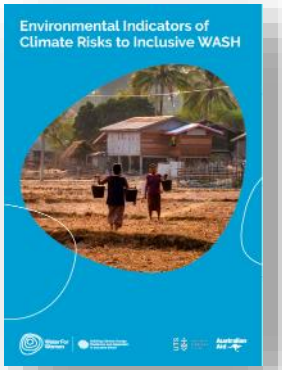
UTS Institute for Sustainable Futures

Risk and resilience in WASH:
Clarifying concepts and key directions

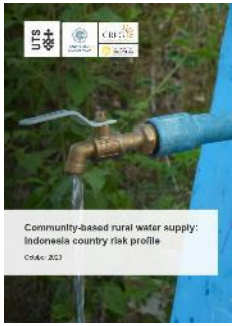
Professor Juliet Willetts

Several sources of recent research…

Conceptualising climate resilience, water and sanitation

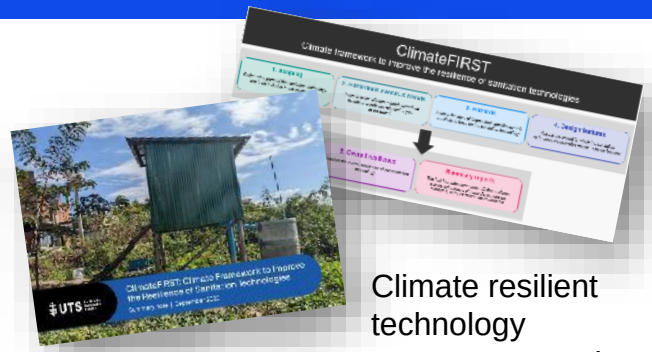


Environmental indicators of climate risk to WASH



Monitoring and assessment of rural water supply systems

Landscape study urban sanitation and climate, involving >60 organisations



Climate resilient technology assessment tool

Impacts on sanitation in four cities in Indonesia and adaptation responses

https://www.uts.edu.au/isf/explore-research/international-development/water-sanitation-and-hygiene-wash/climate-change-and-wash/resources-climate-change-and-wash

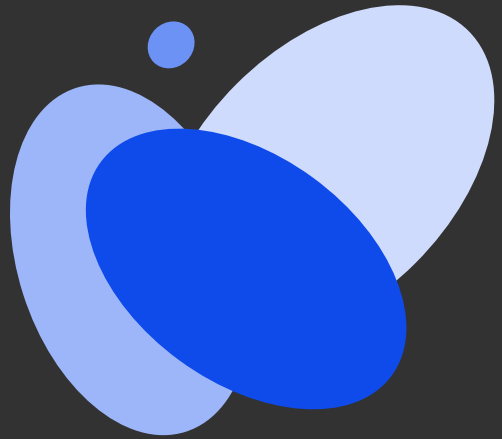
Key messages

1. Risk and resilience are critical concepts in addressing climate change, but variously defined, with flow-on consequences for how we respond and the actions we prioritise

2. We need to ask – resilience of what? And in our answer consider solutions that promote resilience of: (i) environment, ecosystems, water resources; (ii) WASH infrastructure and technology; (iii) WASH service systems; (iv) wider society or community

3. Suggest to use the IPCC 2020 definitions and thinking to inform your ideas about risk and resilience, which integrates multiple perspectives

Risk and resilience: Making sense of varied definitions



Defining risk

How do you define climate risk?

www.menti.com

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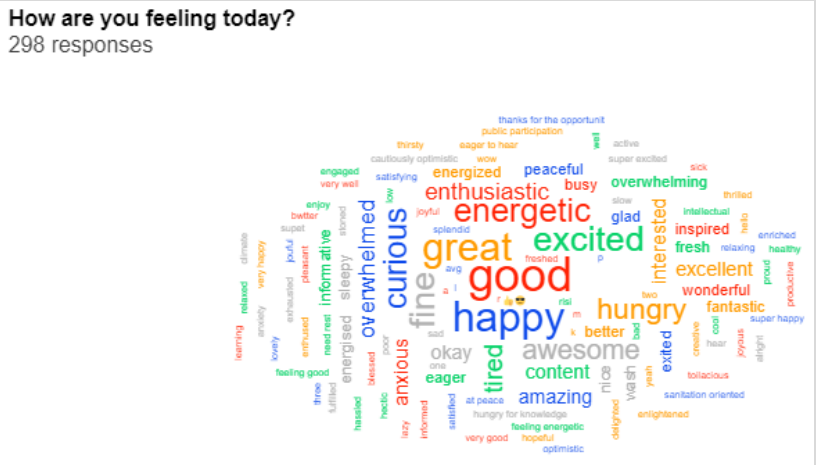
Conceptualising resilience

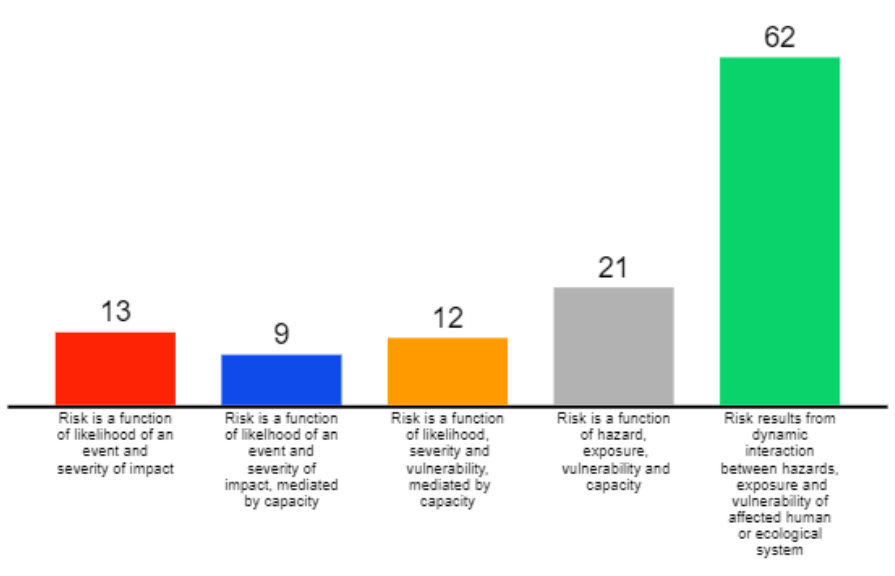
How do you think resilience can best be supported?

