UTS Institute for Sustainable Futures

Climate Framework to Improve the Resilience of Sanitation Technologies

How-to Guide | September 2023

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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.

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Disclaimer

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Introduction

The Climate Framework to Improve the Resilience of Sanitation Technologies (ClimateFIRST) aims to support the global sanitation sector to develop sanitation technologies that can better accommodate the effects of increasingly extreme and volatile climates.

ClimateFIRST is used to:

- Identify the potential impact of climate hazards on a sanitation technology.
- Determine how the climate resilience of a sanitation technology can be strengthened through design.
- Score the overall climate resilience of the sanitation technology.

ClimateFIRST is relevant for sanitation technology designers, research and development personnel, and professionals working to implement sanitation technologies, primarily in low- and middle-income countries. ClimateFIRST is intended to be used for decentralised technologies for the containment and/or treatment of human waste.

Photo: UTS

Background

Climate change is dramatically altering physical climate conditions that directly affect sanitation technologies in urban and rural contexts. Consequently, the climate is increasingly likely to drive the failure of sanitation technologies and increase public health risks through the release of faecal pathogens, nutrients and other pollutants into the environment.

The risks that climate hazards cause failures to sanitation technologies can be reduced through improved design of sanitation technologies. The University of Technology Sydney – Institute for Sustainable Futures (UTS-ISF) developed ClimateFIRST to provide guidance on assessing how these failures might occur and how design features can reduce the risks of failure in a given sanitation technology. The design features featured in ClimateFIRST are based on a literature review of the latest thinking in resilient technological design across sanitation and other sectors, and the opinions of sanitation experts. This work was supported by the Bill and Melinda Gates Foundation.

Resilient sanitation technology design is just one component of climate-resilient sanitation service delivery systems — institutional, governance, service, financial, and social aspects are also critical for resilience. As such, ClimateFIRST is not a complete guide to developing climate-resilient sanitation. Instead, it should be considered as a resource focused on technologies, and to be used as part of wider shift towards resilient sanitation for all.

Through use of ClimateFIRST, sanitation designers and implementers will be better equipped to deploy sanitation options that can perform essential functions despite worsening climate hazards.

About this guide

This guide provides how-to instructions and supplementary material to users of ClimateFIRST. ClimateFIRST itself is an Excel-based tool accompanies this guide. A video version of this guide can be found online.

Carrying out an assessment with ClimateFIRST comprises five steps. This guide describes how to carry out each step and provides tips and examples. It also describes how inputs into ClimateFIRST are summarised and provides more detailed information on climate hazards and resilience design features.

The assessment process is comprised of five steps:

1. Scoping: The assessment team describes the sanitation technology, chooses which components of a sanitation technology are included or excluded in the assessment, and identifies the geographical location in which the sanitation technology is being assessed.
2. Hazardous events and trends: The team identifies the hazardous events and trends (HETs), such as flooding or drought, that are relevant to the sanitation technology's location and describe the HETs' characteristics for that location.
3. Hazards: The team assesses the impact of relevant climate hazards (e.g. force of flood waters) that may be associated with the HETs indicated in Step 2 on the sanitation technology.
4. Design features: The team assesses the extent to which the sanitation technology's design features can help the system avoid, reduce or offset the negative impacts of the hazards identified in Step 3, and considers how the design features could be added to the sanitation technology.
5. Overall resilience: The team gives the sanitation technology an overall resilience score against each HET based on their judgements stemming from the previous steps.

ClimateFIRST then provides a summary of the inputs provided by the assessment team across four tabs.

The following sections cover recommended preparations before beginning the assessment, each of the five steps of the assessment process, and interpretation of the summary outputs.

There are two versions of ClimateFIRST: A full version and a lite version. The lite version focuses only on floods and droughts and assesses a smaller range of design features. The lite version is intended for users who do not have time to complete the full version or wish to do a less detailed assessment. This guide covers the full version, but the instructions are applicable to the lite version as well.

Preparation for the assessment

There are many different dimensions to consider when assessing the resilience of a sanitation technology. Consequently, a thorough assessment may require a full day to complete the steps and allow for discussion amongst the assessment team members.

Teams should complete the following preparation prior to carrying out the assessment to make the process efficient.

Preparing for the assessment

The lead for the assessment process should familiarise themselves with ClimateFIRST. They should be confident to lead others through the process and have allocated sufficient time for the group to derive benefit from doing the assessment together.

Assembling the assessment team

Effective assessments and justifiable decisions require a diversity of perspectives. Assessment teams should be comprised of multiple people who are familiar with the design and operation of the sanitation technology. This may include sanitation engineers, designers, research and development personnel, operators or technicians. It could also include commercialisation partners.

