UTS Institute for Sustainable Futures

ClimateFIRST: Climate Framework to Improve the Resilience of Sanitation Technologies

Summary note | September 2023

NEWgenerator developed by University of South Florida.
Credit: Daniel Yeh, University of South Florida

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Citation

UTS-ISF, 2023. ClimateFIRST: Climate Framework to Improve the Resilience of Sanitation Technologies: Summary note. Prepared by University of Technology Sydney, Institute for Sustainable Futures for the Bill and Melinda Gates Foundation. Authors: Jeremy Kohlitz, Ian Cunningham and Juliet Willetts

About the authors

The University of Technology Sydney – Institute for Sustainable Futures (UTS-ISF) conducts applied research to support water and sanitation policy and practice in Asia and the Pacific. UTS-ISF provide partners with technical expertise including climate change; planning, governance and decision-making; gender equality and inclusion; public health and water resources; monitoring; and policy and practice advice.

Acknowledgements

The authors would like to thank Freya Mills, Pierre Mukheibir, Nuhu Amin, Jay Faletta and Jess MacArthur for their contributions to this work, as well as University of South Florida, Ankur Scientific, Georgia Institute of Technology, Cranfield University and iDE. Input and guidance from Brian Arbogast, Jan-Willem Rosenboom and Alyse Schrecongost and funding support from the Bill and Melinda Gates Foundation are also gratefully acknowledged.

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Cover photo: The Sky Latrine developed by iDE. Credit: Tyler Kozole, iDE
Graphic design and layout by Jo Yuen: www.joyuendesign.com.au

About ClimateFIRST

The Climate Framework to Improve the Resilience of Sanitation Technologies (ClimateFIRST) provides a structured way to consider how climate hazards can affect a sanitation technology and how the risks of these hazards can be reduced through technology design

Who is it for?

Sanitation technology designers, research and development personnel, commercial partners and implementation teams in low-and middle-income countries

What types of sanitation technologies?

Small- to medium-scale onsite and decentralised containment and treatment technologies intended for low- and middle-income country settings

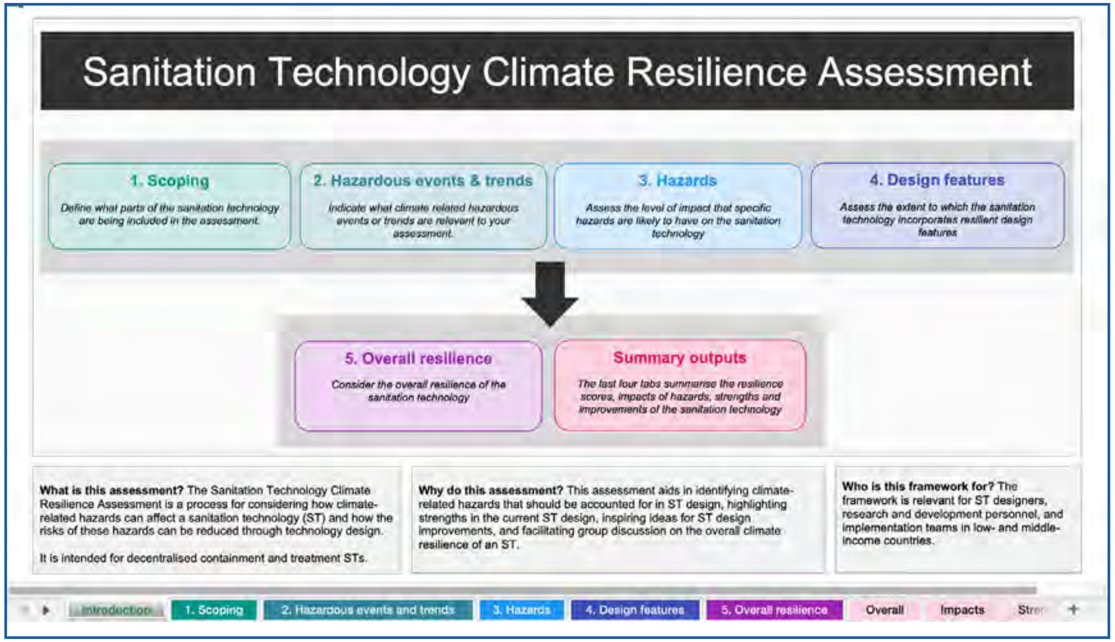
How does ClimateFIRST work?

