertaken prior to the workshop.</p>	<p>Visualising/understanding the spread of expertise across the participants regarding sanitation and climate change.</p> <p>A clear description of roles and responsibilities for sanitation services, and who might be responsible for climate change adaptation initiatives in the future.</p>
	<b>Climate change scenarios</b>	<p>Presenting the range of sea level rise projections under slow and rapid onset scenarios.</p>	<p>An understanding of the projected climate change impacts on the area under investigation, specifically sea level rise and rainfall, under the slow and rapid onset scenarios.</p>
	<b>City wastewater management flows</b>	<p>Facilitating group discussion about the city's SFD and the management of wastewater and sludge more generally.</p>	<p>An understanding of the level of formalised wastewater management via piped sanitation services and what percentage of the sanitation is managed with septic tanks and pits. Also, to identify some of the existing health risks from sanitation that is not safely managed and the level of open defecation.</p>
	<b>Hot spot mapping</b>	<p>Following a systematic process for identifying geographic areas within the city that should be prioritised for actions to reduce the risks of sea level rise to sanitation.</p>	<p>A list of priority areas within the city that will be focused on for the rest of the workshop.</p>

2a



## PHASE 2: SITUATION ANALYSIS

# The institutional landscape

**Purpose:** To better understand what the various institutions see as their main focus between dealing with sanitation servicing or coping with climate change impacts. This will provide insights into the various institutions' knowledge about sanitation servicing issues and those related to climate change. Also, to confirm the with the participants the understanding of the institutional arrangements in the urban sanitation sector that was undertaken prior to the workshop.

### Expected outcomes/outputs:

Completed Venn diagram indicating the interest of the participants or organisations in sanitation, climate change impacts, or both.

A clear description of roles and responsibilities for sanitation services, and who might be responsible for climate change adaptation initiatives in the future.

### Resources needed:

Flip chart paper and markers. Draw the Venn diagram (Worksheet Tool 2) on a piece of flip chart paper.

### Estimated duration:

50 minutes



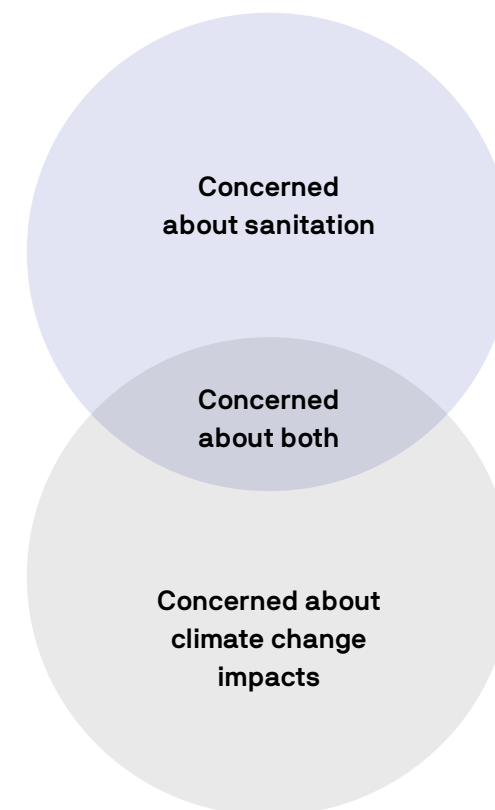
### TIP

If the group is small enough, this exercise could instead be used to reveal what the participants themselves are most concerned about.

### Activity: Mapping who is in the room (30 mins)

- ✓ Welcome and background—briefly explain the purpose and aims of the workshop.
- ✓ As part of the introductions, ask the participants to identify which part of the Venn diagram they or their organisation belongs to. They can reflect on this by considering:
  - What is their organisation worried about?
  - What issues do their organisations plan for?
  - What issues do their organisations respond to?
- ✓ Write the names of the participants' organisation on sticky notes and place them in the corresponding space on the Venn diagram.
- ✓ Take note of where most people are located. How many organisations are located at the centre?
- ✓ Ask the participants to suggest other institutions that should also be involved in this planning process but are not currently present.

### Worksheet tool 3: Institutional focus



2a



## The institutional landscape continued

### Activity: Confirming the roles and responsibilities of the various institutions (30 mins)

- ✓ Present the table of the sanitation services and the responsible institutions (prepared in Step 1b).
- ✓ Ask participants in small groups to critically review the table and make corrections and additions as appropriate.
- ✓ Confirm these changes with the larger group.
- ✓ This information will be useful in Step 4d, when responsibilities are assigned to the various adaptation actions to be undertaken.



2b



## PHASE 2: SITUATION ANALYSIS

# Climate change scenarios

**Purpose:** To inform the participants of the projected climate change impacts on the area under investigation, specifically sea level rise and rainfall.

### Expected outcomes/outputs:

A collective understanding of the indicative range for sea level rise and rainfall changes for the slow and rapid onset scenarios.

### Resources needed:

Published sea level rise, rainfall and temperature projections under high and low regional downscaled climate change modelled scenarios.

### Estimated duration:

25 mins



### TIP

Country/national adaptation plans may be a good source of well described projected climate change scenarios for your location.

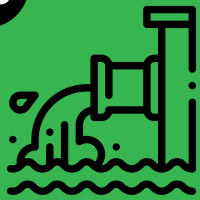
### Activity:

- ✓ Present the climate change information collected beforehand (see Step 1d). This should include a set of projected scenarios for the region, specifically scenarios that show a slow onset of the climate change impacts and another showing a rapid onset.
- ✓ Present the maps of the city showing the likely inundation areas due to sea level rise and increased storm surge (or further inundation if the area is already flood prone).
- ✓ Facilitate a discussion between the participants on whether:
  - the projections seem likely
  - they have witnessed these changes already taking place.

	Scenario 1 SPCZ moves north	Scenario 2 SPCZ moves south
Low emissions (RCP2.6)	<b>Warmer &amp; drier</b> <ul style="list-style-type: none"> <li>● Annual temperature: +0.5°C</li> <li>● Annual rainfall: -10%</li> <li>● More heatwaves</li> <li>● Less humidity</li> <li>● More solar radiation</li> <li>● Heavier rainfall events</li> <li>● Greater tropical cyclone impacts</li> <li>● Sea level rise: 17–30cm</li> </ul>	<b>Much warmer &amp; wetter</b> <ul style="list-style-type: none"> <li>● Annual temperature: +1.1°C</li> <li>● Annual rainfall: +10%</li> <li>● More heatwaves</li> <li>● More humidity</li> <li>● Less solar radiation</li> <li>● Much heavier rainfall events</li> <li>● Greater tropical cyclone impacts</li> <li>● Sea level rise: 17–30cm</li> </ul>
High emissions (RCP8.5)	<b>Much warmer &amp; drier</b> <ul style="list-style-type: none"> <li>● Annual temperature: +0.9°C</li> <li>● Annual rainfall: -20%</li> <li>● More heatwaves</li> <li>● Less humidity</li> <li>● More solar radiation</li> <li>● Heavier rainfall events</li> <li>● Greater tropical cyclone impacts</li> <li>● Sea level rise: 21–37cm</li> </ul>	<b>Hotter &amp; wetter</b> <ul style="list-style-type: none"> <li>● Annual temperature: +1.6°C</li> <li>● Annual rainfall: +10%</li> <li>● Many more heatwaves</li> <li>● More humidity</li> <li>● Less solar radiation</li> <li>● Much heavier rainfall events</li> <li>● Greater tropical cyclone impacts</li> <li>● Sea level rise: 21–37cm</li> </ul>

CSIRO and SPREP (2021). 'NextGen' Projections for the Western Tropical Pacific: Current and Future Climate for Fiji. Final report to the Australia-Pacific Climate Partnership for the Next Generation Climate Projections for the Western Tropical Pacific project.

2c



## PHASE 2: SITUATION ANALYSIS

# City wastewater management flows

**Purpose:** To understand the management of faecal sludge and wastewater in the city, which helps to provide insights on issues to be dealt with as sea levels rise. To also identify some of the existing health risks from current sanitation services that are not safely managed and the level of open defecation.

### Expected outcomes/ outputs:

Participants will have a shared understanding of the key existing risks related to sanitation in the city.

### Resources needed:

Printed out copies of a SFD of the city (prepared in Step 1c)—one for each group.