Gathering reference materials

In addition to this guidance document, teams should collate relevant drawings, schematics or photos of the sanitation technology being assessed to use as references during assessment deliberations. Teams should also have knowledge of, or access to, historical and predicted climate information for the location/context in which the sanitation technology is being assessed. The climate information should indicate which hazards events and trends (HETs) are, or will likely be, of concern in the chosen locations (see Step 2 of the assessment process).

Photo: UTS

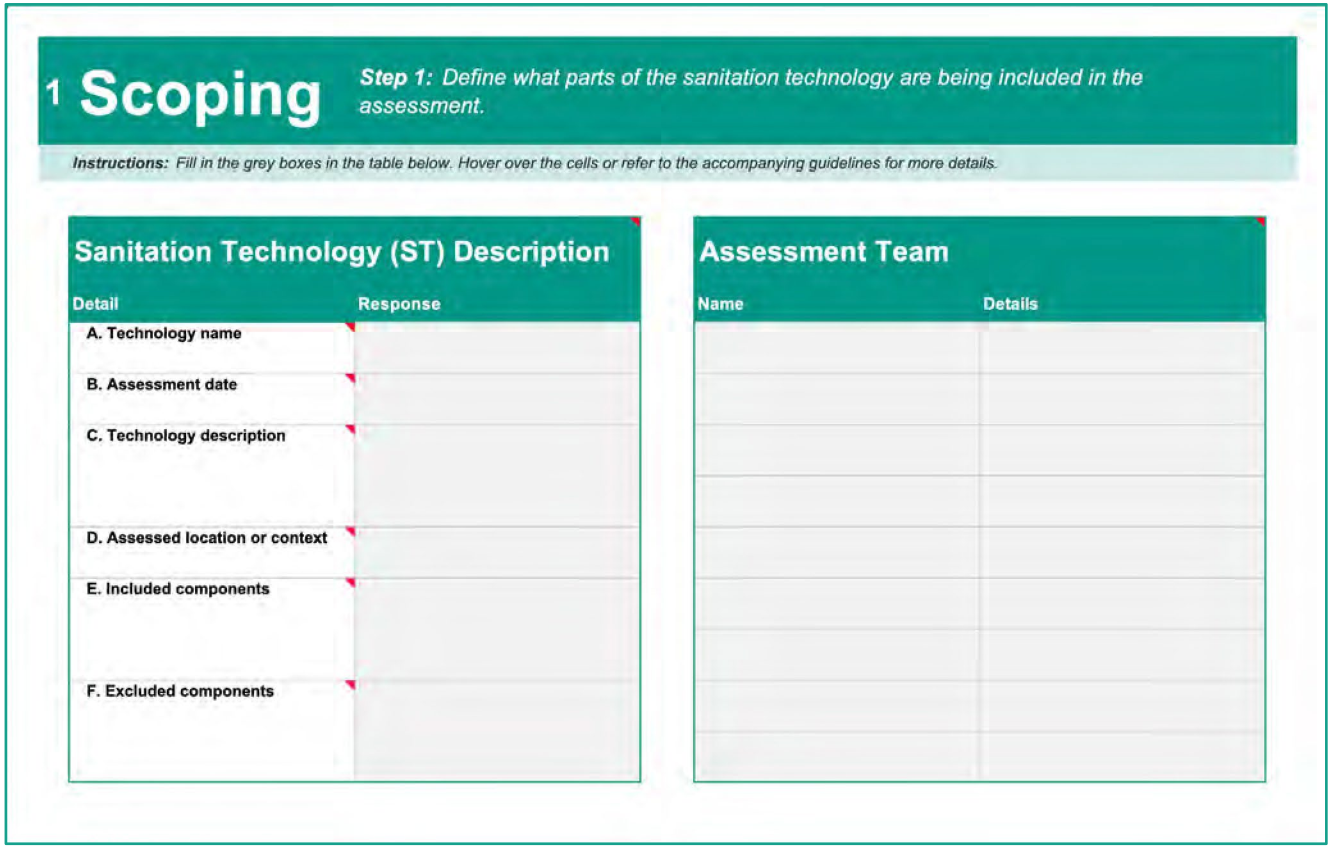
Scoping

The assessment team describes the sanitation technology, chooses which components of an sanitation technology are included or excluded in the assessment, and identifies the geographical location in which the sanitation technology is being assessed.

The assessment team should provide information about the sanitation technology being assessed including its name, the date of the assessment, a brief description of the technology, and names and details (e.g. role, organisation) of the assessment team members.