Users of ClimateFIRST guide themselves through an assessment of their chosen sanitation technology with Excel-based templates. The templates instruct the users on to how to consider potential impacts of climate hazards, resilience design features, and judge overall resilience of the technology. ClimateFIRST then consolidates the users' inputs into summary reports

Why use ClimateFIRST?

ClimateFIRST facilitates critical reflection on sanitation technologies that contributes to:

- identify key risks that can undermine the effectiveness of the technology
- generate ideas for strengthening resilience in technology design
- judge overall resilience, towards comparing the relative merits of different technologies.



Steps in ClimateFIRST

This briefing note gives an overview of the core components of ClimateFIRST, with illustrative examples to demonstrate what the use of ClimateFIRST looks like, the steps to be followed and the outputs.

1. Scoping
2. Hazardous events & trends
3. Hazards
4. Design features
5. Overall resilience

1 Scoping

Scoping the assessment

The first step is to define which parts of the sanitation technology are to be included in the assessment.

Steps

ClimateFIRST requires the user to consider which elements of the technology will be included and excluded in the assessment.

For instance, an assessment could be done that excludes a component to be constructed locally (such as a storage tank) and which is complementary to the main technology. Equally, the assessment could include that component. User interfaces and superstructures can also either be included or excluded from the assessment.

Defining relevant hazardous events and trends

The second step is to define which climate related hazardous events or trends are relevant to your assessment

Steps

Climate FIRST provides eight different possible hazardous events and trends (HET) that are commonly associated with climate change.

The user selects those hazardous events and trends (HET) relevant for the climate context in which they are assessing the sanitation technology.

2 Hazardous events & trends

***Step 2:** Indicate what climate related hazardous events or trends are relevant to your assessment.*

***Instructions:** Select hazardous events and trends that are relevant for the climate context in which you are assessing the ST and fill in the grey boxes in the table below. Hover over the cells or refer to the accompanying guidelines for more details.*

Hazardous events & trends (HET)	Is the HET relevant?	HET Characteristics
Flood Fluvial flooding (overflowing of a river or other water body) and pluvial flooding (precipitation intensity exceeds drainage capacity)	☑ Yes	
Changing precipitation patterns Increased variability in seasonal precipitation patterns and inter-annual precipitation	☑ Yes	
High sea level Permanent inundation from sea level rise or temporary seawater intrusion/coastal flooding due to sea level rise, storm surge, high tide or wave setup	☑ Yes	
Fire weather Weather conditions (temperature, soil moisture, humidity, and wind) that trigger and sustain fires	☑ Yes	
Severe wind High wind velocity due to thunderstorms, wind gusts, tornados, or cyclones	☑ Yes	
Droughts Episodic combination of low rainfall and runoff deficit, and evaporation that leads to dry soil (i.e. hydrological drought)	☑ Yes	
Changing air temperature Increased variability in diurnal and seasonal air temperature	☑ Yes	
Extreme heat Episodic high surface air temperature events that are potentially exacerbated by humidity	☑ Yes	

Identifying impacts of hazards on sanitation technology

After initial scoping, the first step is to assess the level of impact that specific hazards are likely to have on the sanitation technology.

Steps

ClimateFIRST generates a list of potential climate hazards, with specific examples of each.

Users first consider whether the hazard is relevant for their technology and context.

After deliberating how the technology would fare if it was exposed to the hazard, the users assign an impact rating of low, medium, or high to the hazard and provide a justification.

Example

In assessing the NEWgenerator toilet created by the University of South Florida, the users rated the first four hazards as low impact. However, the 'exposure to flames' hazard was rated as moderate impact because of its potential to destroy solar panels and other components.