### Estimated duration:

45 minutes



### TIP

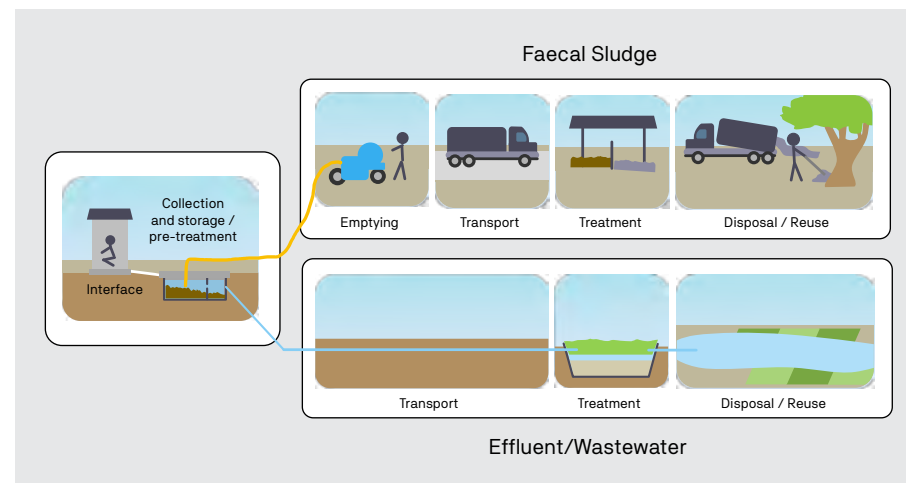
Country/national adaptation plans may be a good source of well described projected climate change scenarios for your location.

### Activity:

✓ Depending on the knowledge of the audience, you may want to present the sanitation service chain concept to ensure the participants understand the definition and importance of safely managed sanitation.

✓ Hand copies of the SFD to small groups of the workshop participants so they can capture their inputs directly onto it (as shown in the SFD example). Ask each group to discuss among themselves:

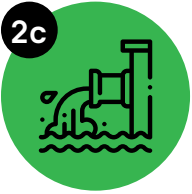
- Where does most of the wastewater and faecal sludge flow to as illustrated on the diagram?
- Is this what you expected the flow of faecal waste to look like in your city?
- Are the estimated percentages roughly accurate?
- What is your opinion on the status or condition of each service chain link (consider the infrastructure and the capacity of the service providers and the reliability of the service in general)?
- What usually happens to the liquid effluent from pits or septic tanks?



- How do high sea levels or flooding already influence the management of faecal waste in the city? This should be annotated on the SFD (see the example on the next page).
- Which components would likely be further affected by sea level rise and storm surge increases? This should be annotated on the SFD.

✓ After the participants have finished discussing in their small groups, call on one person from each group to share thoughts from their discussions.

2c

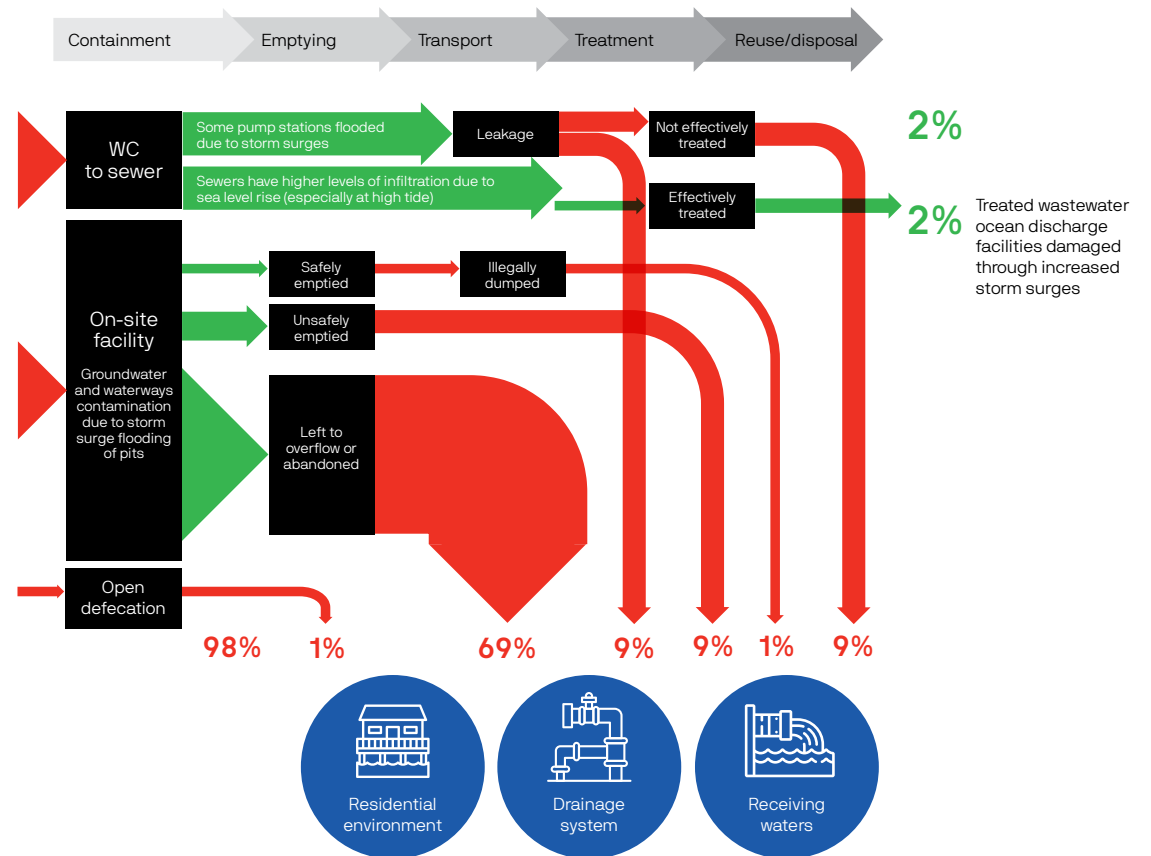


## City wastewater management flows continued



### CASE STUDY: BANJARMASIN, INDONESIA

In Banjarmasin, Indonesia, the SFD showed most of the wastewater and faecal sludge was discharged locally—only a small proportion of the city was covered by sewerage or emptying services. Participants confirmed this matched their own perceptions and remarked containment units are often inaccessible, especially during flooding events when emptying services are needed most.



2d



## PHASE 2: SITUATION ANALYSIS

# Hot spot mapping

**Purpose:** To identify areas where sanitation services will be critically threatened by sea level rise and target them as priorities for action due to the impact on health and the environment.

### Expected outcomes/ outputs:

A list of priority areas within the city that the participants will focus on for the rest of the workshop.

### Resources needed:

GIS city maps with sanitation infrastructure and inundation maps overlaid (created in Step 1e); A3 printout of Worksheet Table 2.

### Estimated duration:

1 hour 20 minutes

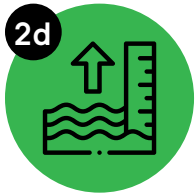
### Activity: part 1

- ✓ Put participants into small groups and provide each group with a (hard or soft) copy of the GIS city map with overlays of sanitation infrastructure and inundation that was created in Step 1e.
- ✓ Explain the activity objective is to identify priority areas (hot spots) that the participants will focus on for the rest of the workshop. These areas may be sub-districts within the city or other areas with recognised administrative or geographic boundaries.
  - How do high sea levels or flooding already influence the management of faecal waste in the city? This should be annotated on the SFD.
  - Which components would likely be further affected by sea level rise and storm surge increases? This should be annotated on the SFD.
- ✓ After the participants have finished discussing in their small groups, call on one person from each group to share thoughts from their discussions.



### CASE STUDY: BANJARMASIN, INDONESIA

Participants in the workshop in Banjarmasin, Indonesia, broke into four separate groups. Due to the high groundwater table present in the entire city, all groups scored their sub-districts high on the environment criterion. But scores varied across sub-districts for the other criteria. After discussion, the groups came to an agreement that sub-districts with informal settlements that contained a high density of low-income housing and poorly constructed sanitation facilities were the priority areas.



## Hot spot mapping continued

### Activity: part 2

✓ Each small group should choose or be assigned a set number of areas within the city to assess. The impact of sea level rise and storm surges on each area should be assessed against criteria on a scale of 1–3 using Worksheet Table 2. This is to assess 1) the impact of sea level rise and storm surges on the sanitation infrastructure and the socioeconomic nature of the area affected, and 2) the likely impact of the resultant sanitation pollution on public health and environment. (Secondary data may be needed to conduct these assessments, e.g. an understanding of the exposure pathways for poor health in the various locations due to sewage overflows would be beneficial.)

- The groups should score each area against each criterion and add them up for a total score. Areas receiving the highest total score should be considered for prioritisation.
- Each of the small groups should present their results and rationale for scoring. If multiple groups assessed the same areas they should compare their scores and discuss any differences.
- Discuss the particular challenges and needs of the priority areas.
- Each group should settle on at least one priority area to focus on going forward.