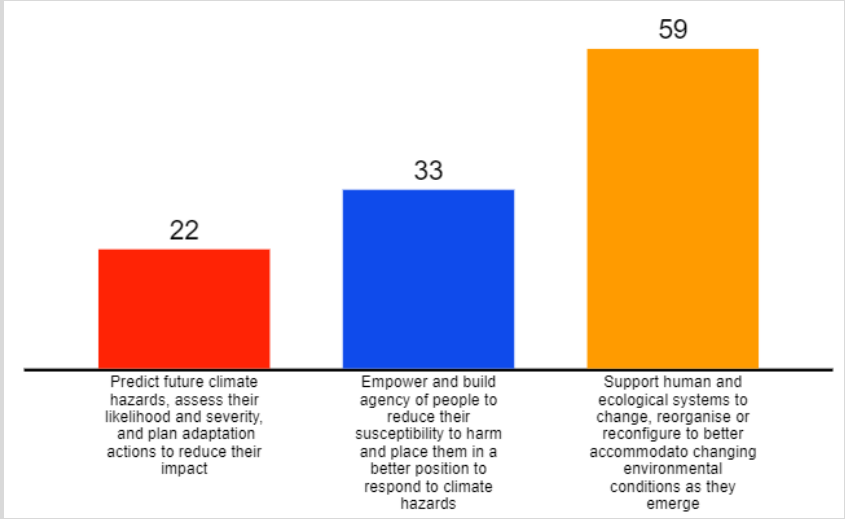


Mentimeter responses:

Defining risk

How do you define climate risk?





Conceptualising resilience

How do you think resilience can best be supported?

Definitions of climate risk over time

Physical science, natural hazard definition

Likelihood x severity

Physical science, but taking into account varied outcomes from exposure to same hazard

Likelihood x severity, mediated by capacity

Integrating social science ideas about structural inequalities

Likelihood x severity x vulnerability, mediated by capacity

A function of hazard, exposure, vulnerability and capacity

Sendai disaster risk framework (2015)

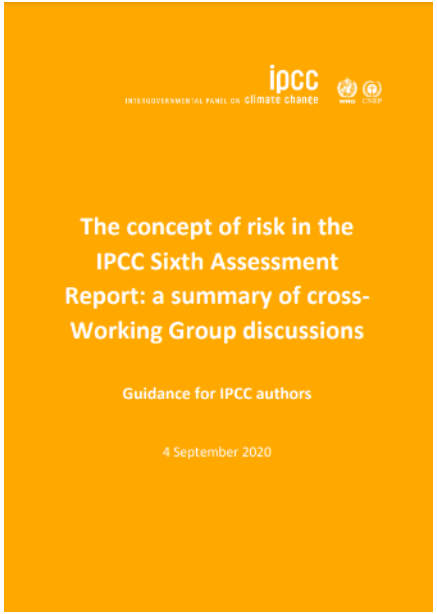
IPCC (2020)

Dynamic interactions between hazards with the exposure and vulnerability of the affected human or ecological system

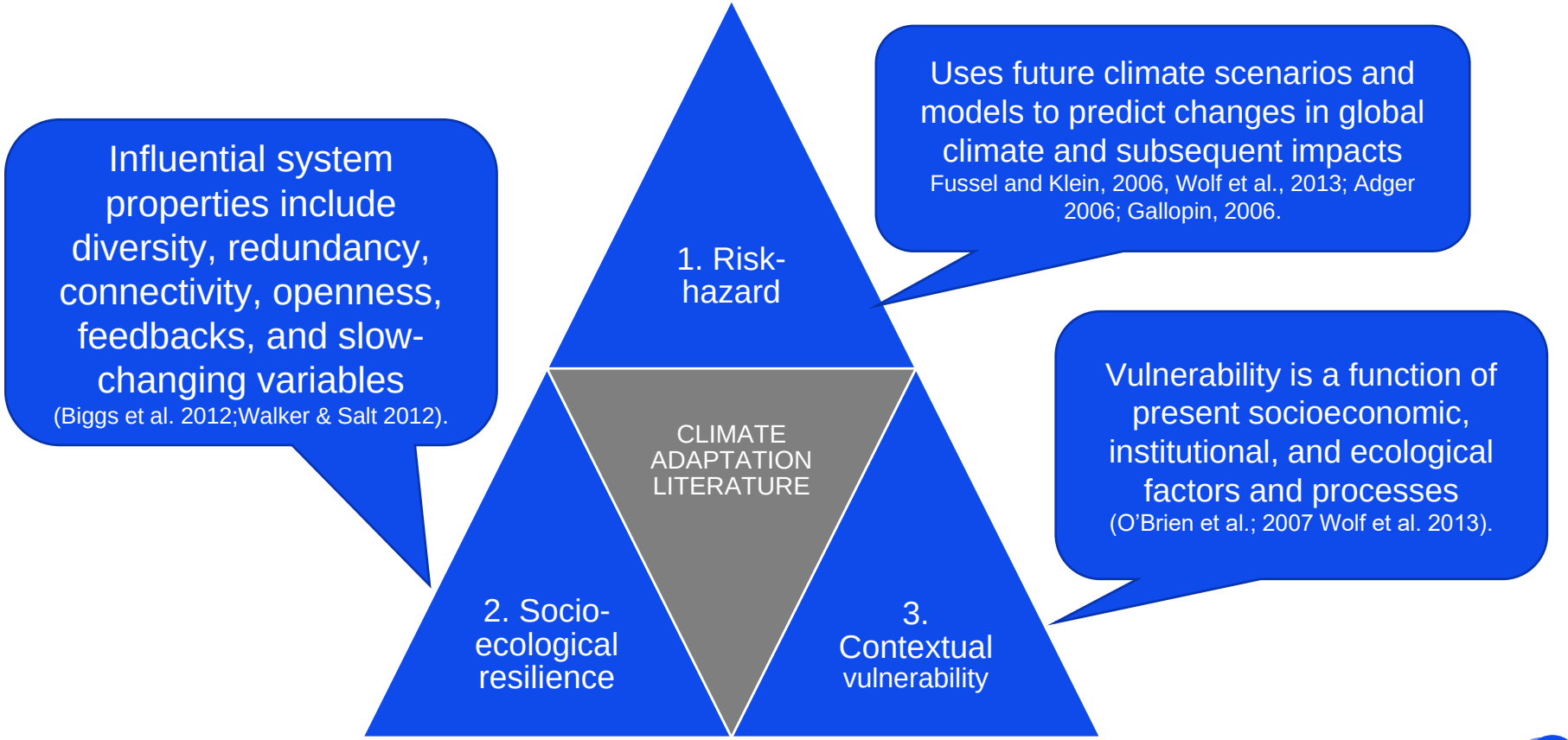
Definition of risk from IPCC 2020

The potential for adverse consequences for human or ecological systems, recognising the **diversity of values and objectives** associated with such systems. In the context of climate change, risks can arise from potential impacts of climate change as well as human responses to climate change. …[…]…

In the context of climate change impacts, **risks result from dynamic interactions between climate-related hazards with the exposure and vulnerability of the affected human or ecological system to the hazards**. Hazards, exposure and vulnerability may each be subject to **uncertainty** in terms of magnitude and likelihood of occurrence, and each **may change over time and space** due to socio-economic changes and human decision-making.



