Understanding climate risks and vulnerabilities for a specific water supply system

Slide pack with examples from Sandy Bay St Vincent

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Background

This lessons learned report focuses on **Understanding climate risks and vulnerabilities for a specific water supply system.** It has been produced as knowledge product component of the *'Climate proofing the Sandy Bay water services improvement project, St. Vincent'*

Aim

- It is intended to provide guidance and awareness on climate risk assessment for water supply, focussing on examples from the Sandy Bay project.

Audience

- It is intended for use by those persons scoping or undertaking climate risk assessment studies either as part of an existing process (such as the Caribbean Climate On-line Risk Assessment Tool (CCORAL)) or for developing bespoke approaches.

This slide pack is module one of four:

Module 1
- Understanding climate risks and vulnerabilities for a specific water supply system.

Module 2
- Identifying and appraising measures to build climate resilience of a specific water supply system

Module 3
- Identifying and appraising the costs and benefits of building the climate resilience of a specific water supply system

Module 4
- Identifying and attracting potential climate funds for building the climate resilience of a specific water supply system

Structure

1. What is climate resilience and why does it matter?

2. A climate risk assessment framework for water supply systems
    1. Step 1 – Define Risk Assessment Matrix
    2. Step 2 – Assess baseline risks
    3. Step 3 – Prepare climate change and socio-economic projections
    4. Step 4 – Assess future risks

3. Important considerations in the approach and using the outputs

4. Group exercise – Risk assessment

What is climate resilience and why does it matter?

Saint Vincent and the Grenadines is already vulnerable to disasters and extreme weather

The climate of SVG is projected to become hotter, and while there is less certainty about rainfall, there is potential that rain will fall in heavier events, while annual rainfall volume reduces.

Additionally, projections suggest that the frequency of Category 4 and 5 storms and maximum storm intensity will increase. This would add an additional stressor to the already vulnerable community, exacerbating existing challenges.

Flood damage in Sandy Bay November 2016. Photos Senator Camillo M Gonsalvez
http://floodlist.com/america/eastern-caribbean-floods-november-2016

What is climate resilience and why does it matter?

"Resilience is the ability to cope with, and recover from, disruption, and anticipate trends and variability in order to maintain services for people and protect the natural environment now and in the future".

UK's Office of Water regulator, definition of resilience 2015

Illustrative example of infrastructure vulnerability: Supply line crossing river bed – high flows and debris risk

A climate risk assessment framework for water supply systems

A climate risk assessment study is often used to identify and quantify the climate risks, and support in identifying and screening potential measures which could improve the resilience of the system.

Potential questions which a risk assessment can answer include:

- **What are the priority risks to the proposed project?**
- **What are infrastructure assets at highest risk?**
- **Which areas are risk 'hotspots'?**
- **How will climate risks change into the future?**

Sandy Bay example: The Risk Assessment on proposed water supply system upgrade project was used to identify adaptation options

A climate risk assessment framework for water supply systems

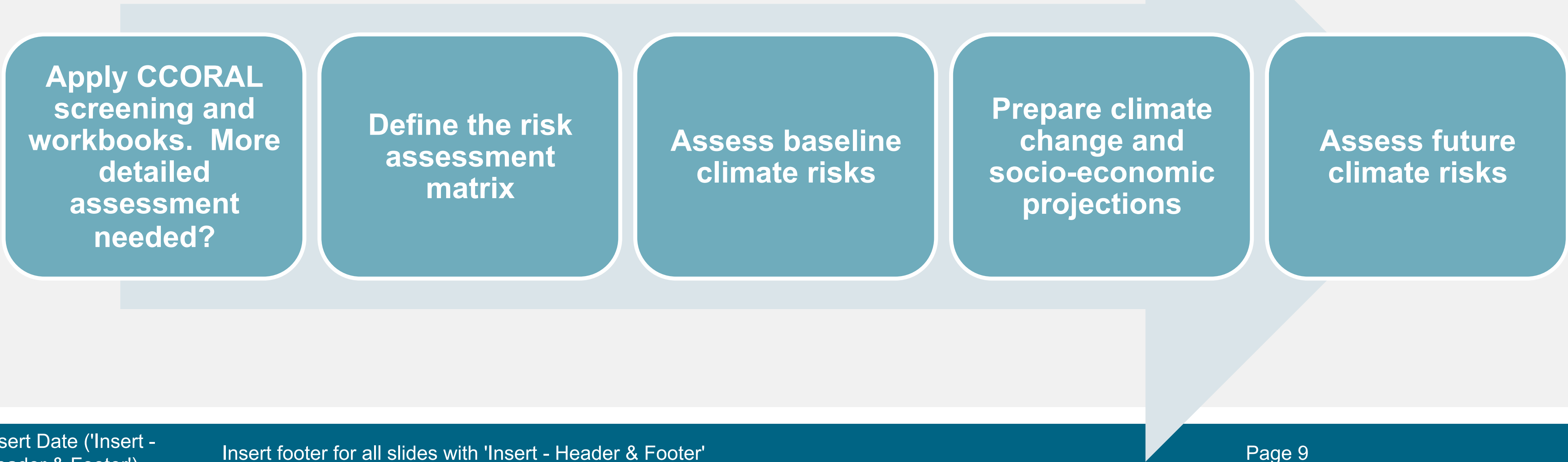
In addition to quantifying risks, risk assessment can provide the following benefits:

- Identifying and prioritising investment options to reduce risks
- Increasing knowledge and awareness in your organisation to better manage risks
- Identifying where more data is needed to monitor risks
- Demonstrating due diligence to external funding partners and making the case for external financial support, especially accessing climate finance

A climate risk assessment framework for water supply systems

Sandy Bay entry point:

- CCORAL applied to initial project concept
- CCORAL identified need for more detailed assessment of risks during detailed project development
- Structured risk assessment approach developed and applied to Sandy Bay, see below
- This structured approach can be used during the application of the CCORAL workbooks, or to support other climate risk assessments outside the CCORAL framework



Step 1 - Define Risk Matrix

		Likelihood of occurrence				
Severity of impact		Very unlikely to occur	Occasional occurrence	Moderately frequent	Occurs often	Very frequent occurrence
	Extreme	**High risk**	**High risk**	**Extreme risk**	**Extreme risk**	**Extreme risk**
	Major	**Moderate risk**	**High risk**	**High risk**	**Extreme risk**	**Extreme risk**
	Moderate	**Low risk**	**Moderate risk**	**High risk**	**High risk**	**Extreme risk**
	Low	**Low risk**	**Low risk**	**Moderate risk**	**High risk**	**High risk**
	Very low	**Negligible risk**	**Low risk**	**Low risk**	**Moderate risk**	**High risk**

Step 1 - Define Risk Matrix

Example likelihood and severity categories

		Occurs less than once per decade	Occurs between one per year and once per decade	Typically occurs once each year	Occurs once per month	Occurs multiple times per month
		Very unlikely to occur	Occasional occurrence	Moderately frequent	Occurs often	Very frequent occurrence
Water supply interruption for one week or more, or potential for consumption to cause major public health incident	Extreme	High risk	High risk	Extreme risk	Extreme risk	Extreme risk
Water supply interruption for one week or less, or potential for consumption to cause serious illness	Major	Moderate risk	High risk	High risk	Extreme risk	Extreme risk
Water supply interruption for one day or less, or potential for consumption to cause minor illness	Moderate	Low risk	Moderate risk	High risk	High risk	Extreme risk
Minor aesthetic impact on water	Low	Low risk	Low risk	Moderate risk	High risk	High risk
Negligible impact	Very low	Negligible risk	Low risk	Low risk	Moderate risk	High risk

Step 2 – Identify and assess baseline risks

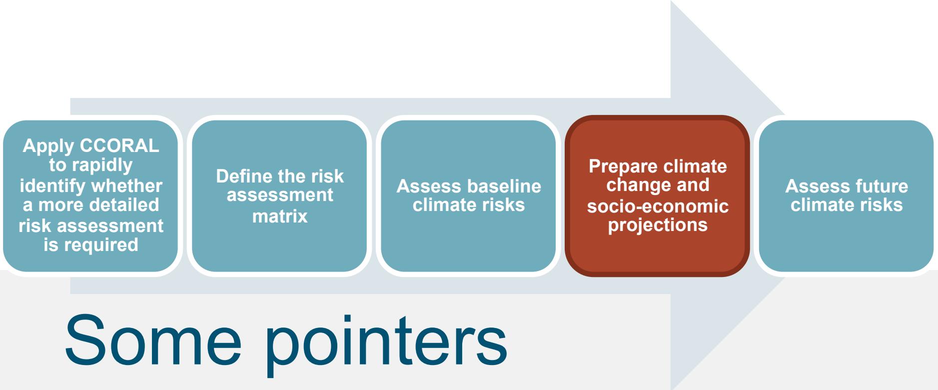
	Likelihood	Likelihood comment	Severity	Severity comment	Risk score
Risk 1 – Heavy rainfall induced turbidity	*Very frequent occurrence*	Occurs 10 times per month in dry season	*Moderate*	Health impacts unknown, disruption usually lasts <1 day	***Extreme risk***
Risk 2 – Landslides and high river flow damage to infrastructure	*Occasional occurrence*	Has occurred in 2013	*Major*	Caused disruption for 1 week	***High risk***
Risk 3 – Bacterial and chemical pollution of raw water during heavy rainfall	*Occasional occurrence*	Not known to occur, but uncertainty is high. Low likelihood assumes chlorination is effective	*Low if chlorination is effective*	Potential for health impact if chlorination fails or chemical contamination occurs	***Low risk***
Risk 4 – Bacterial and chemical pollution of raw water during dry season low flows	*Very unlikely to occur*	Not known to occurred in historical period	*Low if chlorination is effective*	Potential for health impact if chlorination fails or chemical contamination occurs	***Low risk***
Risk 5 – Drought induced reduction in source yield	*Very unlikely to occur*	Not known to occurred in historical period	*Major*	Potential for service interruptions of long duration, health risks of alternative sources	***Moderate risk***
Risk 6 – High water demand during dry periods leading to low pressure and shortages	*Very unlikely to occur*	Not known to occurred in historical period	*Moderate*	Potential for service interruptions	***Low risk***