**Worksheet Table 2: Rating and prioritisation of hot spot areas due to the likely impact of future sea level rise and storm surges**

Name of area	Infrastructure (1–3)	Socioeconomic (1–3)	Environment (1–3)	Health (1–3)	Total	Ranking

- **Infrastructure:** (1 = no impact on sanitation infrastructure; 2 = impacts on localised sanitation assets, e.g. small number of pits or small pump station; 3 = impacts on large number of septic/pits or critical sanitation assets, e.g. major pump station or wastewater treatment facility)
- **Socioeconomic:** (1 = high-income area; 2 = some low-income housing; 3 = high density of low-income housing/informal settlement)
- **Environment:** (1 = low impact on groundwater, waterways and ocean; 2 = moderate impact on ground water, waterways and ocean; 3 = high impact on ground water, waterways and ocean)
- **Health:** (1= low impact on residents' health; 2 = some impact on residents' health; 3 = major impact on residents' health)



PHASE 3:

# Understanding and monitoring the impacts

3a



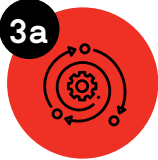
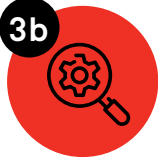
Cause and effect  
mapping

3b



Indicators of  
change

# Framework overview

Phase 3: Understanding and monitoring the impacts			
	Step title	What does it involve?	Expected outcome
	<b>Cause and effect mapping</b>	Identifying the cascading impacts that can occur when urban sanitation is exposed to sea level rise and increased storm surges, specifically from impacts on infrastructure to the environment and health considerations.	Key impacts and risks from sea level rise to sanitation that must be managed and how they cause further risks upstream of the direct impact.
	<b>Indicators of change</b>	Document the indicators of change and who collects this data for each of the impacts.	Completed table with an indicator for each of the identified impacts (where possible), the possible thresholds for action (this may not be possible in the workshop without technical knowledge), who is responsible for collecting the data, and with whom they should share the results.

3a

## PHASE 3: UNDERSTANDING AND MONITORING THE IMPACTS

# Cause and effect mapping

**Purpose:** To identify impacts on sanitation infrastructure related to sea level rise and storm surges in the identified priority areas.

In some instances, the direct impact of the sea level rise or storm surges cannot be avoided. Therefore, it is important to understand the downstream impacts on people and the environment, with a view to identify other intervention points to avoid poor public health outcomes. An impact map is a useful way to see these links.

Notably, in many instances, all or part of the sanitation servicing systems are currently not functioning well, and public health and the environment are already suffering. With sea level rise and increased incidence and severity of storm surges, this situation will worsen.

### Expected outcomes/outputs:

Key impacts and risks from sea level rise to sanitation infrastructure that must be managed and how these disruptions cause further risks upstream of the direct impact.

### Resources needed:

Flip chart paper and markers for writing down cascade of impacts.

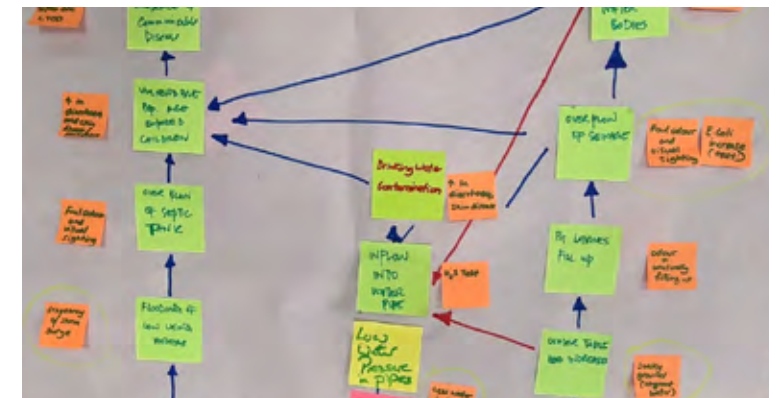
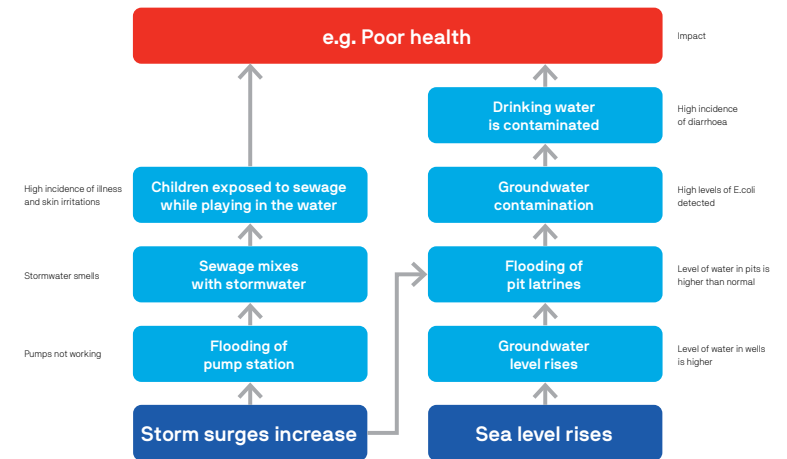
### Estimated duration:

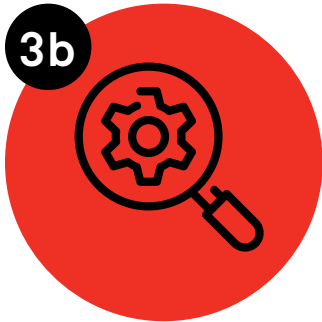
1 hour 30 minutes

### Activity:

- ✓ Each of the small groups should consider one or two of the priority areas identified in the hot spot mapping activity (Step 2d).
- ✓ A chain of events can be constructed using a causal analysis process and answering the question: 'What does this impact directly cause?'. This will prompt participants to think about the next logical impact until they arrive at the most critical impact that relates to health and/or wellbeing.
- ✓ Use the example in Worksheet Tool 3 to illustrate how a causal chain of impacts can be constructed.
- ✓ Ask each group to think about the actual or potential chain of impacts that happen for sanitation because of sea level rise or storm surges. Where sanitation services are already poor, the groups should consider how sea level rise and storm surge impacts will worsen the situation.
- ✓ Each group should present the chain of impacts they identified and the accompanying root causes or conditions.

### Worksheet Tool 3: Example of impact mapping process





PHASE 3: UNDERSTANDING AND MONITORING THE IMPACTS

# Indicators of change

**Purpose:** To determine the indicators of change that can be observed at each impact point in the cause and effect mapping diagram that would trigger an action if the threshold was exceeded.

An indicator can inform when something has happened/changed or, in some instances, when the system is already not performing as expected. For example, an indicator can provide a clue about the frequency that an asset is not performing as expected due to repeated flooding. When the indicator reaches a certain level (or threshold), it may trigger an action to improve the situation.

This process may shine a light on the existing poor system performance (such as contaminated waterways from poorly performing septic tanks or high infiltration of sewers) and trigger a response to improve the situation.

**Expected outcomes/outputs:**

Completed table with an indicator for each of the identified impacts (where possible), the possible thresholds for action (this may not be possible in the workshop without technical knowledge), who is responsible for collecting the data, and with whom the results should be shared.

**Resources needed:**

A3 printout of Worksheet Table 3.

**Estimated duration:**

1 hour

**Activity:**

Having identified the cascading impacts in the previous activity, the participants then:

- ✓ Determine the indicators of change that will be observed at each impact point in the diagram, such as pump failures, groundwater levels, frequency of pipe breaks, etc. Use sticky notes to place these indicators next to the relevant impacts.
- ✓ Fill out Worksheet Table 3 for each of the indicators with the possible thresholds for action, who is responsible for collecting the data, and with whom they should share the results.

**CASE STUDY: SUVA, FIJI**

In Suva, Fiji, participants identified that a pump station was a particular area of concern during the hot spot mapping exercise. From the cause and effect mapping exercise, the participants emphasised that stormwater and saltwater ingress were causing corrosion of metal parts at the pumping station and increased intake at the pump which, in turn, was causing wastewater to overflow from sewers. The participants identified several indicators that could be used to monitoring impacts, including flow rate at the pump, level of salinity in the wastewater, customer complaints, pump runtime and clinical records from the health centre.

**Worksheet Table 3: Indicators of change**

Indicator of change List each indicator of change and the data to be collected	Threshold for action (When will the intensity of the impacts get so bad that action will be required to remedy the situation?)	Who is responsible for monitoring this indicator (for collecting this data) ?	Who should they share the information with or inform about the indicator levels?

