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Discussion Paper

Climate resilient urban sanitation: From ideas to action

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Executive summary

The purpose of this discussion paper is to build momentum and to move from ideas to action on climate resilient sanitation. The paper draws on discussions held at the IWA Development Congress Kigali Workshop on Climate Resilience and Urban Sanitation (December 2023) and the Global South Academic Conclave on Climate and Water, Sanitation and Hygiene (WASH) and climate linkages held at CEPT University (February 2024). The paper was developed by lead facilitators and organisers of these two events as a collaborative effort, including with the IWA Inclusive Urban Sanitation Initiative and the Climate Resilient Sanitation Coalition.

The paper focuses primarily on strategies currently being adopted to support adaptation to climate change impacts on sanitation, including laying out potential for maladaptation that can arise through non-action to address climate impacts, or through unintentional consequences of adaptation actions. For each of the following topics, the paper provides insight on adaptation measures, maladaptations and short- and long-term priorities:

1. Institutions, policy and planning for climate resilient urban sanitation
2. Financing for climate resilient urban sanitation
3. Climate resilient urban sanitation infrastructure and service provision
4. Integration of climate resilient sanitation within the urban water cycle
5. User engagement and inclusive climate resilient urban sanitation services
6. Addressing health risks while improving climate resilient urban sanitation services

Institutions, policy and planning for climate resilient urban sanitation

Promising actions observed to date include mainstreaming of climate adaptation and mitigation into sanitation policies and planning at national and local levels, along with corresponding adjustments to legislation, regulations, plans and budgets. Strengthened institutional coordination and partnerships across sectors are also driving improved planning practice in several African countries. Maladaptations are associated with poor institutional arrangements; policy and planning that fails to address existing vulnerabilities; the absence of leadership and political will to translate climate resilient sanitation policies into action; and limited integration of sanitation into urban resilience planning. Priorities include raising awareness amongst political leaders, stronger engagement with climate actors and establishing national standards and guidelines for climate resilient sanitation.

Financing for climate resilient urban sanitation

Broader gaps in financing may limit investment in climate resilient sanitation, although the high costs of inaction and damage to sanitation infrastructure represent important arguments for early investment. Only limited climate finance is directed to adaptation, and even less to the sanitation sector; however, multiple sources could address gaps, including domestic public and international sources and climate finance. Additional sources include green bonds and loss and damage funds. Carbon credits and blended finance have also been identified as potentially useful, though with minimal application to date to sanitation. Priorities include ensuring equitable distribution of climate finance, increasing climate-responsiveness of existing financing mechanisms and maintaining emphasis on public finance for climate resilient sanitation as a public service.

Climate resilient urban sanitation infrastructure and service provision

Attention to resilience supports sanitation services to remain functional under diverse conditions. Adaptations to technology design are emerging across multiple contexts in

Asia and Africa, particularly to address problems of flood-prone areas. New tools for sanitation technology designers support incorporation of resilient design features, and improvements to monitoring and warning systems support operators and service providers to adapt under uncertain conditions. Maladaptations include return to open defecation when facilities are unavailable or damaged and release of faecal matter from onsite containments during floods. Priorities include integration of climate risks into sanitation planning across the sanitation chain, infrastructure upgrade to reduce costs of damage, training of service providers and operators and investment in research and innovation in climate resilient sanitation technologies and practices.

Integration of climate resilient sanitation within the urban water cycle

Climate change is significantly impacting the urban water cycles, creating new challenges and opportunities in urban water cycle management in cities worldwide. Strengthened integration across the planning and delivery of water supply, sanitation services and stormwater management allow sector professionals to build on synergies and enact more transformative adaptation actions. This includes concurrently addressing water scarcity challenges and promoting safe wastewater reuse, requiring multisectoral planning. Maladaptation is evident in the contamination of water supplies from onsite sanitation systems and failure of combined sewers during increasingly common heavy rainfall events. Priorities include greater institutional coordination across sanitation and other urban water and waste services and increasing water efficiency and wastewater treatment capabilities and adaptability.

User engagement and inclusive climate resilient urban sanitation services

User engagement can be achieved through awareness raising at community level, for example, through participatory vulnerability assessments and improved early warning and rapid response measures. Diversifying inputs to climate resilient sanitation design ensure it meets diverse needs. Maladaptation may arise through a mismatch of technologies and user behaviours: it is driven by the absence of users in sanitation planning, unsustainable user practices (e.g. high water use), unrepresentative community engagement and insufficient investment in capacity building and empowerment. Priorities include use of participatory assessments and mapping processes, user-led disaster preparedness, and strengthened emphasis on transformative adaptation approaches that address fundamental imbalances and systemic inequalities.