Climate adaptation theory and perspectives to inform resilience



Kohlitz et al., 2017 https://opus.lib.uts.edu.au/handle/10453/105609

The way you view resilience influences the types of adaptation actions you focus on

Features	Risk-hazard	Socio-ecological resilience	Contextual vulnerability
Key concepts	Exposure, sensitivity, hazards	Thresholds, self-organisation, linked domains and scales	Adaptive capacity, equality
Primary systems of interest	Physical	Ecological, social-ecological	Social
Timeframe of focus	Near future (as far as models will allow)	Long-term future	Present
Common analytical objectives	Identify hazards and consider likelihood and severity of their impacts	Understand interactions within and between systems and what causes systems to shift to a new equilibrium	Understand who is least and most likely to cope with changes in environment and why
Commonly recommended adaptation options	Implementing technologies, climate-proofing infrastructure, improving management of technology	Optimising or managing resilience properties, developing resilient governance structures and processes	Reducing inequalities, empowering people to cope with external stresses in general, poverty alleviation

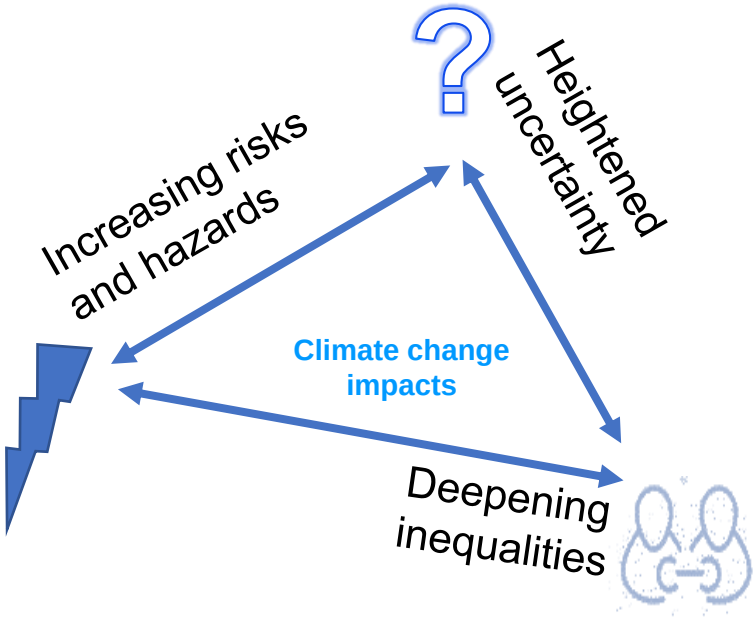
Kohlitz et al., 2017 https://opus.lib.uts.edu.au/handle/10453/105609

What does this mean for WASH and achieving safely managed services for all?

i) Risk/hazard: Increasing risks to WASH infrastructure and water resources posed by climate hazards

ii) Contextual vulnerability: Exacerbation of inequalities – not all populations are affected equally, and some have less capacity to take action

iii) Socio-ecological resilience: Heightened uncertainty and unpredictability require flexibility and adaptiveness in the WASH infrastructure and related management and service systems



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Definition of resilience from IPCC 2020

Resilience is: “The capacity of **interconnected social, economic and ecological systems** to cope with a hazardous **event, trend or disturbance**, responding or reorganising in ways that maintain their **essential function**, identity and structure. Resilience is a positive attribute when it **maintains capacity for adaptation**, learning and/or **transformation**.”

https://www.ipcc.ch/report/ar6/syr/downloads/report/IPCC_AR6_SYR_AnnexesIndex.pdf

Clarifying resilience as applied to WASH even further…

“Resilience to what?”

“Resilience for what purpose?”

“Resilience of what?”

(Meuwissen et al., 2019)

Resilience of what?

ENVIRONMENT / ECOSYSTEM

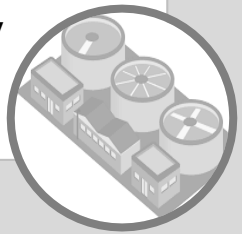
Water sources
- Rainwater
- Groundwater
- Surface water
- Springs

Receiving environment
- Water bodies
- Groundwater
- Soil
- Marine environments

SOCIETY / COMMUNITY

WASH service system

Water & sanitation infrastructure & technology



Resilience of the environment, ecosystem, water resources

Resilience of what?

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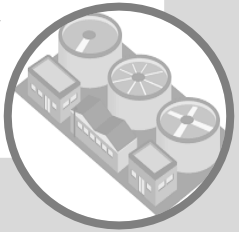


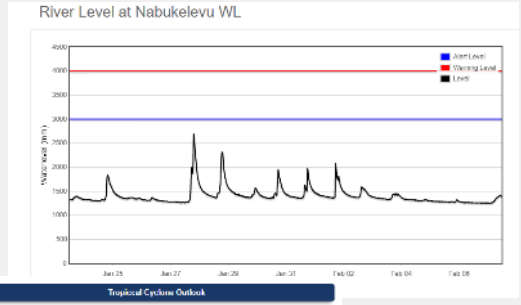
Resilience of environment, ecosystems, water resources

- Monitoring **climate risks** to WASH services by tracking changes in environmental indicators
- **Why:** Climate change predictions are inherently uncertain, hence tracking environmental change can help identify emerging threats to WASH services to allow pre-emptive action.
- **How?** Track hydrological (e.g. rainfall, streamflow, groundwater) and other environmental data, which are increasingly available.

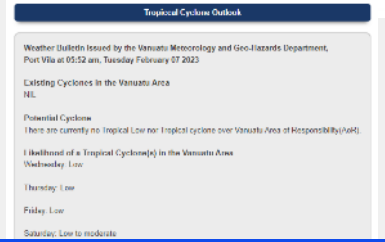
UTS Institute for Sustainable Futures · IWC International WaterCentre · Griffith University Queensland, Australia · WaterAid · Water For Women