PHASE 4:

# Planning the adaptive responses

4a



Intervention points  
and adaptation  
options

4b



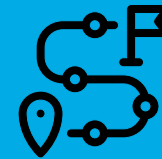
Prioritised  
adaptation  
options

4c




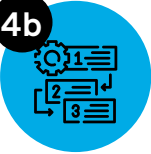
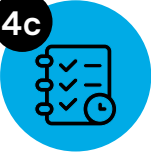
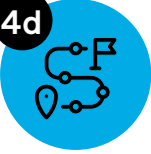
Adaptation  
plan

4d

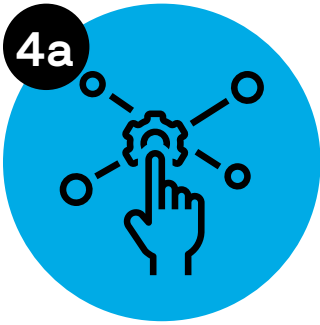


Action plan

# Framework overview

Phase 4: Planning the adaptive responses			
	Step title	What does it involve?	Expected outcome
	<b>Intervention points and adaptation options</b>	Listing possible adaptations for preventing or addressing the identified impacts. These responses will include administrative responses and technical or infrastructural options.	A list of adaptation options for each priority location.
	<b>Prioritised adaptation options</b>	Systematically prioritising the measures using predetermined assessment criteria through a multi-criteria decision process.	Ranked options that provide the best net benefit.
	<b>Adaptive planning</b>	Sequencing the near-, medium- and long-term actions needed to implement the prioritised adaptations and determining who is responsible for their implementation under slow and fast onset scenarios.	An investment plan for implementing a range of adaptations for each priority area that reduce risks of sea level rise to sanitation that is flexible enough to adapt to changing circumstances and better information.
	<b>Action plans</b>	Planning the lead in actions for the deployment of the actions: Who will do what when? What risks need to be taken into consideration, and what opportunities can be harnessed?	<p>A clear plan on whose responsibility it is to do what actions to ensure accountability and to ensure all risks to the adaptation options are prevented as far as possible.</p> <p>A plan for integrating the adaptation plans from this process into the broader planning process.</p>

4a



## PHASE 4: PLANNING THE ADAPTIVE RESPONSES

# Intervention points and adaptation options

**Purpose:** To identify and prioritise response measures or options for addressing the critical impacts identified in the cause and effect mapping activity. These can be related to infrastructure, education, regulations, finances, policy, capacity building, planning, or monitoring and evaluation.

### Expected outcomes/ outputs:

A list of adaptation options for each priority location.

### Resources needed:

List of impacts from the previous activity (Step 3b); flip chart paper and markers for recording adaptation scores.

### Estimated duration:

1 hour



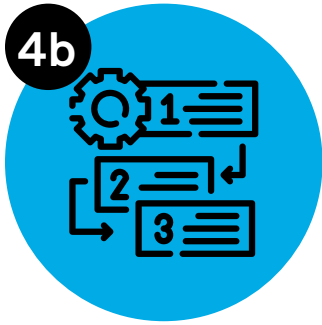
### TIP

If the participants struggle with brainstorming possible adaptation options, they can refer to the list of ideas in Annex 2.

### Activity:

- ✓ Ask the participants about any experiences implementing current or past sanitation improvements that could help in dealing with climate hazards (even if the improvements weren't specifically for climate resilience). Ask them to share how these initiatives came about and the outcomes.
- ✓ Reflecting on the full range of impacts identified in the 'Cause and Effect Mapping' activity (Step 3a), and past experiences with sanitation improvements, the small groups should come up with a list of possible adaptation options for the priority area(s) they are examining.
- ✓ When coming up with adaptations, participants should consider:
  - **Robustness:** adaptations that build resistance to future changes. For example, relocating communal toilets away from tidal flooding or building sanitation or other infrastructure to resist flood damage.
  - **Flexibility:** adaptations that build flexibility into the design, management or operation of sanitation systems. For example, management of sewer overflows when flooding occurs.
  - **Recoverability:** adaptation that enable quick recovery from sudden impacts, thereby minimising risks of service failure. For example, deploying emergency portable toilets when areas become flooded or using education campaigns to advise children not to swim in sewage-infected waters, for instance.
- ✓ Remind the participants to think along the entire service chain, not just at the household level or the treatment facility.
- ✓ The groups should also think about ancillary conditions that influence the impacts identified earlier (this will help to think of non-technical response measures) pertaining to:
  - **Governance** (e.g., lack of policy attention on these issues)
  - **Environment** (e.g., a high water table in the area)
  - **Society** (e.g., limited awareness of environmental health or climate change among the community)
  - **Services** (e.g., limited desludging services available).
- ✓ To ensure full participation, the members in the group each write a few options on a sticky note, and then these can be grouped on the large sheet of paper. Further ideas can then be added through discussion.
- ✓ Participants could also group the options into those that could be deployed relatively quickly, and those that will require more planning and time to implement.

4b



## PHASE 4: PLANNING THE ADAPTIVE RESPONSES

# Prioritised adaptation options

**Purpose:** To set out a mechanism to prioritise the measures using predetermined assessment criteria through a multi-criteria decision process. Choosing between various options often requires trade-offs since not all of the options will deliver the best overall outcome. Using a set of relevant criteria is a collaborative and transparent way of prioritising the interventions/measures suggested in the previous activity (Step 4a).

### Expected outcomes/ outputs:

Completed table with each of the proposed options scored against the five criteria and ranked.

### Resources needed:

A3 printout of Worksheet Table 4.

### Estimated duration:

45 minutes



### TIP

Weightings can be applied to the criteria to capture if some are more important than others, but this may add a level of complexity that may not be needed or add value.

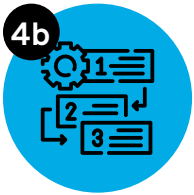
The participants will nominate the selection criteria as they relate to these four prompts:

- **Impact on people**—Will this measure have a positive impact on the community, especially women?
- **Technology**—Is there technology? Is it easy to operate and maintain? Are the necessary skills and capacity available locally?
- **Environment**—Does the measure have a positive or negative impact on the environment?
- **Finances**—What is the cost of the option? Consider installation (capital) and operations for an asset or procedure (operating), and behaviour change programs, institutional change management or regulatory approaches.
- **Institutions**—How complex would the institutional collaboration need to be to deliver this option?

### Activity:

- ✓ In groups, the participants discuss and agree on what the five indicators might mean for them, so they have a common understanding as a group. These definitions should be written down.
- ✓ Then for each of the options listed, the group should agree on a relative score (1–3) for each of the criteria. It is perfectly fine to go back and make changes to an earlier score if it was found to be too high or too low after scoring the other options.
- ✓ The score for each option then should be added up and the options ranked according to their total scores.
- ✓ This ranking will provide an indicative idea of the preferred options to respond to the impacts.
- ✓ Each of the small groups should present their results and rationale for scoring.



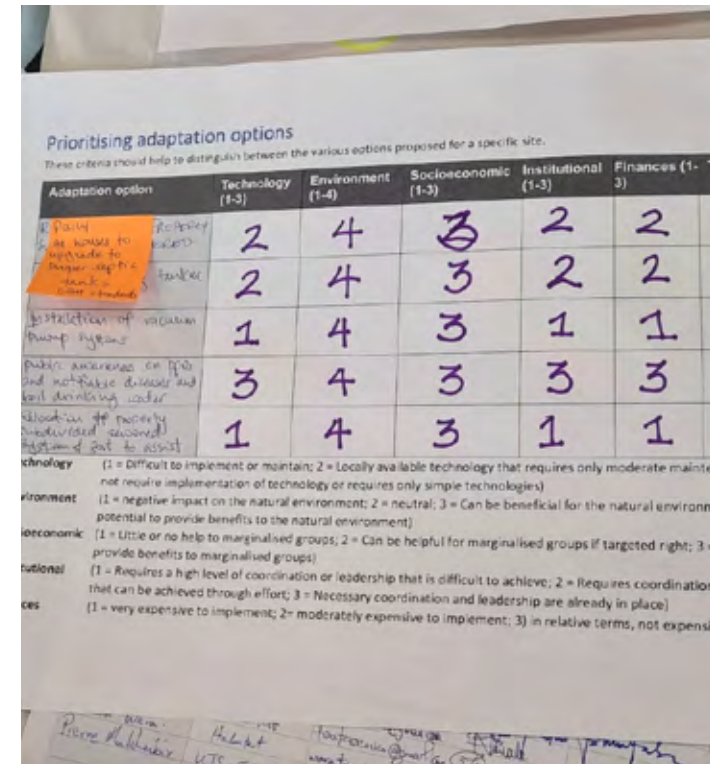


# Prioritised adaptation options continued

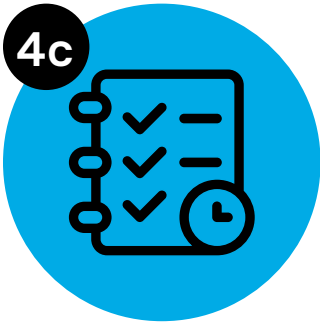
## Worksheet Table 4: Prioritising adaptation options

A multi-criteria decision process is a collaborative and transparent way of prioritising the adaptations listed by the participants. Each area should be assessed on a scale of 1–3 using the table and criteria below.

Adaptation option	Technology (1–3)	Social (1–3)	Environment (1–3)	Socioeconomic (1–3)	Institutional (1–3)	Finances (1–3)	Total



- **Technology:** (1 = difficult to implement or maintain, local skills not available; 2 = locally available technology that requires only moderate maintenance; 3 = does not require implementation of technology or requires only simple technologies)
- **Social:** (1 = challenging and sustained behaviour change required; 2 = moderate behaviour change required; 3 = no behaviour change needed)
- **Environment:** (1 = negative impact on the natural environment; 2 = neutral; 3 = beneficial for the natural environment)
- **Socioeconomic:** (1 = little or no help to local marginalised groups; 2 = can be helpful for local marginalised groups if targeted right; 3 = high potential to provide benefits to local marginalised groups)
- **Institutional:** (1 = requires a high level of coordination, political will or leadership that is difficult to achieve; 2 = requires coordination, political will or leadership that can be achieved through effort; 3 = necessary coordination, political will and leadership are already in place)
- **Finances:** (1 = very expensive to implement; 2 = moderately expensive to implement; 3 = in relative terms, not expensive to implement)



PHASE 4: PLANNING THE ADAPTIVE RESPONSES

# Adaptive planning

**Purpose:** To capture the options that need to be undertaken in the near term, and those longer-term actions. Specifically, consider the sequence of actions under a slow onset sea level rise scenario, and then for a much more rapid onset scenario.