Implementation location

A location or context in which the sanitation technology is being assessed should be considered. This will help identify the relevant HETs and hazards in subsequent steps and provide a grounded reference point when considering the potential impacts of hazards. The location or context may be a place where the sanitation technology is likely to installed (e.g. rural, coastal Bangladesh).



1 Scoping

Step 1: Define what parts of the sanitation technology are being included in the assessment.

Instructions: Fill in the grey boxes in the table below. Hover over the cells or refer to the accompanying guidelines for more details.

Sanitation Technology (ST) Description

Detail	Response
A. Technology name	
B. Assessment date	
C. Technology description	
D. Assessed location or context	
E. Included components	
F. Excluded components	

Assessment Team

Name	Details

Setting scope

The team should decide which components of the sanitation technology to include in or exclude from the assessment. For example, if the team wants to focus on assessing a containment technology, they may choose to exclude latrine superstructures from the assessment. The choices made during scoping are important because they will influence design considerations and resilience scores later on. The team may come back to this step later on and modify the scoping choices.

ClimateFIRST works best for small- to medium-scale decentralised containment and treatment technologies. It is not designed for expansive, large-scale sewer systems. The team should focus on a specific sanitation technology design and not a generic technology (e.g. a specific septic tank design instead of septic tanks in general).

In addition to the containment or treatment technology itself, the team may choose to include (or exclude) other components, such as:

- The toilet/squatting pan
- Slab
- Pipes
- Junction boxes
- The toilet superstructure or other superstructures housing sanitation technologies
- Protective barriers (e.g. drainage, dykes, roofs, etc.) constructed specifically for the benefit of the sanitation technology.

ClimateFIRST should not be used to assess:

- The above components in isolation from a containment or treatment technology.
- Human resources such as capacity of service providers and service authorities.
- The institutional, financial or social context of the sanitation technology.
- External supporting infrastructure such as roads, electricity grids, and water supplies not constructed specifically for the sanitation technology (although the dependence of the sanitation technology on these will be considered by the assessment team).
- Technologies used for the construction and repair of sanitation technologies (e.g. excavators, cement mixers etc.) and for the emptying and conveyance of waste (e.g. emptying trucks, gulpers etc.) that are not in-situ.

Photo: UTS

Hazardous events and trends

The team identifies the hazardous events and trends (HETs), such as flooding or drought, that are relevant to the sanitation technology's location and describe the HETs' characteristics for that location.

The assessment team should select the HETs and against which the sanitation technology's resilience will be assessed.

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	

Hazardous events and trends continued

ClimateFIRST contains eight HETs for use in this assessment:

Floods: Fluvial flooding (overflowing of a river or other water body) and pluvial flooding (precipitation intensity exceeds drainage capacity)

Changing precipitation patterns: Increased variability in seasonal precipitation patterns and inter-annual precipitation

High sea level: Permanent coastal inundation from sea level rise or temporary seawater intrusion/coastal flooding due to sea level rise, storm surge, high tide or wave setup.

Fire weather: Weather conditions (temperature, soil moisture, humidity and wind) that trigger and sustain fires.

Severe wind: High wind velocity due to thunderstorms, wind gusts, tornadoes or cyclones.

Droughts: Episodic combination of low rainfall and runoff deficit, and evaporation that leads to dry soil (i.e. hydrological drought).

Changing air temperature: Increased variability in diurnal and seasonal air temperature.

Extreme heat: Episodic high surface air temperature events potentially exacerbated by humidity.

These HETs have been shortlisted by the creators of ClimateFIRST as most relevant for sanitation from a broader list provided by the Intergovernmental Panel on Climate Change (page 12-12).

The assessment team should select HETs from this list that are relevant to the location of the sanitation technology. For example, if the sanitation technology is being assessed with reference to landlocked country, the "high sea level" HET may not be relevant and can be deselected. If the sanitation technology is still in design phase, or if it has been deployed in multiple environments, the team may choose to assess the sanitation technology against all HETs rather than focusing on location-specific examples.