Addressing health risks in improving climate resilient urban sanitation services

There is a need to combat the increased potential health risks arising from climate change effects on sanitation systems and on pathogens and their spread. Vulnerability adaptation assessments can draw attention to the links between climate, sanitation and health, and make visible health risks for certain population groups. Adaptation is possible through strengthened involvement of the health workforce and multisectoral responses that include sanitation are needed to address resurgence of cholera outbreaks during flood events. Maladaptations can result from failure of sanitation services in climate events and the resultant spread of pathogens in the environment. Maladaptation also occurs from unintended consequences of adaptation actions, for instance through unsafe applications of wastewater reuse driven by water scarcity. Priorities include an improved evidence base and awareness of the health risks of non-climate resilient sanitation as well as targeting investments to recurrent sanitation-related disease hotspots.

Figure 1: Focus group discussion with women from community in Banjarmasin, Indonesia concerning their sanitation experiences and preferences given the challenges of a highly flood-prone area (Image source: Juliet Willetts, UTS).

The key messages arising from the discussions and subsequent analysis are as follows:

Key message 1

Climate resilient sanitation must be inclusive to protect the health of all

Climate change impacts on sanitation increase health risks, particularly for low socio-economic and disadvantaged groups that are likely to have poorer sanitation infrastructure and fewer resources to cope and adapt. Inclusive processes for engaging with communities and users are key to achieving climate resilient sanitation and ensure community coverage that enables health benefits for all.

Key message 2

Mainstreaming climate adaptation in sanitation policy and institutions is of fundamental importance

Without bringing climate concerns into sanitation policy and institutions, maladaptation is likely to occur, caused by insufficient investment, inappropriate designs and unsuitable regulations. Efforts are needed to build political leadership and adjust institutional frameworks for sanitation to better incorporate climate impacts and concerns.

Key message 3

Climate change as an opportunity – focus on co-benefits to the water cycle and other sectors to drive strengthened support and leadership

Wastewater reuse, organic fertilisers and energy sources are just some of the co-benefits that climate resilient sanitation can offer. Further benefits can flow from addressing stormwater and solid waste in combination with sanitation as a single interconnected system. Changing the mindset of decision-makers so that they acknowledge the connections between climate, sanitation and potential co-benefits is key, as is moving beyond silos by engaging wider stakeholders.

Key message 4

New financing pathways are emerging but need testing and feedback mechanisms

Public finance remains the most prominent source of investment for climate resilient sanitation and is a critical source for this public service, as full capital and running cost recovery is difficult across all countries globally, and sanitation is a fundamental measure to protect public health and the environment, as well as offering other co-benefits. Beyond public finance, complementary sources of financing, including climate financing are increasingly available, noting that adaptation finance for sanitation to date has received only a small proportion of such funding. New pathways such as carbon credits, green bonds and mitigation-related climate financing are emerging areas that require testing to understand if and how they may offer viable sources to support climate resilient sanitation.

Key message 5

Research and innovation should provide concrete examples of climate resilient sanitation in practice and improved economics and cost analysis to underpin choices and to justify financing needs

Investment is needed in research and innovation to develop new technologies, practices and approaches for all parts of the sanitation chain, including through action research to anchor findings in policies, programmes and mandates. More 'hard cost information' is needed on the costs of adaptation and the costs of inaction, and cities and communities need models of good practice in climate resilient sanitation.

Key message 6

Climate resilience needs to be looked at across the entire sanitation service chain and always in the context of the broader water cycle

Climate resilience in the context of sanitation services involves ensuring that the entire sanitation service chain can withstand and recover from climate-related stresses and shocks. The sanitation service chain includes various components: capture, containment, emptying, transport, treatment, and reuse or disposal. Each part of this chain is interdependent, and a failure in one component can compromise the entire system. Hence a comprehensive assessment of climate resilience should be undertaken across the entire sanitation service chain, and within the context of the broader water cycle and its interconnectedness.

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1.

Introduction

The purpose of this discussion paper is to generate momentum and to move from ideas to action to meet the challenge of integrating climate resilience into urban sanitation development, particularly for low socio-economic groups that are likely to be most vulnerable to the impacts of climate change.

The paper draws on the views of public sector actors, researchers and development agencies who participated in events at the IWA Development Congress Kigali 'Workshop on Climate Resilience and Urban Sanitation' (December 2023) and the Global South Academic Conclave on 'Climate and Water, Sanitation and Hygiene (WASH) and climate linkages' held at CEPT University (February 2024). It is co-authored by members of the IWA Inclusive Urban Sanitation Initiative, the Climate Resilient Sanitation Coalition, and facilitators and organisers of the two above-mentioned events.