**Expected outcomes/ outputs:**

An investment plan for implementing a range of adaptations for each priority area.

**Resources needed:**

The list of ranked adaptation options for each priority area determined from the previous activity (Step 4b); flip chart paper with the Now, Next, Later investment planning framework drawn on it (or a printout of Worksheet Tool 4 on A3 paper); markers; sticky notes.

**Estimated duration:**

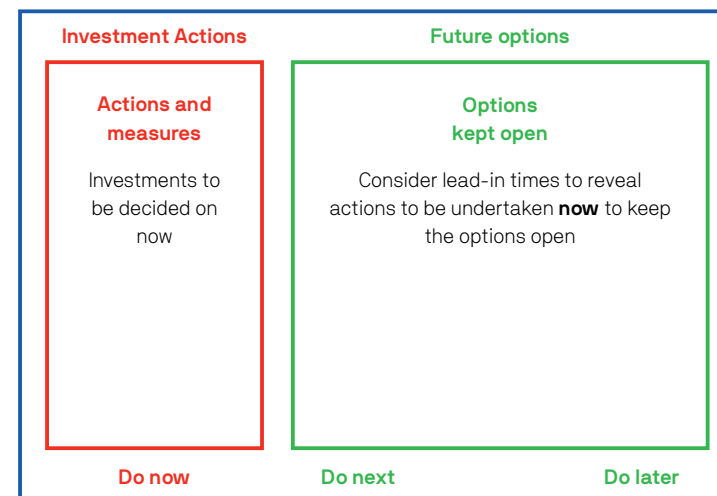
1 hour 30 minutes

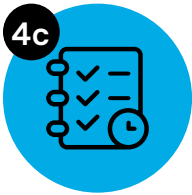
**Activity:**

- ✓ Complete for each of the top three adaptation options the participants ranked for their priority area(s).
- ✓ Specifically, the participants should list changes to monitoring, financing, policy/legislation, planning, learning, environmental management and social engagement that are needed to make the specific adaptation options successful. Each action/mechanism/process should be written down on a sticky note. They should consider what specific actions, mechanisms and processes are needed to make the adaptation happen, such as ensuring supporting regulations are in place, training appropriate staff, purchasing land for infrastructure options, designing awareness materials, etc.
- ✓ Using the Now, Next, Later frame, the participants should locate the adaptation options and supporting lead-in actions into the time frame. The sticky notes with the actions should be placed into the Now (1–5 years from now), Next (5–15 years from now) or Later (15+ years from now or later) column, depending on when they are needed.
- ✓ It is important to not close out future potential options, and to keep them available for later implementation (under ‘Do Next’ or ‘Do Later’). This might mean thinking about which foundational supporting actions will be needed, such as securing additional land for example, preparing the construction plans now, or designing the communication materials now so the option can be more quickly implemented when the need for it is triggered in the future.

- ✓ Two investment plans should be created: one for slow onset scenario in which the effects of sea level rise come on slower or as expected, and another for a rapid onset scenario in which effects of sea level rise occur quicker than expected.

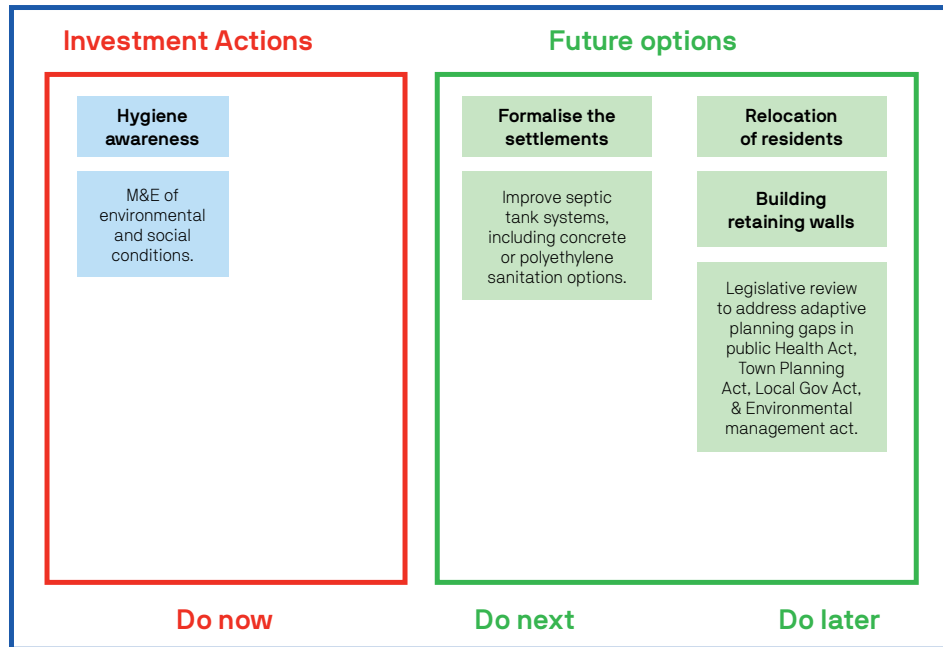
**Worksheet Tool 4: Now, Next, Later investment planning framework**



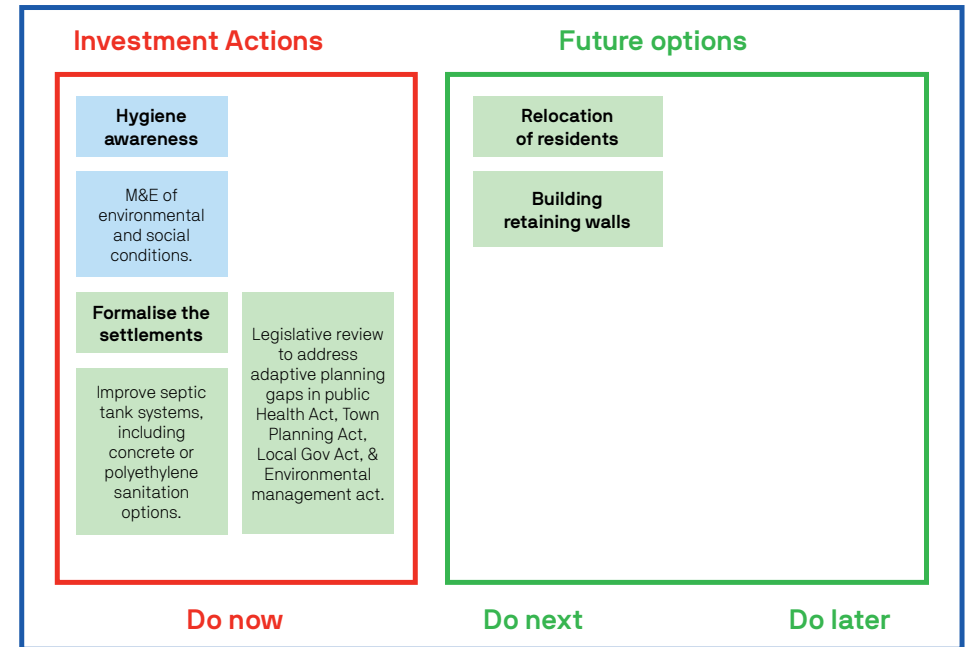


# Adaptive planning continued

## Slow onset scenario impacting on informal settlements



## Rapid onset scenario impacting on informal settlements



### CASE STUDY: SUVA, FIJI

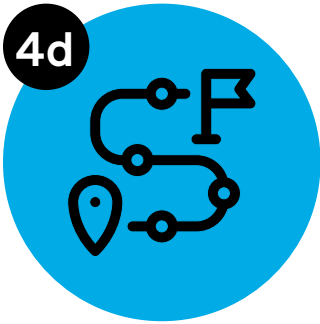
One hotspot identified by participants in the Suva, Fiji, workshop was a coastal informal settlement that experienced human waste overflowing into the living environment when coastal flooding occurred.

The participants came up with seven actions for a **slow onset scenario** of sea level rise over the three time periods:

- ‘Do now’ (over the next 5 years)—raise community awareness on hygiene; monitor social and environmental conditions;

- ‘Do next’ (in 5–10 years)—formalise the settlements; replace septic systems with properly designed concrete or polyethylene septic tank; and
- ‘Do later’ (in 10+ years)—relocated households; build retaining wall; revise health and environmental legislation.

Under a **rapid onset scenario**, the actions were moved forward to the ‘Do now’ and ‘Do next’ timeframes.



PHASE 4: PLANNING THE ADAPTIVE RESPONSES

# Action plan

**Purpose:** To plan the lead in actions for the deployment of the options—who will do what when? Also, to identify the opportunities to support the implementation of the options and ensure all risks to the implementation of the adaptation options are prevented as far as practically possible.