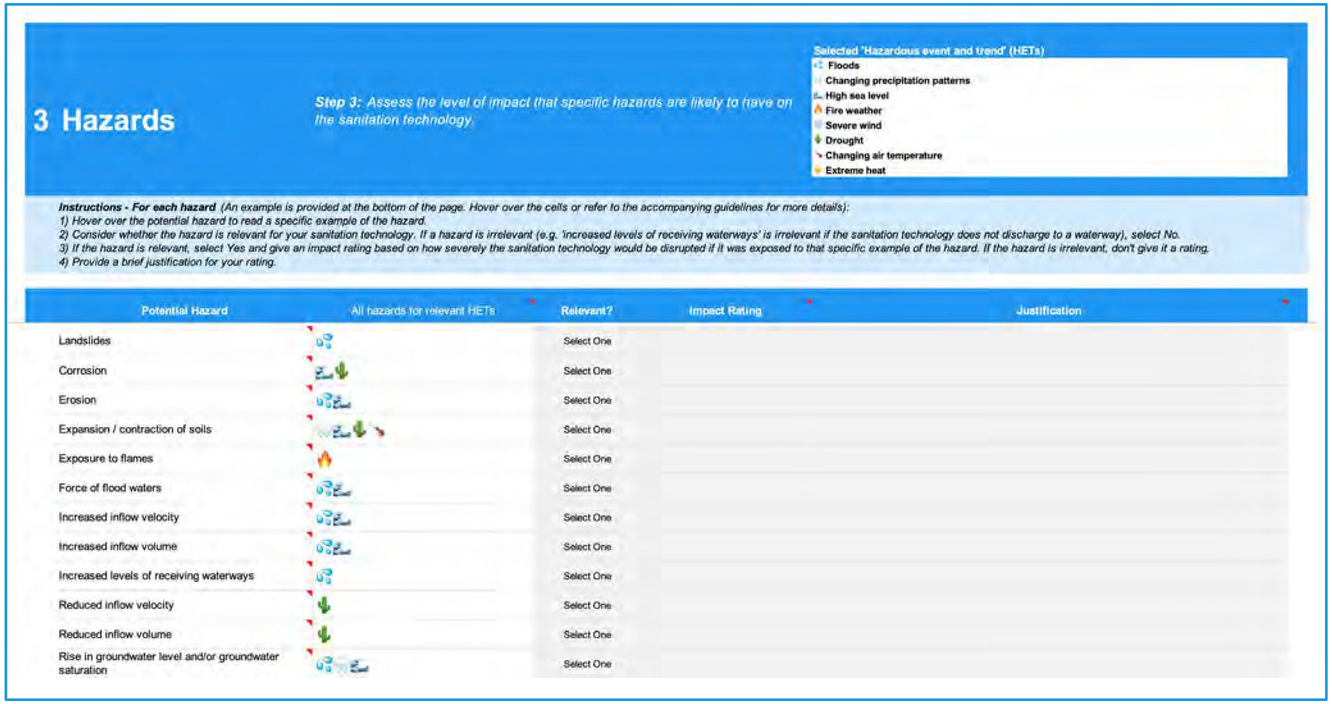
In choosing relevant HETs, the team should consider historical and current climate trends and future climate predictions (e.g. see the World Bank Climate Change Knowledge Portal or the IPCC Interactive Atlas). These trends and predictions may be described briefly in the 'HET Characteristics' column.

In the 'HET Characteristics column', the team can write brief notes about the present and projected nature of the HET in the geographic area in which they are doing the assessment.

It should be noted that a major challenge in designing for climate resilience is the problem of uncertainty. Uncertainty arises from limited knowledge about how climate change will influence HETs in local areas in the future and how society and nature will respond. Dealing with uncertainty is largely a matter of management and governance when it comes to sanitation technologies, rather than the physical design of sanitation technology.

Assessment Step 3 Hazards

The team assesses the impact of relevant climate hazards (e.g. force of flood waters) that may be associated with the HETs indicated in Step 2 on the sanitation technology.



Reviewing the hazards

Hazards are occurrences that may cause damage to the sanitation technology or its ability to function and provide a service. They can lead to consequences for public health or the environment.

Based on the HETs identified in Step 2, ClimateFIRST will output an amalgamated list of potential hazards (a complete list of the hazards is shown in Annex 1). Many hazards are relevant to more than one HET. By clicking on the cell "All hazards for relevant HETs", users can filter the hazards by HET.

A specific example of each potential hazard can be seen by hovering the mouse over the cell. For each potential hazard, the assessment team should:

1. Refer to the specific example of the hazard and decide if it is relevant to the sanitation technology or not. For example, the hazard 'increased levels of receiving waterways' is irrelevant if the sanitation technology does not discharge to a waterway. In the 'Relevant?' column, used the dropdown menu to indicate if the hazard is relevant or not.