There are many existing data sources

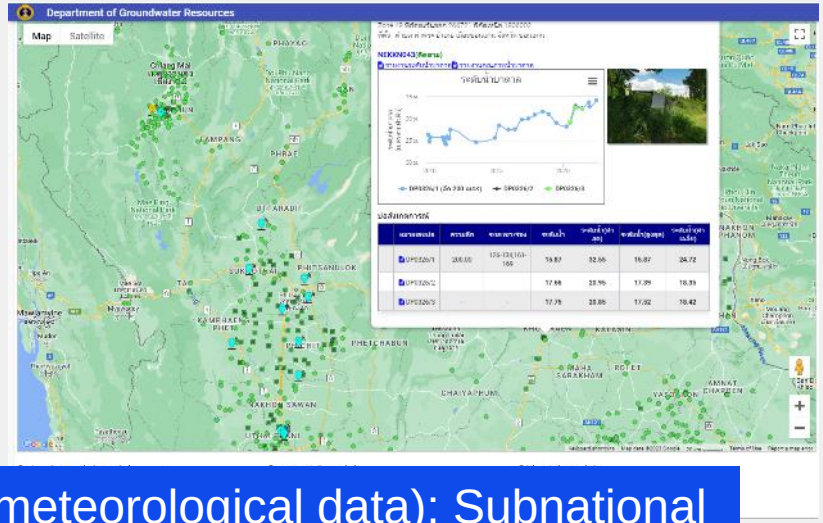
River level monitoring in Fiji



Tropical cyclone monitoring in Vanuatu



Groundwater monitoring wells in Thailand

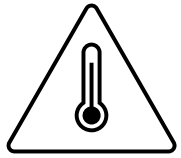


Global databases; National databases (e.g. meteorological data); Subnational monitoring programs (council, district monitoring); Traditional ecological knowledge; Citizen science; Primary data collection / monitoring

Indicators for climate risks to household access

DROUGHT

12 indicators



EXTREME HEAT

4 indicators

6 indicators

EXTREME WEATHER

5 indicators

5 indicators

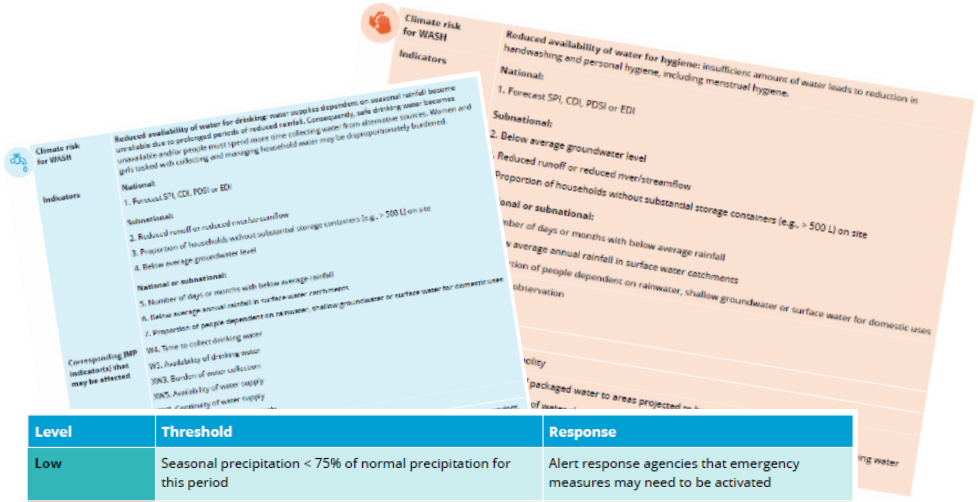
FLOOD

10 indicators

SEA LEVEL RISE

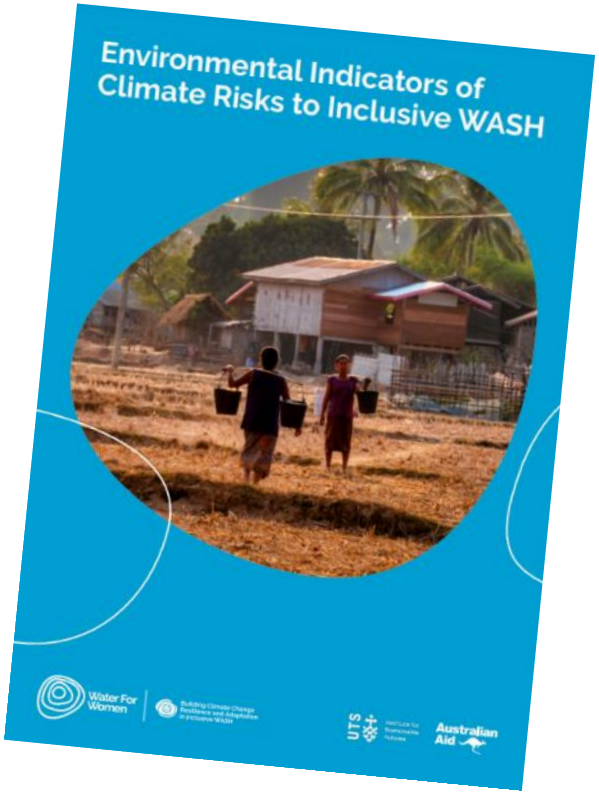
GROUNDWATER RISE

Monitoring climate risks to WASH services: tracking changes in environmental indicators



Level	Threshold	Response
Low	Seasonal precipitation < 75% of normal precipitation for this period	Alert response agencies that emergency measures may need to be activated
Medium	Seasonal precipitation < 50% of normal precipitation for this period	Alert public of possible water shortages and encourage storing water
High	Seasonal precipitation < 25% of normal precipitation for this period	Deploy water trucks or packaged water to affected areas