**Expected outcomes/ outputs:**

A clear plan on whose responsibility it is to do what actions, to ensure accountability. A plan for integrating the adaptation plans from this process into the broader sanitation servicing planning process.

**Resources needed:**

The adaptation investment plans from the previous step (Step 4c); Worksheet Tables 5 and 6.

**Estimated duration:**

2 hours 45 minutes

**Activity: Assigning responsibilities to actions (30 mins)**

Once the options and related lead-in actions have been sequenced on the Now, Next, Later investment planning framework, the participants should detail the following for each action:

- ✓ Which agency is responsible for implementing the actions/processes/mechanism going forward?
- ✓ Approximate timing for each phase of the action plan (i.e., around what year should it be done by) for each of the two scenarios.
- ✓ What current planning processes would this best fit into?

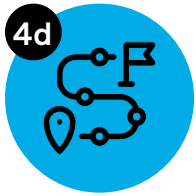


**TIP**

The overall purpose of the action plan may differ depending on who is involved in the activity. If key decision-makers are not present, the intent of the action planning process may be to present recommendations to decision-makers. If people responsible for taking certain actions are not present, additional steps will be needed to plan how to communicate the recommended actions to them and gain their feedback. Hence, when facilitating this activity, you should guide the participants to consider who the action plan is for and how it needs to be presented.

**Worksheet Table 5: Describing the actions/interventions**

Action	Who will be responsible for the action	By when	What current planning processes would this best fit into?



## Action plan continued

### Activity: Challenges and opportunity considerations (30 mins)

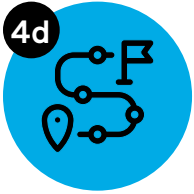
- ✓ For the whole action plan, the participants should consider and document social, technical, environmental, economic, political or legal challenges or opportunities that may be encountered in implementation of the action plan. This should include consideration of what resources (staffing, workloads, budgets, information, training) are needed throughout the action plan.
- ✓ Prepare a list of the top three challenges and opportunities. Using Worksheet Table 7, describe for each one:
  - How this item will be addressed, what actions will be needed.
  - Who will be responsible for these actions—allocate responsibility/who has the mandate to do it?
  - By when—specify the timing.
  - What resources are needed (staffing, information, funding)/who has the resources to undertake the action?

**Worksheet Table 6: Challenges and opportunities**

	Challenges	Opportunities
Social		
Technical		
Environmental		
Economic		
Political		
Legal		

**Worksheet Table 7: Describing the actions/interventions**

Action in response to challenge or opportunity	Who (person and/or organisation)	By when	What is needed for this action to succeed (e.g. resources)?

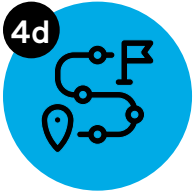


## Action plan continued

### Activity: Ongoing actions and integration into business-as-usual planning processes (30 mins)

- ✓ Each group should agree on who (person, department and organisation) will have ongoing responsibility for coordinating the delivery of the action plan.
- ✓ How will the delivery of the plan be facilitated and monitored? For example, either through regular meetings, agenda items on existing forum or working groups, or assigned authority.
- ✓ All participants should consider and record the following:
  - How do they intend to incorporate the actions assigned to them in the action plan into their ongoing planning within their organisations?
  - Is there scope to make changes to existing practices or improve existing infrastructure?
  - How will the tools and process they have used in the handbook be integrated into their day to day planning work?
  - How will they will pass on the learning and tools to their colleagues?





## Action plan continued

### Activity: Wrap up (75 mins)

- ✓ Each group should present the action plan for their priority area(s) to the whole workshop and take feedback from the other groups.
- ✓ The process for presenting the final action plan to the respective organisations/departments for whom it may be relevant, should also be outlined.
- ✓ Facilitate a discussion/reflections on the process they have followed and the usefulness of the thinking tools and final action plans they have developed (this could be done using a paper-based or online survey tool).
- ✓ Close and thank the participants for their time and valuable inputs.



### CASE STUDY: MATARAM, INDONESIA

In Mataram, Indonesia, the workshop participants presented action plans to department leadership on implementing three adaptation actions:

1. strengthening communications, information and education on sanitation and sea level rise for the public;
2. detailed mapping of sanitation infrastructure at risk; and
3. development of more climate resilient sanitation facilities and infrastructure.

Due to time limitations in the workshop, the participants could only add detail at a high level, but the action plans laid out priorities that could be explored in-depth at a later time. Department leadership (who were not present at the entire workshop) asked questions about the thinking behind the action plans and reflected on possible commitments to operationalise the plans.

# Annexes



# 1

## Annex 1: Types of data for understanding the context

The following types of data may be useful for understanding the status of sanitation infrastructure and flows of waste, sea level rise impacts, and the socioeconomic context in the city:

### Sanitation data

- survey data and/or spatial map of types of containments used by households
- spatial map of public/shared infrastructure assets such as sewers, treatment facilities, pumping stations, transfer stations, etc.
- data on transport and treatment (or lack thereof) of wastewater and faecal sludge (e.g., proportion of tanks discharging effluent to drains; proportion of containment units that are emptied; proportion of sludge that is emptied that is taken to treatment; proportion of sewered wastewater that is delivered to treatment; etc.)
- information on the functionality and coverage of treatment and emptying services.

### Environmental data

- elevation maps that outline low-lying areas
- spatial maps of areas that are prone to tidal or coastal flooding (e.g., coastal areas that flood during high tide or storm surges; areas flooded by rivers when high tides and rainfall coincide)
- spatial maps of areas where the groundwater table is relatively high.

### Socioeconomic data

- spatial maps of where informal settlements or low-income families live
- spatial maps of where diarrhoeal or other WASH-related diseases are relatively high
- number of houses located in coastal areas or on tidal rivers.

# 2

## Annex 2: Example adaptation options

Below are a range of adaptation options that could be implemented to support more climate resilient sanitation (adapted from Climate resilient urban sanitation in Indonesia: Hazards, impacts and responses in four cities.)

### Clear institutional responsibilities and flexible management and service delivery arrangements

1. Greater coordination between central, regional, provincial, NGO and other organisations working in sanitation and/or climate change.
2. Clarify responsibilities between sanitation service delivery authorities versus disaster response authorities when preparing for and responding to climate impacts on sanitation.
3. Plan for scheduled desludging before the beginning of the wet season.
4. Conduct training to build the capacity of local government sanitation stakeholders on climate change impacts and possible response options.
5. Establish regional climate working groups as a centre for climate knowledge, data and support. Ensure their scope includes sanitation and its interlinkages with other sectors.

### Risk- and vulnerability-informed planning and decision-making

6. Consider climate risk in an ongoing review of city sanitation strategies.
7. Increase sharing and access to data between agencies that can inform risk and vulnerability assessments.
8. Review and/or adapt building permits to require that sanitation facilities are raised above average flood levels and areas prone to high storm surges.
9. If there is a regional action plan for climate change, integrate sanitation into climate action priorities.

### Maintaining capacity for continual adaptation through monitoring evaluation and learning

10. Support sanitation service providers to monitor weather conditions so they can prepare their services accordingly.
11. Monitor incidences of diarrhoea and the practice of open defecation following extreme weather events.
12. Conduct periodic reviews of sanitation infrastructure to learn how they are affected by climate hazards.
13. Develop a database of on-site sanitation facilities to identify priority on-site improvement in high-risk locations and facilitate proactive or preventative emptying.
14. Regularly monitor the water quality of water supplies and recreational water bodies during high and low rainfall periods to identify critical sanitation/water interaction and assess the influence of climate on treatment and disposal services.

## 2

## Annex 2: Example adaptation options continued

### Sustainable and responsive financing for both preventive measures and disaster response

15. Consider higher operation and maintenance financial needs in system design, sizing and business models.
16. Consider the existing sources and additional funding needs in annual budgets to prepare for and respond to climate impacts on sanitation, and ensure it is available to vulnerable populations most exposed to climate change.
17. Consider options to mobilise households' willingness to invest in climate resilient sanitation.

### Creative, strengths-based user engagement and awareness

18. Improve climate change literacy—provide information to people about the threat of disease and epidemics—and how sanitation and climate interacts with these threats.
19. Socialise the construction of good quality and resilient septic tanks and the contact information of desludging services.
20. Alert the general public about incoming extreme weather through locally suitable communication channels, paying attention to reach vulnerable or marginal groups.
21. Conduct formative research to determine the barriers and potential solutions to better household preparation for climate impacts on sanitation.
22. Incentivise households to build and maintain a proper septic tank (e.g., through rebates) and emptying their tanks (particularly prior to the wet season) to increase resilience and reduce impacts from climate hazards.