Drawing from the two global sector events, this paper provides insight into current efforts to address climate change in urban sanitation and priorities to bring climate resilience into existing financing, implementation and monitoring systems, based on experiences in diverse country contexts. The paper does not present a comprehensive view on the topic but, rather, points to key areas that warrant attention and where activities have begun towards limiting **disruption of services, safeguarding public health and environmental outcomes and building resilient services.**

The discussion paper focuses on **adaptation to climate change,** in terms of the ability of the sanitation service to function in the context of climate change. Climate mitigation is also touched on, both where it can be addressed in synergy with adaptation, and in relation to the potential for mitigation opportunities to provide new pathways for financing urban sanitation services. At the time of writing, the recently agreed upon Global Goal for Adaptation at COP28 with inclusion of 'climate resilient sanitation' in its thematic targets offers an opportunity to increase joint efforts on adaptation of sanitation services.

The paper is structured around six main topics (institutions, financing, infrastructure and service provision, water cycle integration, user engagement and health risks), and for each we explore current efforts and adaptation actions, potential for maladaptation, and identify both short and long-term sector priorities. A further important topic is environmental risks, and although it is not dealt with in depth, it is addressed at least in part in the water cycle integration section.

2.

Background and context

Climate change is the defining feature of our times, presenting new challenges and exacerbating inequalities and negative health and environmental impacts. The IPCC notes explicitly with 'high confidence' that sanitation systems have been compromised by extreme and slow-onset events, associated with economic losses, service disruptions and well-being impacts, particularly for marginalised groups (IPCC, 2023[1]). Meanwhile, safe sanitation requires universal access to toilets that safely contain excreta, their sustained use in homes and institutions, and safe management of faecal sludge and wastewater through conveyance, treatment and end use and disposal (WHO, 2018).

Urban sanitation services are already complex to develop and deliver in cities and towns in low- and middle-income countries (LMICs), even without the added challenge of climate change. This complexity, combined with current low levels of investment, means that sanitation is alarmingly off-track in terms of meeting the Sustainable Development Goal (SDG) targets[2] including in urban areas. Whilst progress has been made in establishing approaches that address the needs of all citizens in urban areas through citywide inclusive sanitation (CWIS) approaches[3], progress overall is slow.

In this context, addressing climate change in combination with existing urban sanitation challenges is potentially an overwhelming prospect, with some stakeholders arguing for staying focused on access to basic sanitation services at first or on access to safely managed sanitation, without consideration of climate impacts. However, given the rapid rate of change in climate and extreme weather events already occurring, urgent action to integrate climate change considerations, both for mitigation and adaptation, into urban sanitation planning and service delivery is needed. This means balancing a range of urgent necessities simultaneously.

Furthermore, why take sanitation and climate resilience as a focus, and not water supply, or solid waste management and climate change? The reasons why are many:

- With increasing impacts on the hydrological cycle, it will not be possible to secure a resilient water supply and water resources without addressing sanitation. On the contrary, sanitation offers major opportunities to provide a source of additional water in water-scarce regions through careful recycling and wastewater reuse, including consideration of component parts of wastewater to allow for its better reuse (blackwater, greywater, urine).
- In climate policy and dialogue, there is increasing attention to water-related concerns, however there is not yet sufficient attention being paid to sanitation. Hence raising the profile and making clear and tangible the connections between climate, sanitation and resilience of the urban water cycle is critical. These interconnections span disruptions caused by floods, droughts and sea-level rise on sanitation systems,[4] impacting health and amenity, as well as pollution impacts on coastal and freshwater ecosystems, reducing their resilience.[5]
- Sanitation offers a potential opportunity to reduce greenhouse gas emissions, as emissions have been underestimated,[6] and the sector's contribution to methane emissions in particular may be many times higher than anticipated. There is also an opportunity to reduce energy requirements from pumping and treatment systems, including through energy recovery.

As this paper focuses primarily on adaptation, it is important to define this term, as well as its counterpart, maladaptation. Adaptation is defined by IPCC as:

> "In human systems, the process of adjustment to actual or expected climate and its effects, in order to

> moderate harm or exploit beneficial opportunities. In natural systems, the process of adjustment to actual climate and its effects; human intervention may facilitate adjustment to expected climate and its effects." (IPCC 2022[7])

In the context of climate resilient sanitation, adaptation is therefore the process of adjustment to prepare for extreme weather events and disturbances associated with climate change, and the hazards these create for urban sanitation systems.