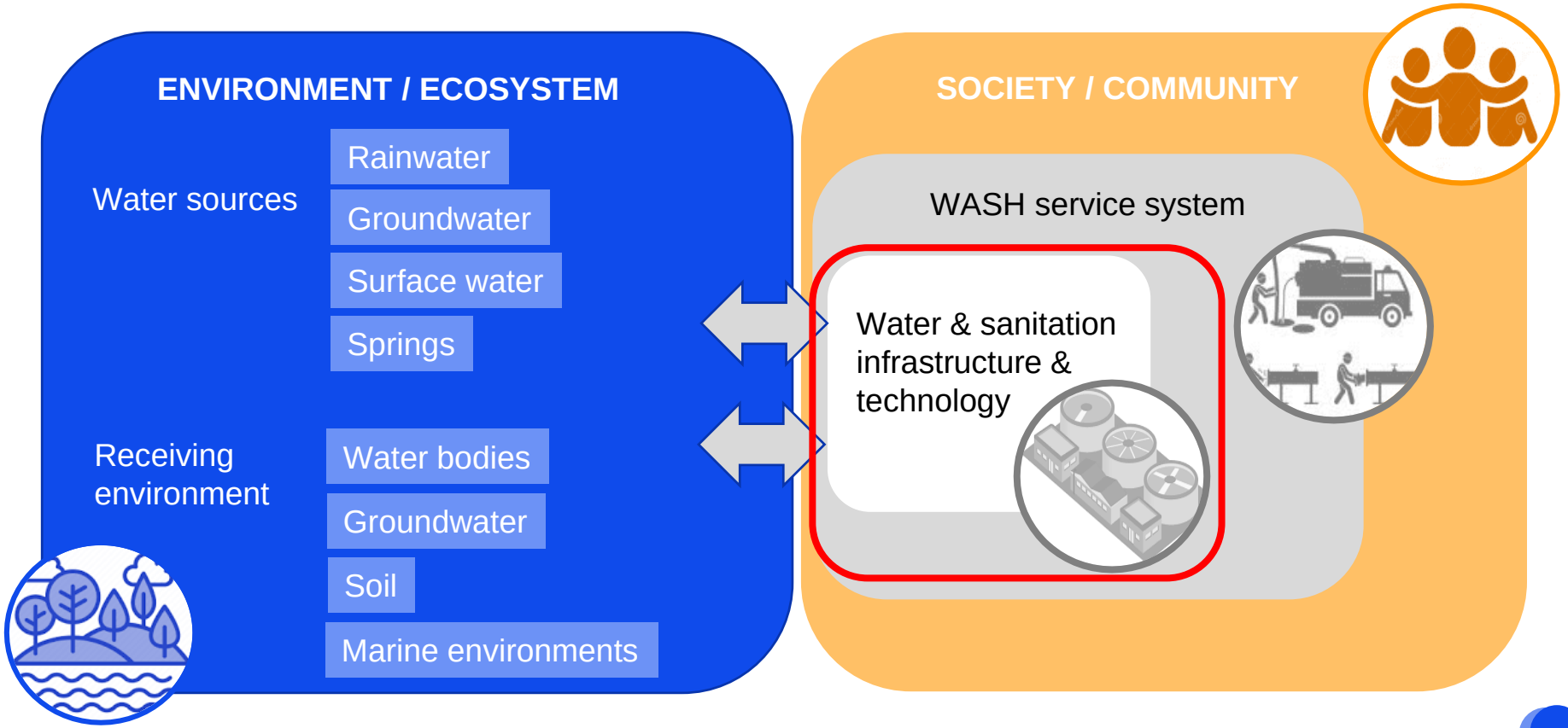
Figure 1. Examples of thresholds for an indicator of the risk of reduced precipitation creating shortfalls in local water supplies



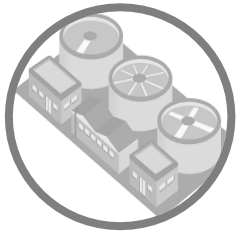
https://www.waterforwomenfund.org/en/news/environmental-indicators-of-climate-risks-to-inclusive-wash.aspx

Resilience of WASH infrastructure or technology

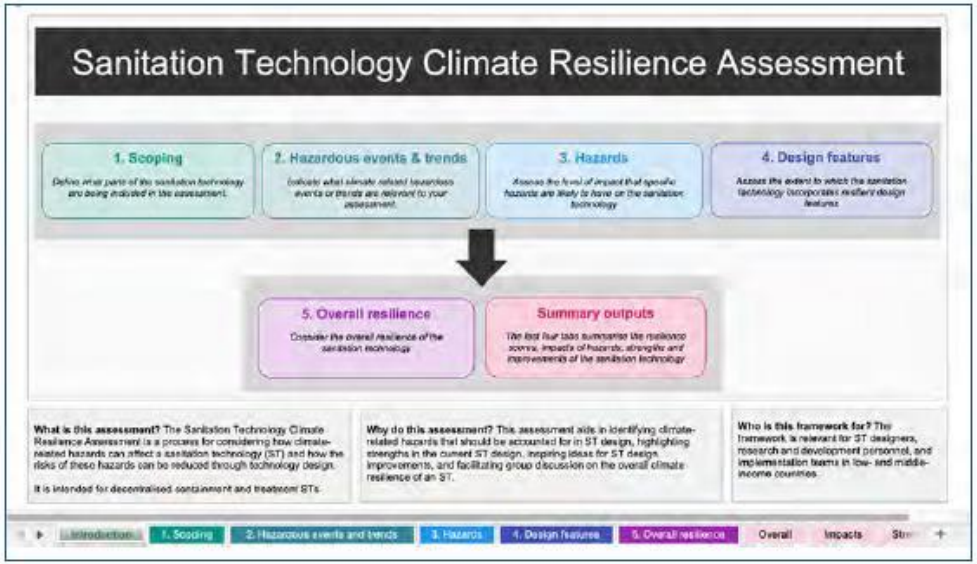
Resilience of what?



ClimateFIRST - Climate Framework to Improve the Resilience of Sanitation Technologies



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



Overview

What is it? An Excel-based process to consider how climate-related hazards can affect a sanitation technology and how the risks of these hazards can be reduced through technology design

Why do it? To identify key climatic risks to manage, improve technology design, and consider relative merits of different technologies

Who is it for? Anyone engaged in the development or implementation of sanitation technologies

What technologies is it for? Onsite/decentralised containment and treatment technologies

1 Scoping

What is the sanitation technology being assessed?

What's included in the assessment?

What isn't?

2 Hazardous events & trends

- Flood
- Changing precipitation patterns
- High sea level
- Fire weather
- Severe wind
- Drought
- Changing air temperature
- Extreme heat

3 Hazards

Flood hazards

- Landslides
- Erosion
- Force of flood waters
- Increased inflow velocity / volume
- Increased level of receiving waterways
- Rise in groundwater level / groundwater saturation
- Water ingress / inundation
- Disrupted O&M / electricity / FSM

Drought hazards

- Corrosion
- Contraction of soils
- Reduced inflow velocity / volume
- Reduced dilution capacity of receiving waterways

Flood and drought hazards

- Changes in pathogen concentration in inflow
- Disrupted water supply inputs

Category	Resilience design feature
A. Avoiding exposure to hazards	1. Raising
	2. Burying
	3. Portability
	4. No/low Inputs
B. Withstanding exposure to hazards	5. Armouring and strengthening
	6. Oversizing
	7. Shapes that distribute pressure
	8. Circumvention
	9. Sealing and Barriers
C. Enabling flexibility	10. Adaptability
	11. Modular design
	12. Platform design
	13. Redundancy and diversity
	14. Signalling
D. Containing failures	15. Frangibility
	16. Fail-operational
	17. Decentralisation
E. Limiting consequences of complete failure	18. Safe disposal
	19. Reusable materials
	20. Fail-silence
F. Facilitating fast recovery	21. Repair speed
	22. Accessibility for rapid flaw detection and repair
G. Providing benefits beyond sanitation technology resilience	23. Reciprocity
	24. Hybridising
	25. Transformative capacity

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4 Design features

for every child

Raising

Source: iDE Cambodia

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4 Design features

Portability; No/low inputs

Source: Sustainable Organic Integrated Livelihoods (SOIL)

Source: USF

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4 Design features

Redundancy and diversity

Source: UTS-ISF

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More is not necessarily better!