- Apply CCORAL to rapidly identify whether a more detailed risk assessment is required
- Define the risk assessment matrix
- **Assess baseline climate risks**
- Prepare climate change and socio-economic projections
- Assess future climate risks

Step 2 – Identify and assess baseline risks

Risk 1 – Heavy rainfall induced turbidity
Risk 2 – Landslides and high river flow damage to infrastructure
Risk 3 – Bacterial and chemical pollution of raw water during heavy rainfall
Risk 4 – Bacterial and chemical pollution of raw water during dry season low flows
Risk 5 – Drought induced reduction in source yield
Risk 6 – High water demand during dry periods leading to low pressure and shortages

		Likelihood of occurrence				
Severity of impact		Very unlikely to occur	Occasional occurrence	Moderately frequent	Occurs often	Very frequent occurrence
	Extreme	**High risk**	**High risk**	**Extreme risk**	**Extreme risk**	**Extreme risk**
	Major	5 – Drought low flows	2 – Landslide and storm damage	**High risk**	**Extreme risk**	**Extreme risk**
	Moderate	6 – Dry weather demand	**Moderate risk**	**High risk**	**High risk**	1 – Turbidity
	Low	4 – Bacterial / chemical contamination in low flows	3 – Bacterial / chemical contamination in storm runoff	**Moderate risk**	**High risk**	**High risk**
	Very low	**Negligible risk**	**Low risk**	**Low risk**	**Moderate risk**	**High risk**



Future projections

Some pointers

- Climate change projections may include changes in temperature, evaporation rates, rainfall amounts, seasonality, the occurrence of extreme events and sea level rise amongst others.
- The high uncertainty associated with climate change projections can make it difficult to define a clear change, therefore a central and upper estimate is useful to show uncertainty.
- The Caribsave Risk Atlas provides country level climate change projections across the Caribbean and is a valuable source of information for producing projections for climate risk assessment.
- Climate change science continues to evolve, and it is therefore important to periodically review the climate change projections.

Apply CCORAL to rapidly identify whether a more detailed risk assessment is required

Define the risk assessment matrix

Assess baseline climate risks

Prepare climate change and socio-economic projections

Assess future climate risks

Future projections

Examples from SVG

SVG annual average temperature change projections (degrees Celsius from 1970-1999 baseline)

Scenario	2020s			2050s			2080s		
	Lower	Central	Upper	Lower	Central	Upper	Lower	Central	Upper
GCM ensemble Low emissions (B1)	0.3	0.7	0.6	0.6	1.1	1.3	0.9	1.5	2
GCM ensemble Med emissions (A1B)	0.3	0.7	1.1	1	1.4	2	1.3	2.1	2.9
GCM ensemble High emissions (A2)	0.4	0.7	0.9	1.1	1.4	2	1.9	2.5	3.4
RCM (ECHAM4) High (A2)								3.1	
RCM (HadCM3) High (A2)								2.4	

SVG annual average rainfall change projections (percentage of 1970-1999 baseline)

Scenario	2020s			2050s			2080s		
	Lower	Central	Upper	Lower	Central	Upper	Lower	Central	Upper
GCM ensemble Low emissions (B1)	-18	-5	11	-34	-7	9	-41	-10	13
GCM ensemble Med emissions (A1B)	-19	-6	8	-31	-12	5	-53	-16	3
GCM ensemble High emissions (A2)	-26	-5	10	-36	-9	3	-66	-18	6
RCM (ECHAM4) High (A2)								-22	
RCM (HadCM3) High (A2)								-30	