In contrast, maladaptation is defined as:

> "Actions that may lead to increased risk of adverse climate-related outcomes, including via increased greenhouse gas emissions, increased vulnerability to climate change, or diminished welfare, now or in the future. Maladaptation is usually an unintended consequence." (IPCC, 2022).

Maladaptation has been described as a process through which people become even more vulnerable to climate change rather than less vulnerable,[8] as shown in Figure 2.

The IPCC also further differentiates between incremental adaptation which "maintains the essence and integrity of a system or process at a given scale" and transformational adaptation, which "changes the fundamental attributes of a socio-ecological system in anticipation of climate change and its impacts" (IPCC 2022[10]).

Transformative adaptation requires larger changes in values, greater resourcing, plurality of stakeholders, sectors and levels and greater divergence from status quo.[11] With the agreement in COP28 to a Global Goal on Adaptation in 2023, and the magnitude of climate impacts felt worldwide already, has come increased dialogue about the criticality of transformative adaptation. In the context of sanitation services transformative adaptation could mean more dramatic changes in how services are delivered, alignment to emerging trends of reconfiguration of the urban water cycle to concurrently address water scarcity, wastewater and stormwater climate impacts and challenges in a coordinated manner and greater focus on structural changes that perpetuate vulnerability and high exposure to faecal pollution in lower socio-economic groups.

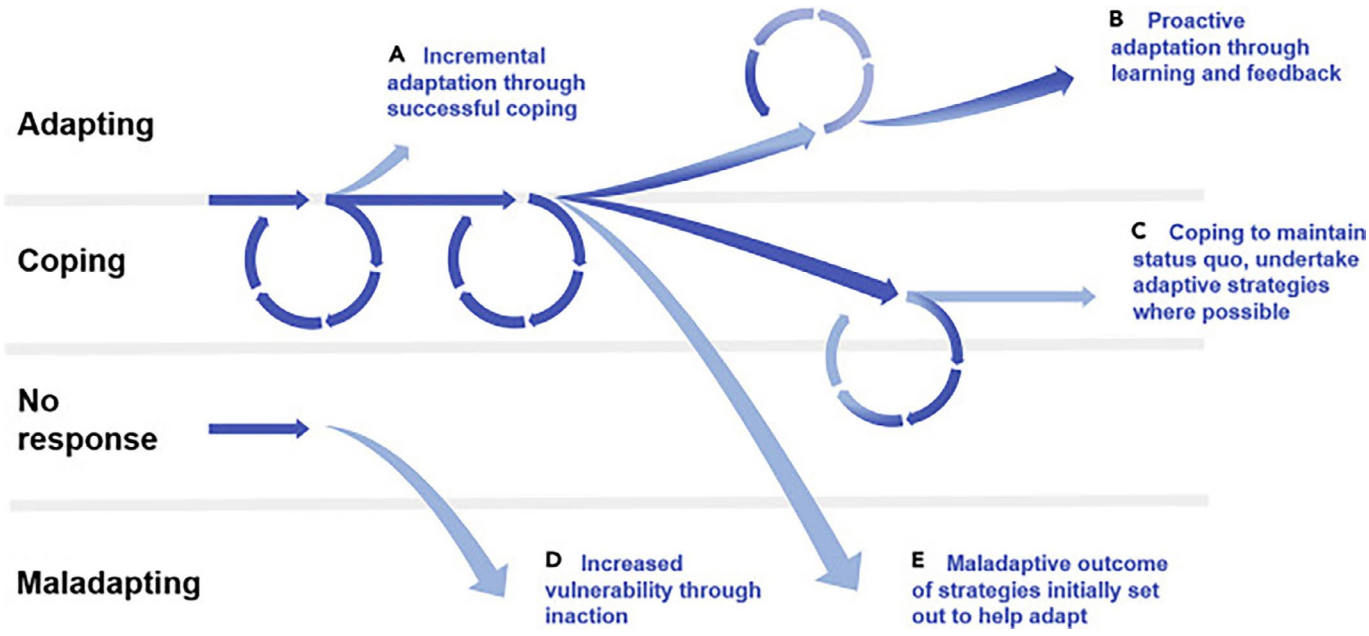

Figure 2: Conceptual diagram of adaptation outcomes over time, including maladaptation.[9]

Section endnotes

1 https://www.ipcc.ch/report/ar6/wg2/downloads/report/IPCC_AR6_WGII_SummaryForPolicymakers.pdf

2 https://washdata.org/reports/jmp-2023-annual-report

3 https://www.frontiersin.org/articles/10.3389/fenvs.2020.00019/full

4 UTS-ISF (2022) Urban sanitation and climate change: A public service at risk. https://opus.lib.uts.edu.au/handle/10453/161557