There may be trade-offs between different design features

5 Overall resilience

		Hazards Impact						
		Low Impact	Moderate Impact	High Impact	Overall		Resilience rating	Justification
	Flood	8%	69%	23%		Moderate Impact	Medium Resilience	The structural integrityof the ABR is resilient to floods, though inlet pipes may be disturbed if not buried. A risk for floods is inundation/increased flow into chambers reducing retention time and treatment effectiveness. It could also "blow" manholes and lead to pollution.
	Changing Precipitation Patterns	75%	25%	0%		Low Impact	High Resilience	The ABR is able to buffer changes in precipitation patterns, it is unlikely to create serious impacts.
	High Sea Level	14%	64%	21%		Moderate Impact	Low Resilience	Inlet pipes may be disturbed if not buried. Inundation/increased flow into chambers reducing retention time and treatment effectiveness. It could also "blow" manholes and lead to faecal pollution of the environment. Salt water may impact the biota temporarily in the ABR.
	Fire Weather	33%	33%	33%		Moderate Impact	High Resilience	Fires are likely to have a low impact on the main ABR structure as it is concrete and buried. However, fires may impact any exposed inlet pipes, though if they are exposed they would also be easy/fast to repair.
	Severe Wind	50%	25%	25%		Moderate Impact	High Resilience	Winds are considered low risk for the ABR. The main risk from winds is additional debris that may enter the system though this is unlikely as entry points for debris are inside dwellings and into the toilet.
	Droughts	29%	57%	14%		Moderate Impact	Medium Resilience	Droughts may reduce the water available for flushing needed to move faecal/sewage into the ABR. Droughts would likely not impact the treatment efficacy as it would lead to increased residence time in the treatment train. Doughts would also reduce the dilution at any discharge points/waters
	Changing Air Temperature	100%	0%	0%		Low Impact	High Resilience	Changes in air temperature are unlikely to have any impacts on the ABR. They may cause some fluctuations in the treatment processes, these would be expected to be minor in this location
	Extreme Heat	100%	0%	0%		Low Impact	High Resilience	Extreme heat is unlikely to have any impacts on the ABR. Events may cause some fluctuations in the treatment processes, these would be expected to be minor.

Resilience of the service system

Resilience of what?

ENVIRONMENT / ECOSYSTEM

Water sources
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- Springs

Receiving environment
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- Soil
- Marine environments

SOCIETY / COMMUNITY

WASH service system

Water & sanitation infrastructure & technology

A large proportion of rural water supply systems are exposed to climate hazards in Indonesia

Climate hazards including flooding, droughts and sea-level rise likely to affect 12,000 to 14,000 (34-46%) community-based rural water supply systems

No	PROVINCE	Annual Rainfall	Sea Level Rise	Drought	Flood Risk						
1	Aceh	2	3	2	2						
2	Bali	3	2	2	1						
3	Banten	1	2	3	2						
4	Bengkulu	2	1	2	2						
5	Yogyakarta	3	1	2	1						
6	Gorontalo	3	3	2	2						
7	Jambi	2	2	2	2						
8	Jawa Barat	2	2	2	2						
9	Jawa Tengah	2	3	3	2						
10	Jawa Timur	3	2	2	2						
11	Jakarta	NA	NA	NA	NA						
12	Kalimantan Barat	1	1	3	2						
13	Kalimantan Selatan	2	2	3	2						
14	Kalimantan Tengah	2	1	2	2						
15	Kalimantan Timur	2	1	2	2						
16	Kalimantan Utara	1	1	2	2						
17	Kepulauan Bangka Belitung	3	3	2	2						
18	Kepulauan Riau	2	3	2	2						
19	Lampung	3	1	3	2						
20	Maluku	2	3	2	2						
21	Maluku Utara	3	3	3	1	1	3	3	3	2	2
22	Nusa Tenggara Barat	3	1	3	1	2	3	2	2	2	1
23	Nusa Tenggara Timur	3	1	3	1	1	3	3	3	3	2
24	Riau	2	3	1	2	1	2	3	3	2	1
25	Sulawesi Barat	2	3	2	2	1	2	3	3	2	2
26	Sulawesi Selatan	2	1	3	1	1	2	2	3	2	2
27	Sulawesi Tengah	3	3	2	2	1	2	3	3	1	1
28	Sulawesi Tenggara	3	1	3	1	1	3	2	3	1	1
29	Sulawesi Utara	3	3	3	2	1	2	2	2	2	2
30	Sumatera Barat	2	1	2	2	1	2	2	2	3	3
31	Sumatera Selatan	2	1	2	2	1	2	2	2	2	3
32	Sumatera Utara	2	3	1	2	1	2	2	3	2	1
33	Papua	2	1	2	2	1	3	3	3	2	1
34	Papua Barat	1	3	2	2	1	3	3	3	3	NA
35	Papua Barat Daya	1	3	3	2	1	2	3	3	3	NA
36	Papua Pegunungan	1	1	3	2	1	3	3	3	2	1
37	Papua Selatan	2	1	3	2	1	3	2	2	1	1
38	Papua Tengah	1	3	2	2	1	3	3	3	2	1
Estimation of rural population affected		79,462,190	67,251,186	76,542,653	0	54,212,406	76,448,889	23,809,358	43,217,061	17,000,999	23,181,247
No. of PAMSIMAS systems affected		12,588	14,591	17,145	0	3,310	14,334	10,964	15,208	5,735	6,276
% of Pamsimas systems affected		34.2	39.4	46.3	0.0	8.9	38.7	28.8	41.0	15.5	16.9