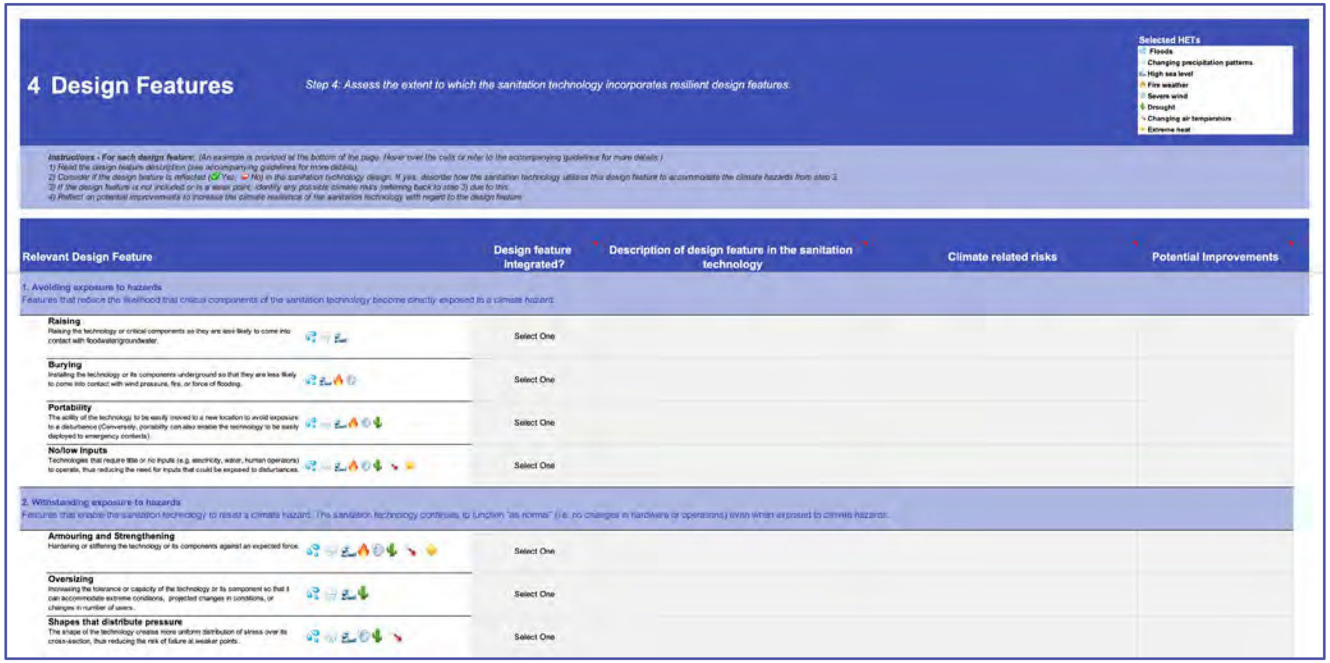
2. If the hazard is relevant, give an 'impact rating' to indicate how severely the sanitation technology would be affected if it was exposed to the specific example of the hazard. (Low = Little or no impact on the sanitation technology; Moderate = Moderate impact causing reduced performance; High = High impact likely causing a failure of the sanitation technology).

3. In the 'Justification' column, briefly explain the rationale for why that impact rating was given.

An example of a filled-out row is provided at the bottom of the tab for reference.

Design features

The team assesses the extent to which the sanitation technology's design features can help the system avoid, reduce or offset the negative impacts of the hazards identified in Step 3, and considers how the design features could be added to the sanitation technology.



Resilient design features

Based on the HETs selected in Step 2, ClimateFIRST will suggest up to 25 resilience design features that can be applied to sanitation technologies. Annex 2 lists these design features in full along with examples of how they may be applied to sanitation technologies, examples of how the design features may compromise resilience in other ways, and inputs to consider for implementation of the design feature and O&M.

Design Features continued

These design features are grouped into seven categories*:

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.
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.
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.
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.
5. Limiting consequences of complete failure: Design features that minimise the negative consequences of a sanitation technology failing due to a climate hazard.
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.
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.

The listed design features are options for improving the resilience of a sanitation technology. However, the implementing each feature comes with costs and potentially trade-offs where resilience is reduced in other ways; Annex 2 lists examples of these. Hence, sanitation technologies are not expected to include every design feature. Integrating too many features can make a sanitation technology expensive and impractical.

The icons next to each design feature indicate which HETs are most relevant to the feature. For example, the ‘raising’ design feature can help with resilience against floods and high sea levels, but it is generally not helpful for droughts or severe wind.

Assessing the sanitation technology’s design features and identifying design improvements

For each design feature, the team should consider whether the feature is reflected in the sanitation technology design in any way that supports resilience, and select Yes or No in the ‘Design feature integrated?’ column. Refer to Annex 2 for more details on each feature.

If the team selects Yes, they should then describe the design feature and how it helps accommodate climate hazards in the ‘Description of design feature in sanitation technology’ column.