Potential Hazard	All hazards for relevant HETs	Relevant?	Impact Rating	Justification
Landslides		Yes	Low Impact	The NG is not particularly susceptible to landslides. The container would also be able to handle small/moderate sized slides.
Corrosion		Yes	Low Impact	All electrical components are water tight and would resist corrosion.
Erosion		Yes	Low Impact	This is a possibility especially in sites with easily eroded soils and significant slopes.
Expansion / contraction of soils		Yes	Low Impact	This would only impact the EQ tank.
Exposure to flames		Yes	Moderate Impact	Container would shield most/all components in the event of a fast moving grass fire. Longer-term exposure to high temps could destroy the solar panels and internal components.

4 Design features

Considering design features for resilience

Next, users consider the extent to which the sanitation technology incorporates resilient design features.

Steps

ClimateFIRST lists up to 25 design features that can make sanitation technologies more resilient to climate hazards.

If the design feature is already integrated into the technology, the users describe how it supports resilience.

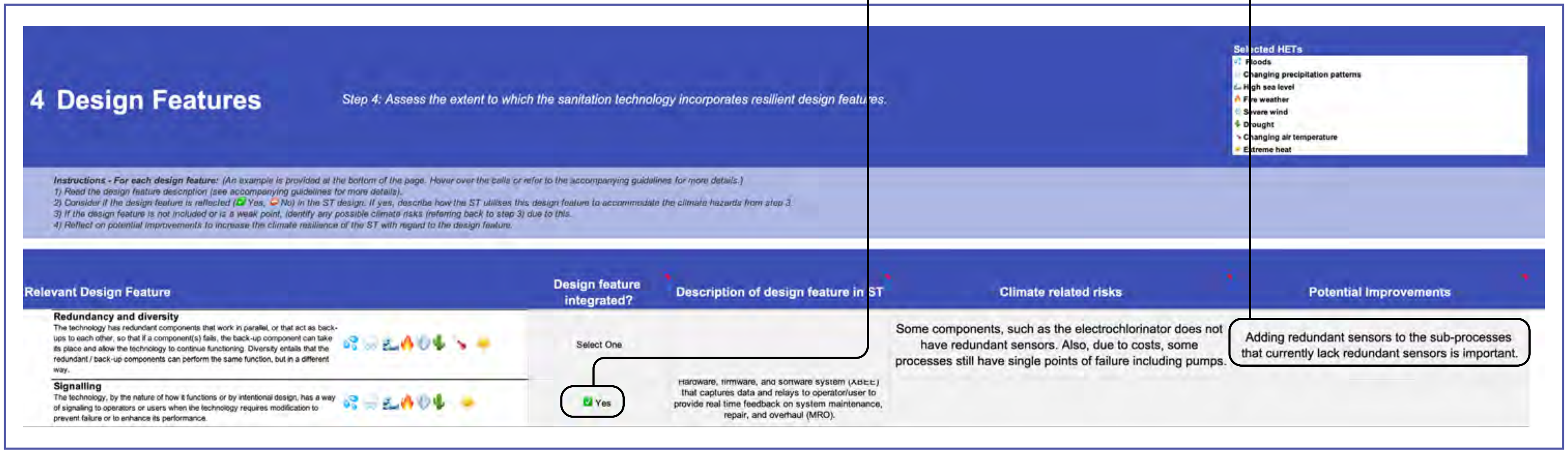
If the technology does not integrate the design feature, the users consider if this creates a risk for the technology and how the feature might be added to the technology.

A Example

In assessing the Cranfield University Circular Toilet (b-HRT), the users found the 'signalling design' feature is already integrated, enabling quick repaid and maintenance of the technology.

B Example

Considering the 'redundancy and diversity' design feature of NEWgenerator toilet, the users noted that redundant sensors could be added to improve reliability.



4 Design Features

Step 4: Assess the extent to which the sanitation technology incorporates resilient design features.

Selected HETs: Floods; Changing precipitation patterns; High sea level; Fire weather; Severe wind; Drought; Changing air temperature; Extreme heat

Instructions - For each design feature: *(An example is provided at the bottom of the page. Hover over the cells or refer to the accompanying guidelines for more details.)*
1) Read the design feature description (see accompanying guidelines for more details).
2) Consider if the design feature is reflected (Yes, No) in the ST design. If yes, describe how the ST utilises this design feature to accommodate the climate hazards from step 3.
3) If the design feature is not included or is a weak point, identify any possible climate risks (referring back to step 3) due to this.
4) Reflect on potential improvements to increase the climate resilience of the ST with regard to the design feature.