KONEKSI
Knowledge Partnership Platform
Australia - Indonesia

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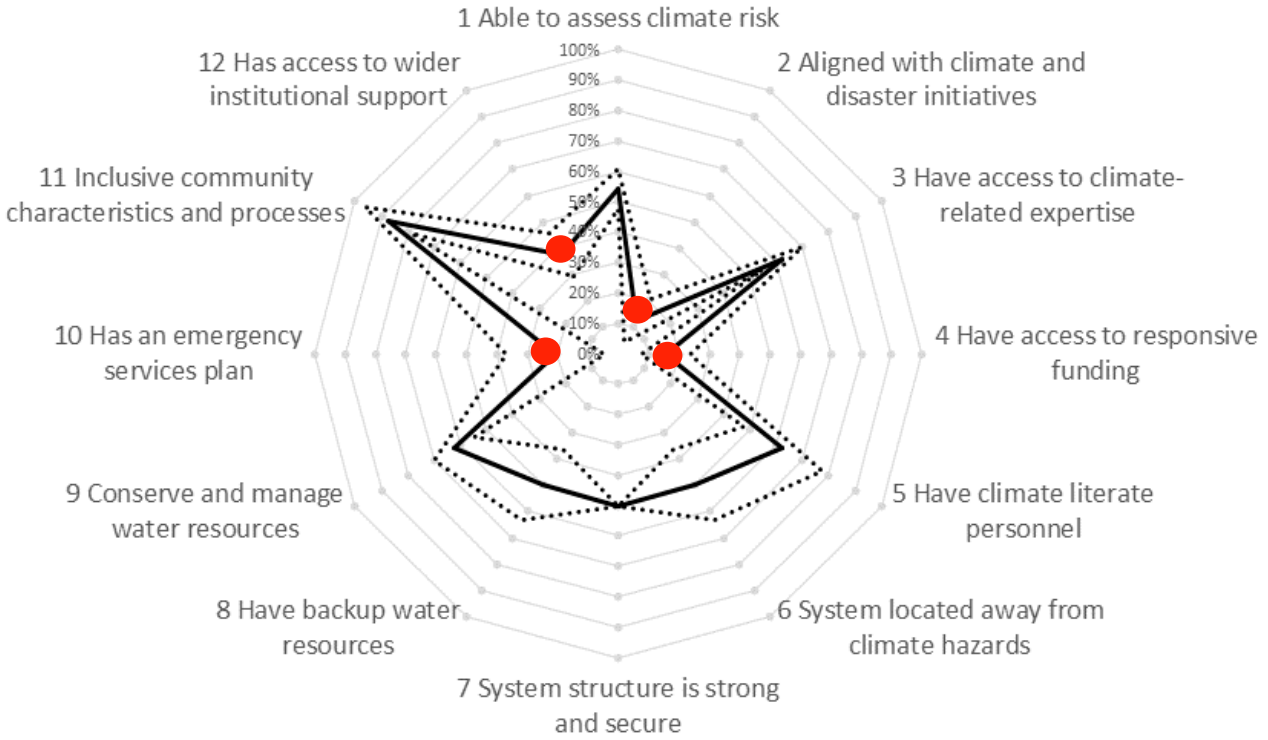
CRPG
Centre for Regulation, Policy and Governance

UNIVERSITAS GADJAH MADA

Current community-based management particularly faces institutional challenges in achieving climate resilience

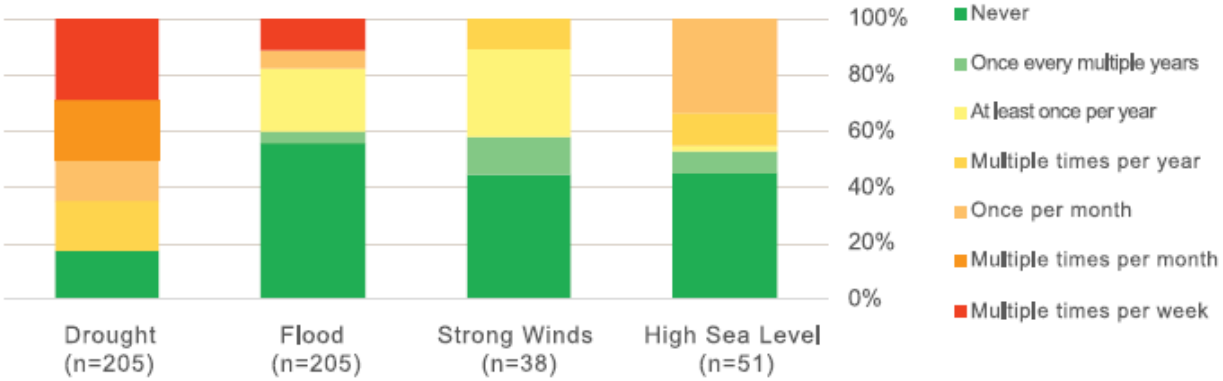


In Sumba Timur key issues were:

- Poor access to responsive funding
- Limited engagement with disaster initiatives
- Little proactive emergency planning
- Inadequate institutional support

Similarly, sanitation services in four cities in Indonesia experienced significant disruptions from climate hazards

Frequency of lack of toilet access due to a climate hazard



Emptying demand increased during flooding, however accessibility to desludge and treatment plant operation decreased at the same time

Local government had limited capacity to prepare and respond to climate impacts on sanitation

Some initial initiatives exist: e.g. desludging during flooding; water source protection (LombokTimur); climate change socialisation (Makassar); dredging canals and flood-resistant septic tanks (Makassar and Bekasi)

Challenges :

- **Low level of awareness** about climate risks to sanitation
- **Prioritisation of other sectors** (e.g. agriculture) for climate resilience
- **Unclear responsibilities, climate expertise needed**
- **Unconsolidated data** on risk prone area and climate trends
- **Allocation of financing** for preparation and recovery from climate impacts on sanitation

Elements of a climate resilient urban sanitation system – a framework to guide development of adaptation actions

Institutions, governance and services

- Clear institutional responsibilities and flexible management and service delivery arrangements
- Risk and vulnerability informed planning and decision making
- Maintaining capacity for continual adaptation through M&E and learning
- Integrated action on the whole water cycle to protect services, environment and public health

Financing
Sustainable and responsive financing for both preventive measures and disaster responses

User and societal engagement
Creative, strength-based user and societal engagement and awareness

Infrastructure
Robust and repairable sanitation infrastructure options

Willetts et al., 2023, Codeveloping adaptation actions

UTS Institute for Sustainable Futures

Resilience of the society or community

Resilience of what?

ENVIRONMENT / ECOSYSTEM

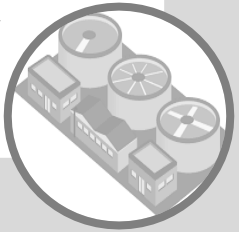
Water sources
- Rainwater
- Groundwater
- Surface water
- Springs

Receiving environment
- Water bodies
- Groundwater
- Soil
- Marine environments

SOCIETY / COMMUNITY

WASH service system

Water & sanitation infrastructure & technology



COP28 – Global Goal on Adaptation

Decision -/CMA.5

Glasgow–Sharm el-Sheikh work programme on the global goal on adaptation referred to in decision 7/CMA.3

The Conference of the Parties serv
Agreement,

Recalling Article 7 of the Paris
established the global goal on adaptation
resilience and reducing vulnerability to c
sustainable development and ensuring an ac
temperature goal referred to in Article 2 o
recognizes that adaptation is a global challe
regional and international dimensions, an
contribution to the long-term global respon
and ecosystems, taking into account the
ntry Parties that are particularly vulne
as Article 14 of the Paris Agreement a
CMA.4,

Noting with concern the findings in t
sment Report of the Intergovernment
celerated implementation of adaptati
tion gaps,