If the team select No, they should consider if the absence or weakness of this design feature could compromise the sanitation technology’s resilience in the ‘Climate related risks’ column. They should also consider ideas for incorporating the design feature in the sanitation technology in the ‘Potential improvements’ column. However, these columns are optional do not need to be filled out for every design feature. Some design features may be impractical to implement and do not require consideration. Focus on design features that feel the most useful.

Even if the team selects Yes to indicate a design feature is already incorporated, they may choose to still identify risks and improvements if they think of any.

It is helpful to refer back to the Hazards tab for a reminder of the ways that hazards affect the sanitation technology and how physical design reduces impacts (or might fail to). An example of a filled-out row is provided at the bottom of the tab for reference.

* Note that these design features only pertain to climate resilience. All sanitation technologies should also be designed to make sanitation available, physically accessible, safe, affordable and acceptable to users in line with the Humans Rights to Water and Sanitation framework. This includes ensuring that toilets meet the needs of women and are accessible to people with disabilities.

5 Assessment Step — Overall resilience

The team gives the sanitation technology an overall resilience score against each HET based on their judgements stemming from the previous steps.

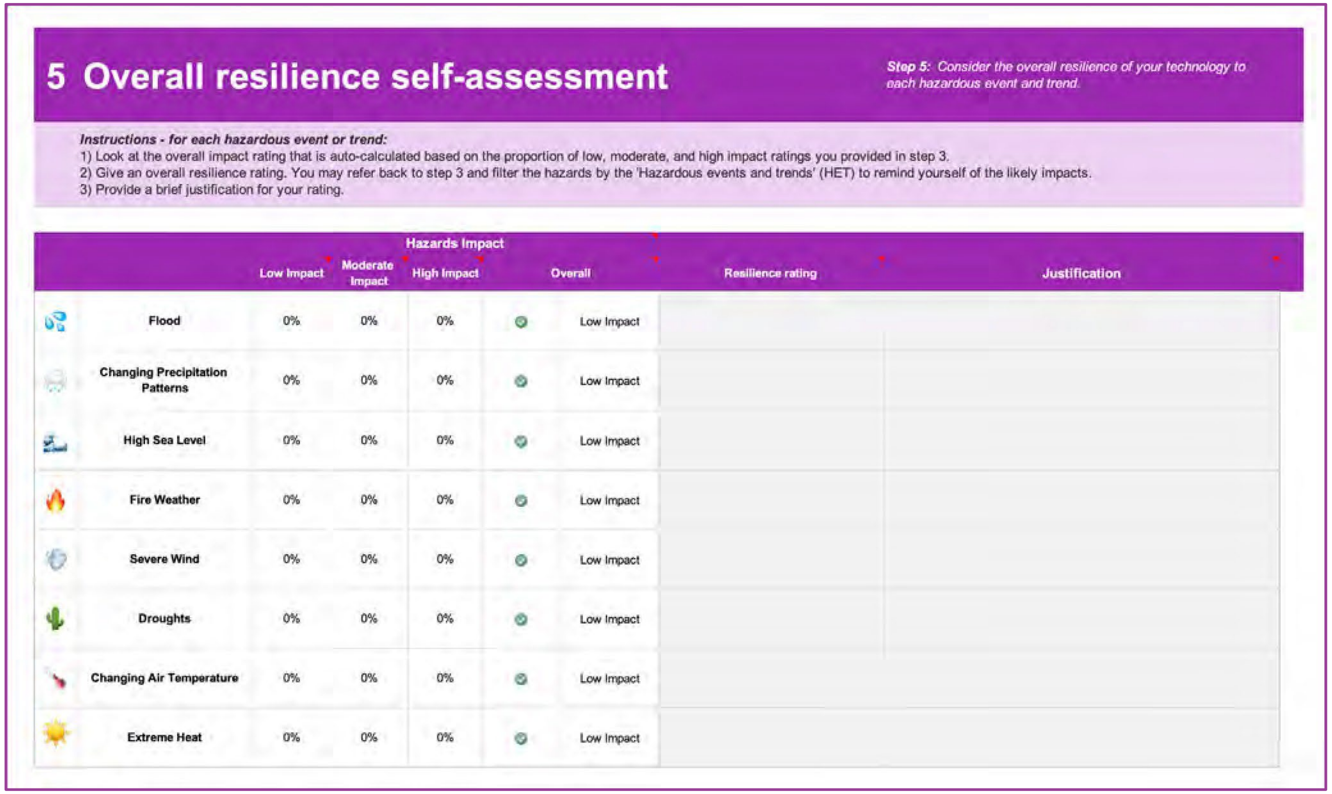
ClimateFIRST provides an overview of the percentage of hazards that were given low, moderate or high impact ratings inputted during Step 3. ClimateFIRST also auto-calculates an overall impact rating based on these percentages.