Relevant Design Feature	Design feature integrated?	Description of design feature in ST	Climate related risks	Potential Improvements
Redundancy and diversity The technology has redundant components that work in parallel, or that act as back-ups to each other, so that if a component(s) fails, the back-up component can take its place and allow the technology to continue functioning. Diversity entails that the redundant / back-up components can perform the same function, but in a different way.	Select One		Some components, such as the electrochlorinator does not have redundant sensors. Also, due to costs, some processes still have single points of failure including pumps.	Adding redundant sensors to the sub-processes that currently lack redundant sensors is important.
Signalling The technology, by the nature of how it functions or by intentional design, has a way of signaling to operators or users when the technology requires modification to prevent failure or to enhance its performance.	Yes	Hardware, firmware, and software system (ABEE) that captures data and relays to operator/user to provide real time feedback on system maintenance, repair, and overhaul (MRO).		

Considering design features for resilience continued

There are seven groups of features, each with a number of specific resilience design features:

1 Avoiding exposure to hazards

Design features that reduce the likelihood that critical components and processes of the sanitation technology become directly exposed to a climate hazard.

Includes: raising, burying, portability, and no/low inputs.

2 Withstanding exposure to hazards

Design features that enable the sanitation technology to continue functioning "as normal" (i.e. no changes in hardware or operations) even when exposed to climate hazards.

Includes: armouring and strengthening, oversizing, shapes that distribute pressure, circumvention, and sealing and barriers.

3 Enabling flexibility

Design features that enable the adaptation or reconfiguration of a sanitation technology's hardware components or that enable changes to a sanitation technology's processes or operations so that the sanitation technology can continue providing services when exposed to climate hazards.

Includes: adaptability, modular design, platform design, redundancy and diversity, and signalling.

4 Containing failures

Design features that enable a sanitation technology to continue providing services (albeit potentially degraded) that meet user needs despite damage caused by climate hazards.

Includes: frangibility, fail-operational, and decentralisation.

5 Limiting consequences of complete failure

Design features that minimise the negative consequences of a sanitation technology failing due to a climate hazard.

Includes: safe disposal, reusable material, and fail-silence.

6 Facilitating fast recovery

Design features that enable the sanitation technology to be quickly rebuilt or restored if it is damaged, disrupted or destroyed by a climate hazard.

Includes: repair speed, and accessibility for rapid flaw detection and repair.

7 Providing benefits beyond resilience

Design features that enable the sanitation technology to provide other benefits to people or to other systems that aid in broader community or system resilience.

Includes: reciprocity, hybridising, and transformative capacity.

Judging overall resilience

Finally, users judge the overall resilience of the technology to each hazardous event and trend.

Steps

Based on the proportion of hazards scored as having low, moderate or high impact, ClimateFIRST calculates an overall impact rating for each 'hazardous event or trend' (HET).

The users reflect on how they rated the hazards, the overall impact rating, and the resilience design features, then give a low, medium or high resilience rating for each hazardous event or trend.

Example

In assessing a two-chamber septic tank design, ClimateFIRST scored flooding to have 'moderate impact' based on user inputs to each specific hazard associated with flooding. The users judged the technology to have low resilience to flooding because of the high impact of backflow or disrupted faecal sludge management, and a lack of design features for coping with these hazards.

5 Overall resilience self-assessment

Step 5: Consider the overall resilience of your technology to each hazardous event and trend.

Instructions - for each hazardous event or trend:
1) Look at the overall impact rating that is auto-calculated based on the proportion of low, moderate, and high impact ratings you provided in step 3.
2) Give an overall resilience rating. You may refer back to step 3 and filter the hazards by the HET to remind yourself of the likely impacts.
3) Provide a brief justification for your rating.