9. *Urges* Parties and *invites* non-Party stakeholders to pursue the objectives outlined in paragraph 8 above and to increase ambition and enhance adaptation action and support, in order to accelerate swift action at scale and at all levels, from local to global, in alignment with other global frameworks, towards the achievement of, inter alia, the following targets by 2030, and progressively beyond:

(a) Significantly reducing climate-induced water scarcity and enhancing climate resilience to water-related hazards towards a climate-resilient water supply, climate-resilient sanitation and towards access to safe and affordable potable water for all;

(b) Attaining climate-resilient food and agricultural production and supply and distribution of food, as well as increasing sustainable and regenerative production and equitable access to adequate food and nutrition for all;

(c) Attaining resilience against climate change related health impacts, promoting climate-resilient health services, and significantly reducing climate-related morbidity and mortality, particularly in the most vulnerable communities;

(d) Reducing climate impacts on ecosystems and biodiversity, and accelerating the use of ecosystem-based adaptation and nature-based solutions, including through their management, enhancement, restoration and conservation and the protection of terrestrial, inland water, mountain, marine and coastal ecosystems;

(e) Increasing the resilience of infrastructure and human settlements to climate change impacts to ensur
climate-related impacts o

(f) Substantial
eradication and livelihoo
measures for all;

Water and sanitation included as the first of a set of global adaptation thematic targets – accepted as critical for societal adaptation

Common domains and dimensions for measuring community resilience, based on academic literature (review papers) and development agency frameworks

SOCIAL

1. Health and well-being
2. Food security
3. Basic needs met
4. Capacity to anticipate risks
5. Capacity to innovate
6. Individual attitudes and motivations
7. Collective capacity
8. Social justice and equality

ECONOMIC

9. Financial resources at household level
10. Government financial resources
11. Private sector/businesses
12. Sustainable, diverse and secure livelihoods

INSTITUTIONAL

13. Good governance at community level
14. Good governance at the state level
15. Climate/disaster preparedness planning
16. Climate/disaster response and recovery
17. Social protection
18. Inter- and intra-sectoral collaboration and networking

INFRASTRUCTURAL

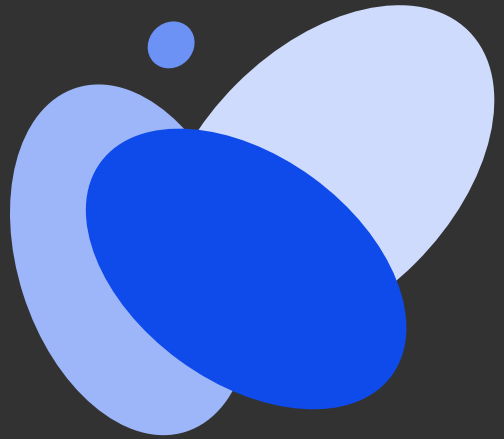
19. Secure water and sanitation infrastructure
20. Secure transport infrastructure
21. Secure energy, telecommunications and ICT infrastructure
22. Secure healthcare infrastructure
23. Secure education infrastructure
24. Secure community services

ENVIRONMENTAL

25. Environmental quality
26. Environmental protections

How does (or could) WASH initiatives best contribute to selected key dimensions of community or societal resilience?

So what? What does all this mean for climate resilient WASH?



Key messages

1. Risk and resilience are critical concepts in addressing climate change, but variously defined, with flow-on consequences for how we respond and the actions we prioritise

2. We need to ask – resilience of what? And in our answer consider solutions that promote resilience of: (i) environment, ecosystems, water resources; (ii) WASH infrastructure and technology; (iii) WASH service systems; (iv) wider society or community

3. Suggest to use the IPCC 2020 definitions and thinking to inform your ideas about risk and resilience, which integrates multiple perspectives

Talisman

I will give you a talisman.
Whenever you are in doubt, or
when the self becomes too much
with you, apply the following test.
Recall the face of the poorest and
the weakest man whom you may
have seen, and ask yourself if the
step you contemplate is going to
be of any use to him. Will he gain
anything by it? Will it restore him to
a control over his own life and
destiny? In other words, will it lead
to swaraj for the hungry and
spiritually starving millions?

Then you will find your doubts and
yourself melting away.

M. K. Gandhi

[CWMG vol. 89, p.125]

Defining climate resilient WASH

What do you consider to be the most critical elements of climate-resilient WASH?

www.menti.com

2978 1368

Resources on climate and WASH

ClimateFIRST: Framework to improve resilience of sanitation technologies – briefing note, tool and other outputs

Urban sanitation and climate change: A public service at risk bit.ly/3U10Gop

Climate resilient urban sanitation in Indonesia:

- Report: https://www.unicef.org/indonesia/reports/climate-resilient-urban-sanitation-indonesia-hazards-impacts-and-responses-four-cities
- Journal paper: https://doi.org/10.1177%2F23998083221098740
- Podcast: https://anchor.fm/paperstopractice/episodes/Episode-6-Action-for-resilient-citywide-sanitation-co-developed-with-local-governments-in-Indonesia-e1qe4m9/a-a845fke

ISF-UTS and SNV, 2019. Considering climate change in urban sanitation: conceptual approaches and practical implications. The Hague: SNV. http://www.snv.org/public/cms/sites/default/files/explore/download/2019-considering-climatechange-in-urban-san-ushhd-learning-snv_0.pdf

Climate change and WASH: SWA Sector Minister's Meeting Briefing Paper https://www.sanitationandwaterforall.org/sites/default/files/2022-04/2022SMM-SWA%20Climate%20Task%20Team-Briefing%20paper_0.pdf

UTS-ISF website: Climate change and WASH https://www.uts.edu.au/isf/explore-research/international-development/water-sanitation-and-hygiene-wash/climate-change-and-wash

Water for Women Fund: Critical connection between WASH and climate change https://www.uts.edu.au/sites/default/files/2022-04/Making%20the%20critical%20connections.pdf

Water for women Fund / UTS: Environmental indicators of risk to inclusive WASH: https://www.waterforwomenfund.org/en/news/environmental-indicators-of-climate-risks-to-inclusive-wash.aspx

Frontiers Rural sanitation and climate change https://www.uts.edu.au/sites/default/files/2021-08/Frontiers17_ClimateChange_FINAL%2Blinks.pdf

Analysing the capacity to respond: https://www.tandfonline.com/doi/abs/10.1080/17565529.2018.1562867

Climate change and urban sanitation: https://snv.org/assets/explore/download/201908-climatechange-learning-brief-lr_0.pdf

Kohlitz et al., 2017 Climate change vulnerability and resilience of water, sanitation, and hygiene services: a theoretical perspective https://opus.lib.uts.edu.au/handle/10453/105609