Apply CCORAL to rapidly identify whether a more detailed risk assessment is required → Define the risk assessment matrix → Assess baseline climate risks → Prepare climate change and socio-economic projections → **Assess future climate risks**

Assess future risks

Risk	Climate change drivers	Direction of change	Impacts on system	Non-climate compounding factors
Risk 1 – Heavy rainfall induced turbidity	Increase / decrease in heavy rainfall Increase / decrease in hurricane activity	**Direction of change uncertain**	Increased / decreased frequency of raw water turbidity incidents	Deforestation and farming in upper catchment could increase risk
Risk 2 – Landslides and high river flow damage to infrastructure	Increase / decrease in heavy rainfall Increase / decrease in hurricane activity	**Direction of change uncertain**	Increased / decreased frequency of damage to infrastructure	Deforestation and farming in upper catchment could increase risk
Risk 3 – Bacterial and chemical pollution of raw water during heavy rainfall	Increase / decrease in heavy rainfall	**Direction of change uncertain**	Increased / decreased frequency and / or severity of raw water storm runoff contaminated with microbes / chemicals	Deforestation, farming in upper catchment (animal waste / chemicals) could increase risk
Risk 4 – Bacterial and chemical pollution of raw water during dry season low flows	Decrease in seasonal rainfall / Increase in temperature	**Decrease in rainfall likely, increase in temperature very likely**	Increased frequency and / or severity droughts, reducing river flows and the dilution of	Farming in upper catchment (animal waste / chemicals) could increase risk
Risk 5 – Drought induced reduction in source yield	Decrease in seasonal rainfall / increase in temperature	**Decrease in rainfall likely, increase in temperature very likely**	Decrease in source dry weather flow in average and drought years	Land use change in upper catchment reducing groundwater infiltration could increase risk
Risk 6 – High water demand during dry periods leading to low pressure and shortages	Increase in temperature	**Increase in temperature very likely**	Increased dry weather demand from consumers places strain on source and system capacity	Consumer behaviour and socio-demographic changes leading to higher demand could increase risk
Risk 7 – Loss of electrical supply at Sandy Bay treatment plant (proposed option only)	Increase / decrease in heavy rainfall Increase / decrease in hurricane activity	**Direction of change uncertain**	Increased / decreased frequency of power outages	Upgrading of electricity systems could improve resilience and reliability to offset this risk

Key considerations

- Risks are based on historical period, how can we identify ‘emergent’ risks which have not been seen yet?
  - Look at other water systems? Do hydrological / hazard modelling for future conditions?
  - What about very unlikely risks with very serious consequences (black swan events) e.g. volcanic eruption?
- Risks to who / what?
  - Depending on the perspective (water customer / water utility / other water user / catchment user) the risks may be different. Need to be clear about who / what is at risk.
- Non-climate risks
  - Assessment only covers climate risks, but these may be less important than non-climate risks e.g. pollution, vandalism, plant failure etc.
  - Could be extended to cover all risks, or integrated within water safety plans
- Data limitations
  - The reliability of the assessment depends on the quality of the data available
  - Large and complex problems may merit modelling of future conditions e.g. source yields etc, if sufficient calibration data is available

Risk assessment group exercise

Groups of 4 – 6

See handout

Overview of activity

1. Identify an important water supply system to apply the risk assessment process
2. Identify the main impacts on the system which negatively affect performance or result in significant costs
3. Using the risk assessment matrix, assess the risk for each impact
4. Consider how future changes might affect the identified risks
5. Present your findings to the rest of the group

		Likelihood of occurrence				
		Very unlikely to occur	Occasional occurrence	Moderately frequent	Occurs often	Very frequent occurrence
Severity of impact	Extreme	High risk	High risk	Extreme risk	Extreme risk	Extreme risk
	Major	Moderate risk	High risk	High risk	Extreme risk	Extreme risk
	Moderate	Low risk	Moderate risk	High risk	High risk	Extreme risk
	Low	Low risk	Low risk	Moderate risk	High risk	High risk
	Very low	Negligible risk	Low risk	Low risk	Moderate risk	High risk

HR Wallingford
Working with water

ACCLIMATISE
building climate resilience

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Global Water Partnership
Caribbean

CWSA

Caribbean Community
Climate Change Centre

CDKN
Climate & Development
Knowledge Network