	Hazards Impact					Resilience rating	Justification
	Low Impact	Moderate Impact	High Impact	Overall			
Flood	55%	10%	35%		Moderate Impact	Low Resilience	Septic tanks design should resist cracking and floodwater should not ingress into the septic tank. However, backflow through the outlet/soakpit and disruptions to FSM that could cause failures.
Changing Precipitation Patterns	100%	0%	0%		Low Impact		

Summary reports

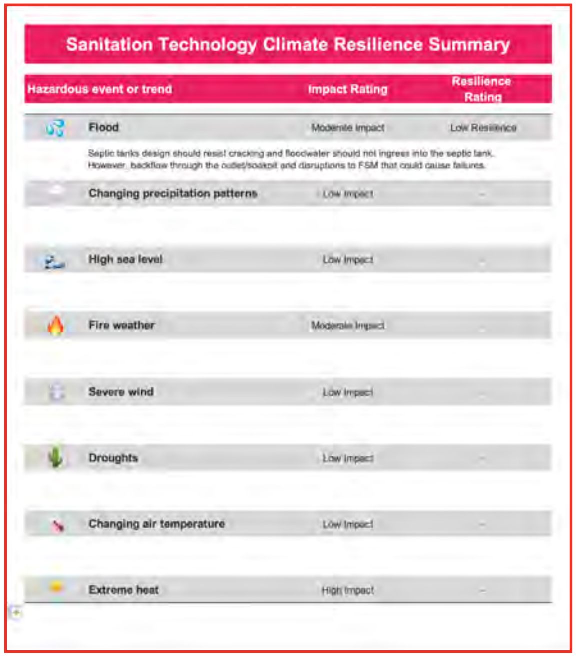
ClimateFIRST collates information provided by the user into four summary reports, including:

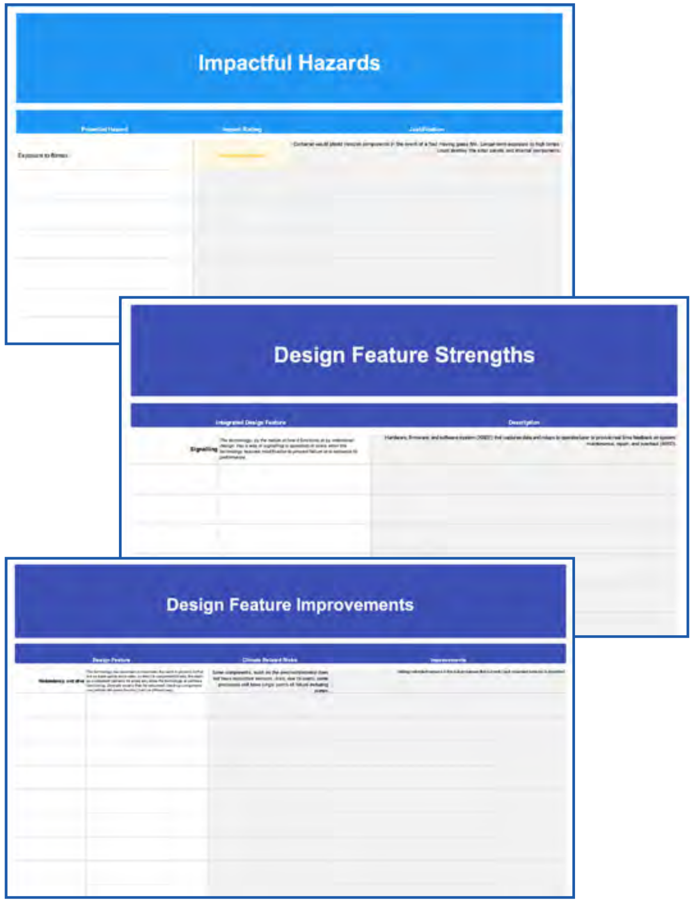
i. Summary of overall resilience to relevant hazardous events and trends

ii. The most impactful hazards identified

iii. Design feature strengths (suitable for marketing of technologies)

iv. Design feature improvements (areas where adjustments are likely to improve the technology resilience).