5 Pelletier, M. et al, 2020. Resilience of aquatic systems: Review and management implications. Aquat Sci. 2020 Mar 28; 82(2): 1–44.doi: 10.1007/s00027-020-00717-z; Hyde-Smith et al., 2022 Climate change impacts on urban sanitation: A systematic review and failure mode analysis, https://pubs.acs.org/doi/10.1021/acs.est.1c07424

6 Cheng et al., 2022. https://www.sciencedirect.com/science/article/pii/S0013935122007952

7 https://www.ipcc.ch/report/sr15/glossary/

8 https://www.sciencedirect.com/science/article/pii/S2590332220304838

9 Ibid.

10 https://www.ipcc.ch/report/sr15/glossary/

11 Fedele et al., 2019 https://www.sciencedirect.com/science/article/pii/S1462901119305337

3.

Methods

This discussion paper was prepared as an output from a workshop session held at the IWA Development Congress in Kigali (December 2023) 'Workshop on Climate Resilience and Urban Sanitation', with a total of 35 participants, and the Global South Academic Conclave on 'Climate and Water, Sanitation and Hygiene (WASH) and climate linkages' held at CEPT university (February 2024) with more than 350 participants from 30 countries. At the IWA event, six facilitators with specific expertise relevant to their allocated topic led table discussions. The topics were:

1. Institutions, policy and planning for climate resilient urban sanitation
2. Financing for climate resilient urban sanitation
3. Climate resilient urban sanitation infrastructure and service provision
4. Integration of climate resilient sanitation within the urban water cycle
5. User engagement and inclusive climate resilient urban sanitation services
6. Addressing health risks in improving climate resilient urban sanitation services

The round table discussions addressed three main questions:

1. What positive experiences have you seen of coping or adaptation in this area of climate resilient sanitation?
2. Are there any failures we should learn from or mal-adaptations to avoid?
3. What should be the short- and long-term priorities for this area?

Building on notes of the discussions at the IWA Kigali workshop, we integrated points raised by speakers and presenters at the Global South Academic Conclave on "Climate and Water, Sanitation and Hygiene (WASH) and Climate Linkages", contributed by co-authors who led the organisation of the latter event.

To further enhance the materials emerging from these two events, sub-groups of co-authors led the development of each of the six main sections, integrating recent literature and experiences from their countries, and refining the short- and long-term priorities. Internal peer review was used to check for omissions and to improve the quality of analysis and writing.

4.

Institutions, policy and planning

4.1. Adaptation strategies, actions and trends

The conventional focus on reducing climate risks in urban sanitation has largely revolved around technology design.[12] However, there is increasing recognition that resilience in sanitation services is also dependent on the incorporation of resilience concepts into institutional, policy and planning frameworks[13], including associated regulatory and service delivery frameworks. Despite the tendency among policymakers and climate financiers to prioritise tangible infrastructure upgrades as key adaptation measures,[14] it is critical to emphasise the importance of increasing adaptive capacity through softer, but equally important, strategies such as policy integration and intersectoral coordination.[15]

One key approach is to **mainstream climate change adaptation, mitigation and resilience in existing and new water and sanitation policies and planning processes at national and local level.** Policy integration and intersectoral coordination are particularly important because climate change is a complex cross-cutting problem, given its many interconnected pathways and consequences in various sectors.[16] As a starting point, sanitation policies should align with climate commitments and be included in countries' Nationally Determined Contributions (NDCs) and National Adaptation Plans (NAPs).[17] Recent studies show that while around 9% of global NDC activities relate to SDG 6,[18] they mostly refer to improving water management[19] with only a few linked to sanitation.[20] By mid-2020 only 2% of NDCs were linked with access to sanitation and 3% to wastewater treatment.[21]

The 'Call to Action on Climate-Resilient Sanitation', launched by the Climate Resilient Sanitation Coalition during COP27, urges governments to embed climate resilience across all facets of sanitation governance and services, spanning national and subnational levels. This includes integrating climate-resilient sanitation strategies into national and subnational **policies, legislation, plans, budgets, systems and services.**[22]

Many countries have already acted on **adaptation approaches in sanitation policies and targets.**[23] The Bangladesh NAP considers climate resilient sanitation, as does the NDC document for Bolivia, addressing associated adaptation and disaster risk reduction, and Nepal and Fiji have integrated sanitation targets into their NDCs. Other notable efforts include Kampala City Council's integration of climate impacts on urban sanitation into local budgeting processes, and Malaysia's adoption of a national sewerage planning policy that considers climate change. In India, the National Action Plan on Climate Change (NAPCC) through the National Water Mission[24] focuses on ensuring a proportion of urban water needs are met through wastewater recycling. As such, national sanitation and infrastructure efforts (Swachh Bharat and Atal Mission for Rejuvenation and Urban Transformation) in India focus on treated wastewater reuse as a major component.[25]