### Robust or flood resistant infrastructure options

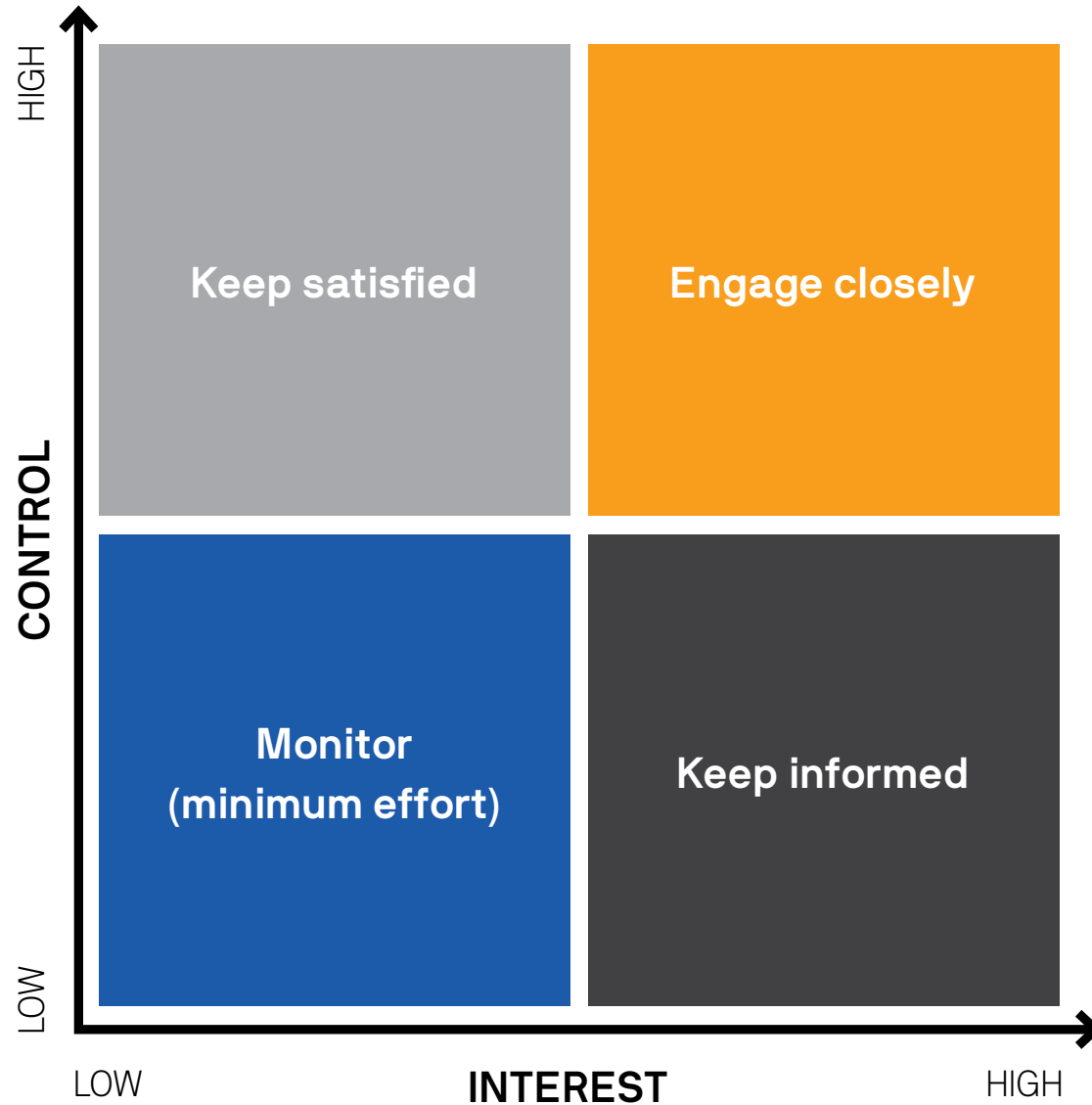
23. Raise septic tanks and pit toilets, containment units, pump stations, or treatment facilities higher above ground.
24. Bury sewers and/or anchor sewers to the ground or provide robust support to resist force of flowing floodwater.
25. 'Floating' septic tanks and/or toilets that use buoyancy to float on top of rising water levels/tides.
26. Waterless toilet options that do not require a water supply that could be disrupted by flooding.
27. Submersible pumps that still function when inundated with floodwater.
28. Install non-return/flap valves on sewers/pipes to prevent backflow into containment units or toilets.
29. Increase the size of the buffer at treatment facilities for accepting higher volumes of waste during wet periods due to inflow and infiltration.
30. Promote the construction of watertight septic tanks (possibly prefabricated), pump stations, electrical housings and inspection holes, and enforce standards for construction.

31. Ensure manholes on sewers fit properly so they do not pop out too easily when pressure in sewers is elevated.
32. Arrange a 'Certificate of Acceptability of Function' to certify that certain sanitation technologies are working properly.
33. Provide portable emergency toilets in flooded areas.
34. Support sanitation service providers, such as emptying providers or treatment plant operators, to develop operational plans for extremely wet conditions.

# 3

## Annex 3: Worksheet tables and tools

Worksheet tool 1:  
Institutional mapping



# 3

## Annex 3: Worksheet tables and tools continued

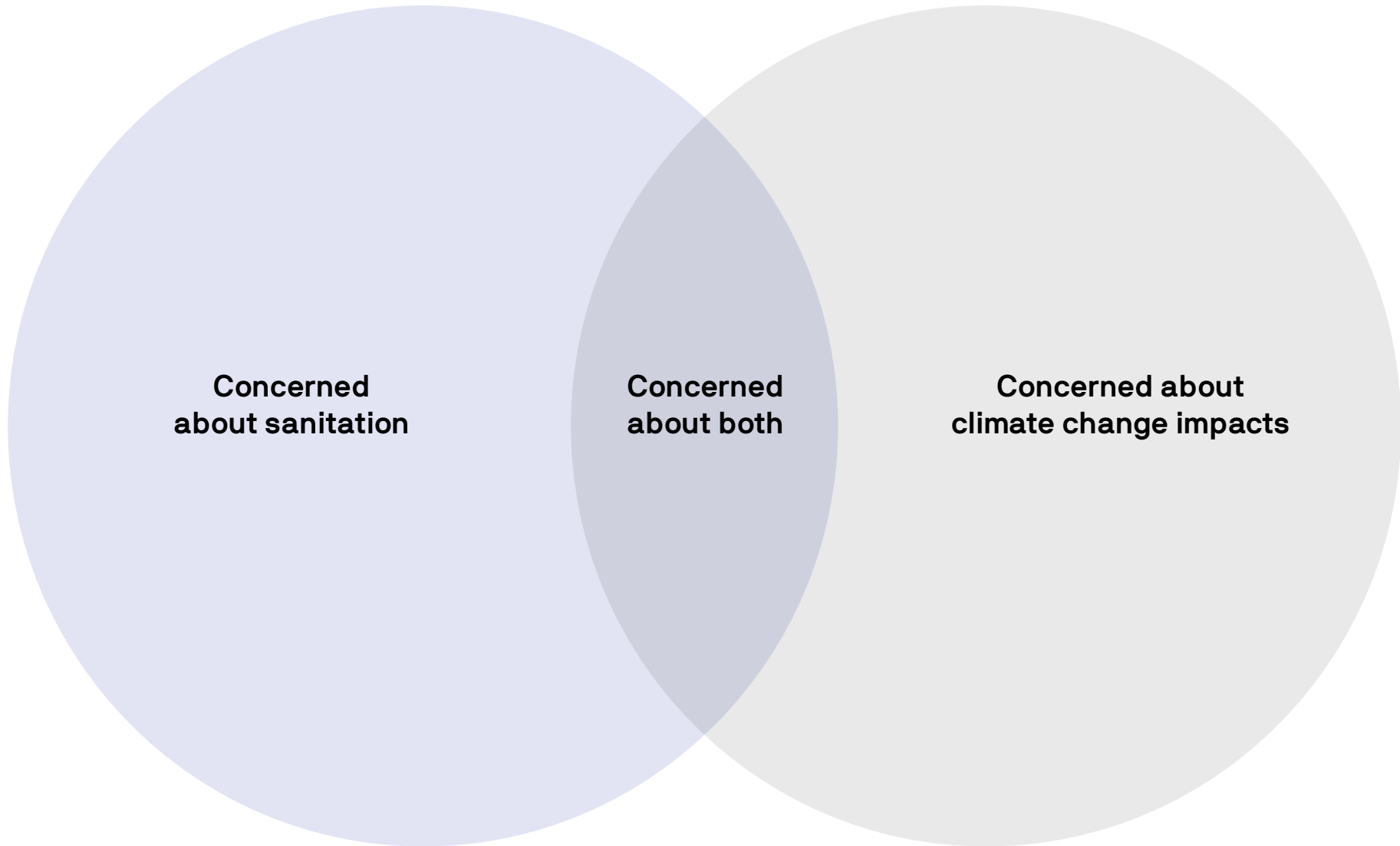
### Worksheet Table 1: Institutional landscape

Urban sanitation service	Who is responsible for:			
	Regulations	Planning	Approvals	Operations
e.g., sewer services				
e.g., septic tanks and pit latrines				
e.g., emptying/desludging services				
e.g., treatment/disposal services				