The assessment should then:

1. Give an overall low, medium or high 'Resilience rating' of the sanitation technology to each of the relevant HETs (Low Resilience = Likely to fail or have extended outage; Medium resilience = reduced sanitation technology performance or temporary outage; High resilience = continues to function). These responses should be informed by the activities completed in Steps 3 and 4 and the auto-calculated impact rating.

   As an extreme example, if all hazards from Step 4 had a high impact on the sanitation technology, it is expected that the overall resilience would be low.

2. In the 'Justification' column, briefly justify why the low, moderate or high rating was given.



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 'Hazardous events and trends' (HET) to remind yourself of the likely impacts.
3) Provide a brief justification for your rating.

	Hazards Impact					
	Low Impact	Moderate Impact	High Impact	Overall	Resilience rating	Justification
Flood	0%	0%	0%	Low Impact		
Changing Precipitation Patterns	0%	0%	0%	Low Impact		
High Sea Level	0%	0%	0%	Low Impact		
Fire Weather	0%	0%	0%	Low Impact		
Severe Wind	0%	0%	0%	Low Impact		
Droughts	0%	0%	0%	Low Impact		
Changing Air Temperature	0%	0%	0%	Low Impact		
Extreme Heat	0%	0%	0%	Low Impact		

Summary Reports

ClimateFIRST summarises the content documented by the assessment team across four tabs:

- Overall: A summary of the auto-calculated impact rating, the resilience rating, and the justification for the resilience rating for each relevant HET.
- Impacts: A list of the hazards that the assessment team rated as having 'moderate' or 'high impact' on the sanitation technology and the justification for the rating.
- Strengths: A list of the resilience design features that the assessment team indicated were integrated into the sanitation technology and a description of the feature.
- Improvements: A list of improvements that the assessment team suggested could be done to incorporate resilience design features, and corresponding climate related risks they could reduce.

These summary outputs may be used as an easy reference to the assessment about what conclusions were reached and improvements that could be made to future designs of the sanitation technology.

Photo: All Seasons Upgrade. Credit: Kim Heng Lay, iDE

Annex 1: List of HETs and associated hazards

	Hazardous events and trends (HET)								
	Floods Fluvial flooding (overflowing of a river or other water body) and pluvial flooding (precipitation intensity exceeds drainage capacity)	**Changing precipitation patterns** Increased variability in seasonal precipitation patterns and inter-annual precipitation	**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	**Fire weather** Weather conditions (temperature, soil moisture, humidity, and wind) that trigger and sustain fires	**Severe wind** High wind velocity due to thunderstorms, wind gusts, tornadoes, or cyclones	**Drought** Episodic combination of low rainfall and runoff deficit, and evaporation that leads to dry soil (i.e. hydrological drought)	**Changing air temperature** Increased variability in diurnal and seasonal air temperature	**Extreme heat** Episodic high surface air temperature events that are potentially exacerbated by humidity
Hazards	Landslides Erosion Force of flood waters Increased inflow velocity Increased inflow volume Increased levels of receiving waterways Rise in groundwater level and/or groundwater saturation Water ingress/inundation Changes in pathogen concentration in inflow Disrupted access to sanitation technology for O&M Disrupted access to sanitation technology for major repairs Disrupted electricity inputs to sanitation technology Disrupted faecal sludge emptying services Disrupted water inputs to sanitation technology	Expansion/ contraction of soils Rise in groundwater level and/or groundwater saturation Variable inflow velocity Variable inflow volume	Corrosion Erosion Expansion/contraction of soils Force of flood waters Increased inflow velocity Increased inflow volume Rise in groundwater level and/or groundwater saturation Water ingress/inundation Biological organisms exposed to saltwater Disrupted access to sanitation technology for O&M Disrupted access to sanitation technology for major repairs Disrupted electricity inputs to sanitation technology Disrupted faecal sludge emptying services Disrupted water inputs to sanitation technology	Exposure to flames Temperature driven expansion/ contraction of materials Disrupted access to sanitation technology for O&M Disrupted access to sanitation technology for major repairs Disrupted electricity inputs to sanitation technology Disrupted faecal sludge emptying services Disrupted water inputs to sanitation technology	Uprooting by fallen trees Wind force on sanitation structures Wind-blown debris Disrupted access to sanitation technology for O&M Disrupted access to sanitation technology for major repairs Disrupted electricity inputs to sanitation technology Disrupted faecal sludge emptying services Disrupted water inputs to sanitation technology	Corrosion Expansion/ contraction of soils Reduced inflow velocity Reduced inflow volume Changes in pathogen concentration in inflow Reduced dilution capacity of receiving waters Disrupted water inputs to sanitation technology	Expansion/ contraction of soils Temperature driven expansion/ contraction of materials Extreme heat Variation in inflow or storage temperature	Temperature driven expansion/ contraction of materials Extreme heat Variation in inflow or storage temperature Disrupted electricity inputs to sanitation technology

Annex 2: Resilience design features

Avoiding exposure to hazards

Features that reduce the likelihood that critical components of the sanitation technology become directly exposed to a climate hazard.