Countries are also working on updating **regulations and guidelines.** In Vietnam, updated laws on water supply, sewerage, and wastewater treatment are being drafted that integrate climate resilience, supported by the Vietnam Water and Sanitation Association. Similarly, Indonesia is developing a climate-resilient WASH framework and an SDG roadmap, coinciding with advocacy efforts at ministerial levels. UN agencies provided technical guidance in Ghana for flood-resilient water supply and sanitation facilities, with guidelines being mainstreamed into national policies.[26] In Kenya and Nepal, UN-Habitat conducted policy assessments to integrate sanitation into urban development laws and regulation.[27] Regionally, the African Sanitation Policy Guidelines underscore the importance of resilient sanitation systems in the face of climate change.[28]

Furthermore, **institutional coordination and partnerships across sectors** are being emphasised, and this is considered an important factor for adaptation. In Zambia, stakeholders are collaborating with climate actors to formulate guidelines for resilient sanitation.[29] In Nakuru county, Kenya, a steering committee was established to develop and implement a Countywide Strategic Sanitation Plan, recognising climate change threats to sanitation systems.[30] The Nakuru Countywide Sanitation Technical Steering Committee (NACOSTEC) includes representatives from various county departments such as water, health, finance and urban development, as well as local water and sanitation companies and the Nakuru Municipality Board, in order to promote comprehensive and coordinated sanitation planning. This diverse composition supports the development and implementation of the Countywide Strategic Sanitation Plan, addressing, among other issues, climate change impacts on sanitation systems.

4.2. Maladaptations

Lack of or poor institutional arrangements, policy and planning can lead to counter-productive climate adaptation and mitigation actions, often rooted in existing institutional challenges within the sanitation sector. Such maladaptation will amplify the vulnerability of sanitation systems across the service chain, particularly for the most disadvantaged groups.

Lack of leadership and political will to translate climate-resilient sanitation policies and plans into action is another form of maladaptation.[31] Political leaders and policymakers frequently overlook sanitation in climate change policy talks, preventing the establishment of ambitious objectives and the allocation of resources required for successful action.[32] This rivalry for attention with other policy challenges risks deprioritising climate change adaptation. High-level political leadership, as demonstrated by inter-ministerial committees, has the potential to foster cross-sectoral collaboration, as witnessed during the COVID-19 pandemic. At that time, this leadership guaranteed that hand hygiene and environmental cleanliness were a priority despite conflicting government agendas.

Poor integration of sanitation into urban resilience planning is another widely recognised challenge[33] that risks maladaptation. Urban areas in LMICs face many stressors which become compounded with climate change, including urbanisation and rapid population growth. Because these stressors are often interconnected, planning for climate change needs to be integrated within urban planning. However, the urban resilience planning sector seldom appreciates the pivotal role of sanitation in improving public health, improving water quality, reducing environment pollution, and eradicating poverty and inequality in cities and human settlements. Although the challenge of unsafe and inadequate sanitation services acutely impacts sustainable urban development, urban policies, strategies and plans rarely prioritise sanitation systems.

Chronic underinvestment for climate resilient sanitation, combined with inadequate design standards for infrastructure in the face of climate change and with poor enforcement, will continue to lead to low-quality infrastructure that is more susceptible to damage or affected by various climate risks.

Unclear institutional responsibility and non-existent accountability mechanisms for climate-resilient sanitation in many LMICs make it difficult to hold individuals and institutions accountable to the climate goals and ambitions they have formulated.

Lack of local climate data, information systems and climate scenarios and predictions to inform city-level sanitation planning is another challenge to adaptation. Diversifying data sources and building stronger collaboration across sectors in sanitation and climate data collection and sharing, including data triangulation at national and subnational levels is recommended. Coordination of data across sectors plays a key role in improving the availability, quality, analysis, dissemination, and use of data to inform decision-making and planning.

4.3. Short-term priorities

— **Enhance awareness among political leaders, policymakers and urban planners on climate change impacts on sanitation and sanitation impacts on climate change.** It is important to emphasise the necessity of integrating climate change adaptation

and resilience into both existing and future water and sanitation policies and planning processes. Academic, research and development institutions have a role to play in to providing up-to-date data and research findings to empower political leaders, policymakers and urban planners in making informed decisions and formulating effective policies and plans.