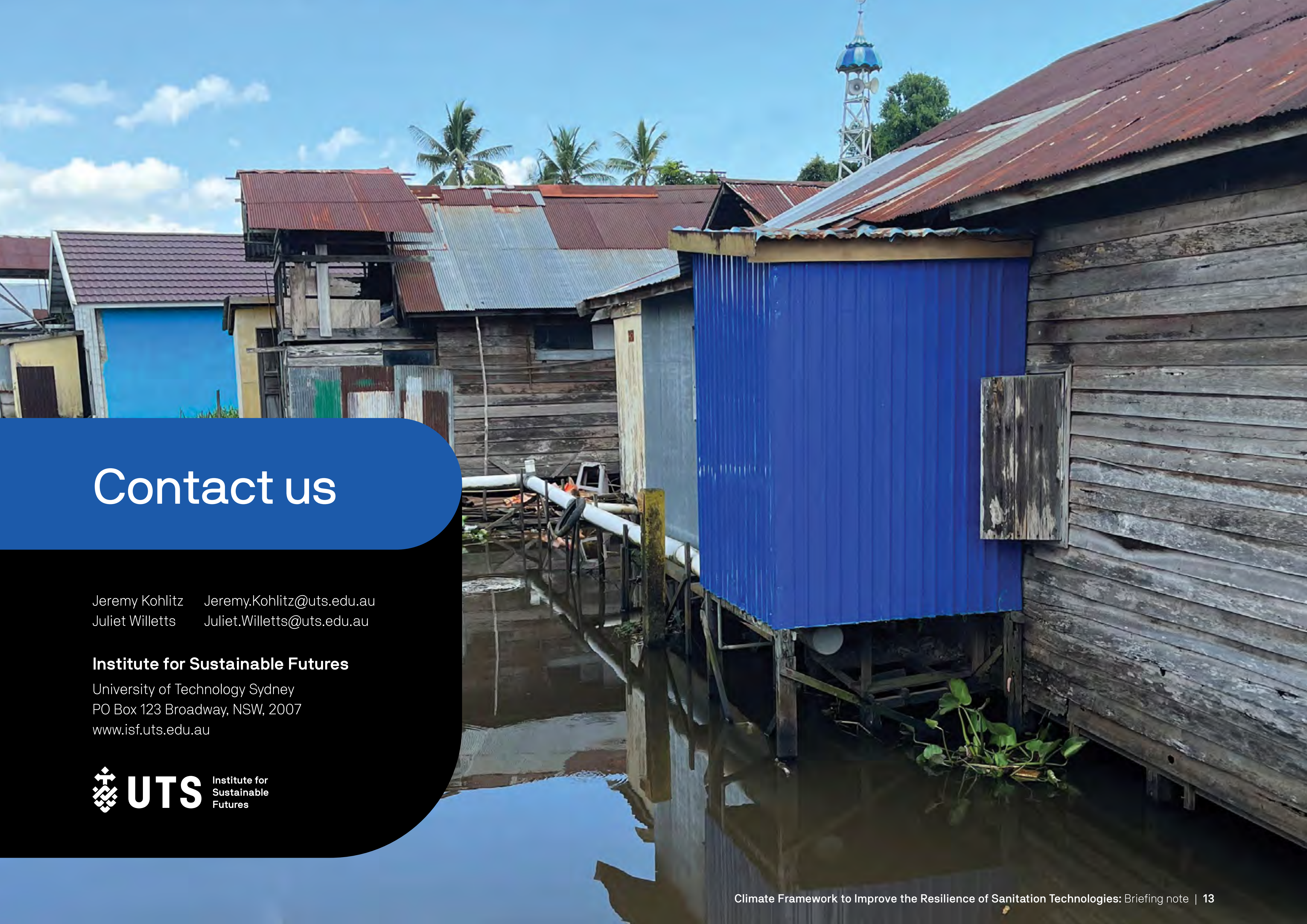
Get started

Materials to get you started on your own sanitation technology resilience assessment are located **here**.

You'll find:

- A full-version of ClimateFIRST
- A lite-version of ClimateFIRST (for quicker assessments)
- A written guide on using ClimateFIRST
- A video guide on using ClimateFIRST
- Examples of completed assessments.

Development of ClimateFIRST was funded by the Bill and Melinda Gates Foundation.



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