Resilient design feature
Raising: Raising the technology or critical components so they are less likely to come into contact with floodwater, groundwater, or rising sea levels
Burying: Installing the technology or its components underground so that they are less likely to come into contact with wind pressure, fire, or force of flooding
Portability: The ability of the technology to be easily moved to a new location to avoid exposure to a hazard
No/low inputs: Technologies that require little or no inputs (e.g. electricity, water, human operators) to operate, thus reducing the need for inputs that could be exposed to hazards

Withstanding exposure to hazards

Features that enable the sanitation technology to resist a climate hazard. The sanitation technology continues to function “as normal” (i.e. no changes in hardware or operations) even when exposed to climate hazards

Resilient design feature
Armouring and strengthening: Hardening or stiffening the technology or its components against a hazard
Oversizing: Increasing the tolerance or capacity of the technology or its component so that it can accommodate extreme conditions, projected changes in conditions, or changes in the number of users
Shapes that distribute pressure: The shape of the technology creates more uniform distribution of stress over its cross-section, thus reducing the risk of failure at weaker points
Circumvention: Technology materials or designs that allow wind or water to pass through so that the stress on the technology or component is reduced
Sealing and barriers: Integrating seals, barriers or other forms of protection into the technology to protect critical components or processes from being disrupted by a hazard

Enabling flexibility

Features that enable the sanitation technology to be adapted or reconfigured, or have its operation changed, in order to continue providing services when exposed to climate hazards.

Resilient design feature
Adaptability: The technology can be adapted or upgraded easily to function better under the changing environmental conditions (e.g. increasingly wet or increasingly dry conditions)
Modular design: Additional modules can be added (plug-in type model) or removed to increase or decrease capacity of the system to accommodate variability in demand and environmental conditions
Platform design: The technology shares components with other similar technologies, making it easier to transition between technologies to suit customer demand or prevailing environmental conditions
Redundancy and diversity: The technology has diverse and redundant components that work in parallel or that act as back-ups to each other. In the case of component failure(s), the back-up component enables the technology to continue functioning by performing the same functions in a different way
Signalling: The technology, by the nature of how it functions or by intentional design, has a way of signalling to operators or users when the sanitation technology requires modification to prevent failure or to enhance its performance

Containing failures

Features that enable the sanitation technology to continue providing basic services and meet user needs despite damage to technology components caused by climate hazards.

Resilient design feature
Frangibility: Less essential components of the technology are designed to breakaway or fail when exposed to a hazard to protect more essential components of the technology
Fail-operational: The technology can still provide its overall function even when components or processes are damaged and undergoing repair
Decentralisation: Failures in decentralised systems (small- scale individual or clustered systems) are isolated locally rather than centrally

Limiting consequences of complete failure

Features that minimise the negative health and environmental consequences of complete sanitation technology failure due to a climate hazard.

Resilient design feature
Safe disposal: The materials from the destroyed technology are not toxic to the environment or public health and can be safely disposed
Reusable materials: The materials from the destroyed technology can be reused for other purposes (including rebuilding the technology)
Fail-silence: If the technology completely fails, it does not pose a health risk to the public or the environment beyond being unable to perform its function

Facilitating fast recovery

Features that enable the sanitation technology to be quickly rebuilt or restored if they are damaged, disrupted or destroyed by a climate hazard.

Resilient design feature
Repair speed: The technology and its components, processes, or operations can be quickly replaced, rebuilt or restored if destroyed or disrupted, thereby minimising performance downtime or degradation
Accessibility for rapid flaw detection and repair: Components or processes of the technology can be easily accessed for examination and repairs

Providing benefits beyond resilience

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

Resilient design feature
Reciprocity: Through operations, the technology also builds resilience in, or aids, another on-site or off-site system
Hybridising: Unrelated systems or technologies share the same physical space or structure, thus saving space and enhancing opportunities for reciprocity
Transformative capacity: The technology provides an additional service(s) beyond its usual intent that further aids resilient communities

Annex 2: References

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