- **Ensure the involvement of stakeholders working on climate change and climate impacts in sanitation working groups** and promote engagement between sanitation actors and cross-cutting sectors, such as emergency response, water resources, urban planning and flood management. Inter-sectoral coordination plays an important role in establishing effective planning, service delivery and monitoring, early warning, and response systems.
- **Ensure adaptation measures for sanitation are reflected as targets in the NDCs** in addition to mitigation targets. This will help embed adaptation within such policies as part of ongoing programmes and efforts on water and sanitation.

4.4. Long-term priorities

- **Incorporate adaptive planning and management practices into sanitation management** to enable proactive, responsive and organised adaptation efforts. This includes implementing monitoring and feedback systems and allocating resources for staff capacity building in adaptive planning, as well as incorporating inclusive, gender responsive approaches.
- **Establish comprehensive national standards and guidelines for climate-resilient sanitation,** as demonstrated by Ghana's initiative to create a compendium of climate-resilient water and sanitation technology options. Additionally, minimum standards for resilient WASH facilities in flood-prone areas have been formulated as part of this effort in Ghana, an approach that could be replicated elsewhere.
- **Take sanitation into account in the planning of broader urban systems** to enhance overall system resilience. This includes factors such as flood management, disaster risk reduction and water security to ensure comprehensive urban planning.