**3**

**Annex 3: Worksheet tables and tools** continued

**Worksheet tool 3: Institutional focus**



# 3

## Annex 3: Worksheet tables and tools continued

### Worksheet table 2: Rating and prioritisation of potential hot spot due to the likely impact of future sea level rise and storm surges

For the areas with a high likelihood of storm surges and SLR impacts, assess them to determine their relative importance

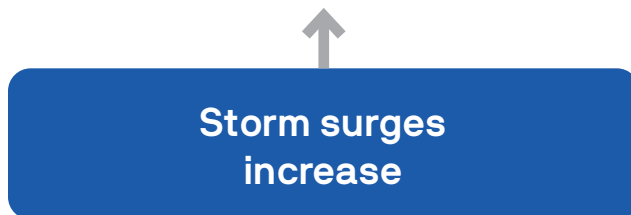
Name of area	Infrastructure (1-3)	Socioeconomic (1-3)	Environment (1-3)	Health(1-3)	Total	Ranking

- **Infrastructure:** (1 = no impact on sanitation infrastructure; 2 = impacts on localised sanitation assets, e.g. small number of pits or small pump station; 3 = impacts on large number of septics/pits or critical sanitation assets, e.g. major pump station or wastewater treatment facility)
- **Socioeconomic:** (1 = high-income area; 2 = some low-income housing; 3 = high density of low-income housing/informal settlement)
- **Environment:** (1 = low impact on groundwater, waterways and ocean; 2 = moderate impact on ground water, waterways and ocean; 3 = high impact on ground water, waterways and ocean)
- **Health:** (1= low impact on residents' health; 2 = some impact on residents' health; 3 = major impact on residents' health)

# 3

## Annex 3: Worksheet tables and tools continued

### Worksheet Tool 3: Impact mapping process





# 3

## Annex 3: Worksheet tables and tools continued

**Worksheet Table 3: Indicators of change**

<b>Indicator of change</b> List each indicator of change and the data to be collected	<b>Threshold for action</b> (When will the intensity of the impacts get so bad that action will be required to remedy the situation?)	<b>Who is responsible for monitoring this indicator (for collecting this data) ?</b>	<b>Who should they share the information with or inform about the indicator levels?</b>

# 3

## Annex 3: Worksheet tables and tools continued

### Worksheet Table 4: Prioritising adaptation options

These criteria should help to distinguish between the various options proposed for a specific site.

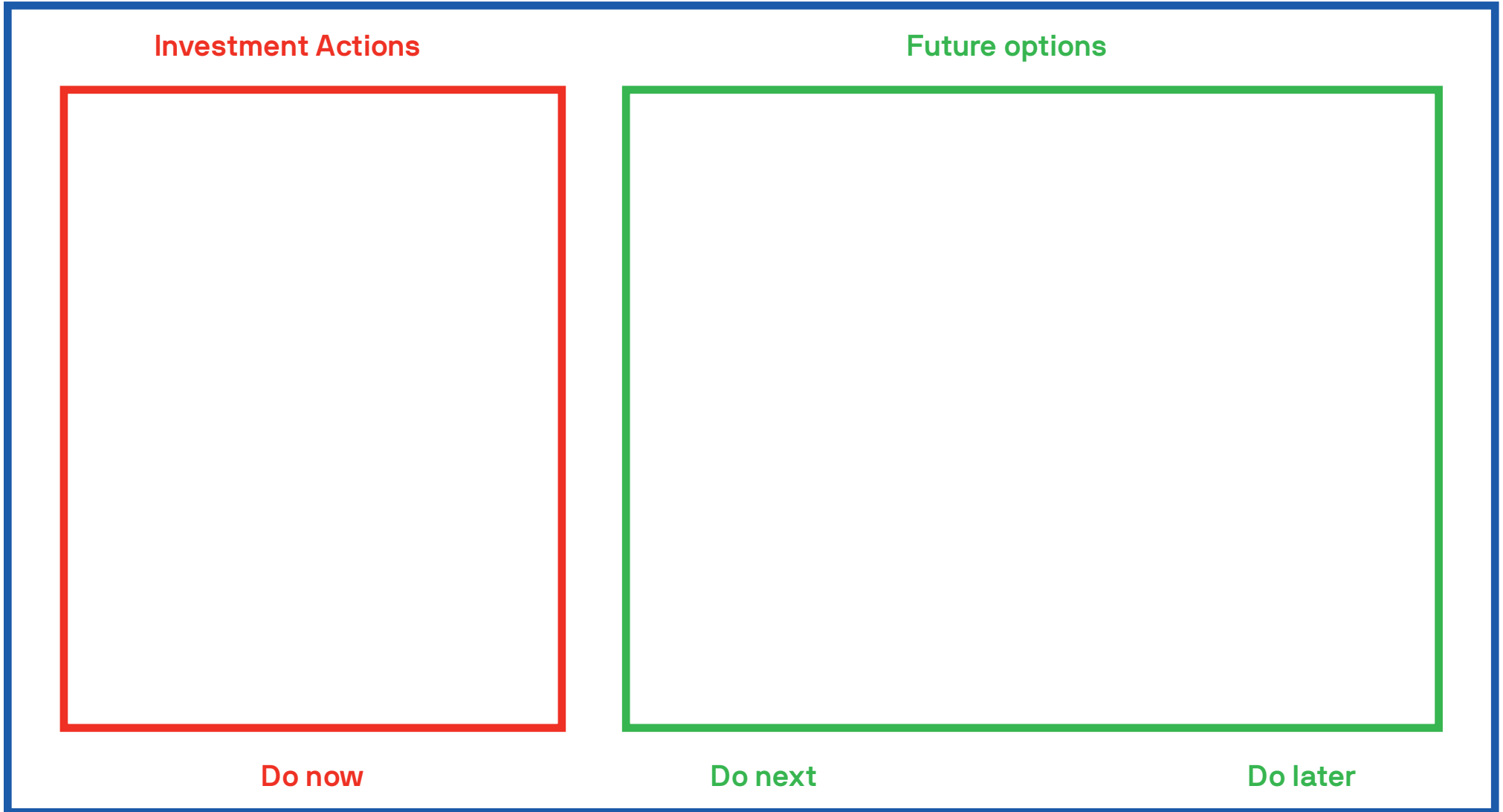
Adaptation option	Technology (1–3)	Social (1–3)	Environment (1–3)	Socioeconomic (1–3)	Institutional (1–3)	Finances (1–3)	Total

- **Technology:** (1 = difficult to implement or maintain, local skills not available; 2 = locally available technology that requires only moderate maintenance; 3 = does not require implementation of technology or requires only simple technologies)
- **Social:** (1 = challenging and sustained behaviour change required; 2 = moderate behaviour change required; 3 = no behaviour change needed)
- **Environment:** (1 = negative impact on the natural environment; 2 = neutral; 3 = beneficial for the natural environment)
- **Socioeconomic:** (1 = little or no help to local marginalised groups; 2 = can be helpful for local marginalised groups if targeted right; 3 = high potential to provide benefits to local marginalised groups)
- **Institutional:** (1 = requires a high level of coordination, political will or leadership that is difficult to achieve; 2 = requires coordination, political will or leadership that can be achieved through effort; 3 = necessary coordination, political will and leadership are already in place)
- **Finances:** (1 = very expensive to implement; 2 = moderately expensive to implement; 3 = in relative terms, not expensive to implement)

# 3

## Annex 3: Worksheet tables and tools continued

### Worksheet tool 4: Now, Next, Later investment planning framework



# 3

## Annex 3: Worksheet tables and tools continued

**Worksheet table 5: Describing the actions/interventions**

Action	Who will be responsible for the action	By when	What current planning processes would this best fit into?

# 3

## Annex 3: Worksheet tables and tools continued

### Worksheet Table 6: Challenges and opportunities

Identify potential challenges and opportunities that may hinder or help the implementation of the measure and actions identified in the previous step.

	Challenges	Opportunities
Social		
Technical		
Environmental		
Economic		
Political		
Legal		

Prepare a list of the top three challenges and opportunities. For each one, describe:

- How this item will be addressed, what actions will be needed.
- Who will be responsible for these actions – allocate responsibility/who has the mandate to do it?
- By when – specify the timing
- What resources are needed (staffing, information, funding) / who has the resources?

# 3

## Annex 3: Worksheet tables and tools continued

### Worksheet Table 7: Describing the actions/interventions

Action in response to challenge or opportunity	Who (person and/or organisation)	By when	What is needed for this action to succeed (e.g. resources)?

# Contact

## For more information please contact:

Professor Pierre Mukheibir  
Dr Jeremy Kohlitz  
Professor Juliet Willetts

### University of Technology Sydney

PO Box 123 Broadway, NSW, 2007  
[www.isf.uts.edu.au](http://www.isf.uts.edu.au)

Phone: +61 02 9514 4950

Email: [Pierre.Mukheibir@uts.edu.au](mailto:Pierre.Mukheibir@uts.edu.au)