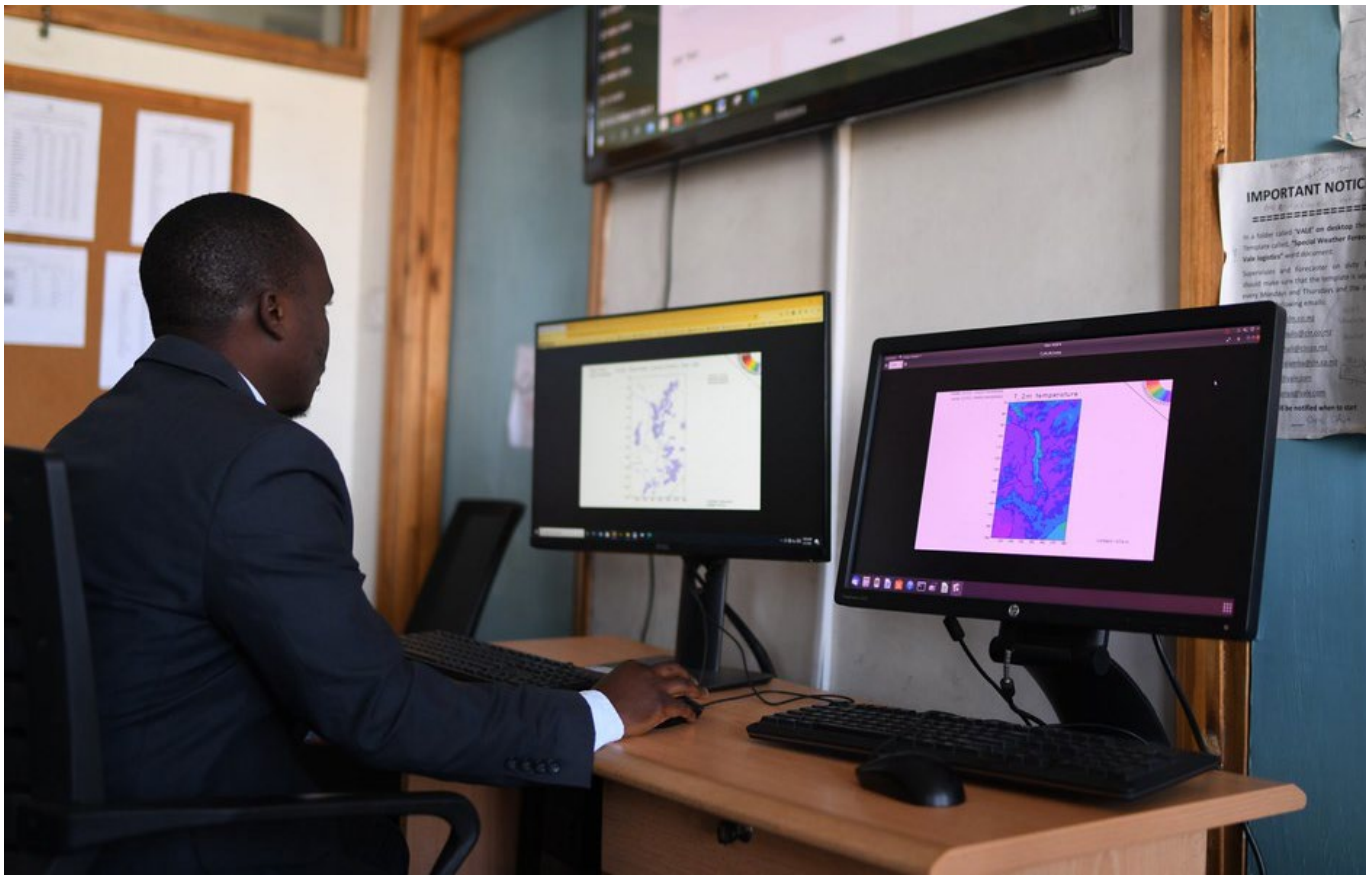

Figure 3: Scaling up the use of modernized climate information and early warning systems in Malawi (Image source: UNDP Malawi).

Section endnotes

12 UTS-ISF (2022) Urban sanitation and climate change: A public service at risk. https://opus.lib.uts.edu.au/handle/10453/161557

13 Mills, F., Kohlitz, J., Carrard, N. and Willetts, J., 2019. Considering climate change in urban sanitation: conceptual approaches and practical implications. The Hague: SNV.

14 Dickin, S., Bayoumi, M., Giné, R. et al. Sustainable sanitation and gaps in global climate policy and financing. npj Clean Water 3, 24 (2020). https://doi.org/10.1038/s41545-020-0072-8

15 Kohlitz, J., Willetts, J., Gero, A., Lyons, S., Boisson, S. and Medlicott, K., 2019. Climate, Sanitation and Health. Geneva: WHO.

16 Kupers, R., 2020. A Climate Policy Revolution. *What the Science of Complexity Reveals about Saving Our Planet.* https://www.hup.harvard.edu/catalog.php?isbn=9780674972124

17 SWA Climate Action Webinar Series Webinar 1: Opportunities for integrating WASH into national climate policy and planning, April 13 2021 https://www.sanitationandwaterforall.org/knowledge-exchange/Opportunities-for-integrating-WASH-into-national-climate-policy-and-planning

18 Ensure availability and sustainable management of water and sanitation for all.

19 Pauw, W. P. et al. NDC explorer. https://doi.org/10.23661/ndc_explorer_2017_2.0 (2016).

20 Dickin, S. & Dzebo, A. Missing in climate action: concrete health activities in nationally determined contributions. *Lancet Planet Health.* 2, e144 (2018). doi: 10.1016/S2542-5196(18)30046-9.

21 Dickin, S., Bayoumi, M., Giné, R. et al. 2020. Sustainable sanitation and gaps in global climate policy and financing. *npj Clean Water* 3, 24. https://doi.org/10.1038/s41545-020-0072-8

22 https://www.unicef.org/documents/ensuring-access-climate-resilient-sanitation-services-36-billion-people-2030

23 UTS-ISF (2022) Urban sanitation and climate change: A public service at risk. https://opus.lib.uts.edu.au/handle/10453/161557

24 https://nwm.gov.in/

25 Ministry of Jal Shakti, India (2022) Wastewater Management for Efficacious Use of Water Resources. https://pib.gov.in/Pressreleaseshare.aspx?PRID=1884892

26 265 communities in Northern Ghana receive resilient water sanitation and hygiene facilities under joint UN programme | United Nations in Ghana. https://ghana.un.org/en/138317-265-communities-northern-ghana-receive-resilient-water-sanitation-and-hygiene-facilities

27 CWIS. www.unhabitat.org.np/project_detail/city-wide-inclusive-sanitation-cwis

28 UTS-ISF (2022) Urban sanitation and climate change: A public service at risk. https://opus.lib.uts.edu.au/handle/10453/161557

29 Ibid.

30 World Bank. 2019. Nakuru Countywide Strategic Sanitation Plan - Countywide Inclusive Sanitation Strategy. https://thedocs.worldbank.org/en/doc/932861595953186546-0090022020/original/G.NakuruCountywideSanitationStrategyFINALwithFOREWORDMarch2019.pdf

31 IPCC report recognises missing ingredient for climate action: Political will | Grist

32 Biesbroek, R. (2021) Policy integration and climate change adaptation, *Current Opinion in Environmental Sustainability,* 52, 75-81, https://doi.org/10.1016/j.cosust.2021.07.003.

33 UTS-ISF (2022) Urban sanitation and climate change: A public service at risk. https://opus.lib.uts.edu.au/handle/10453/161557

5.

Financing for adaptation

5.1 Overview of financing gaps and challenges

There is a significant financing gap to meet the targets in SDG 6. The World Bank estimates that it will cost approximately USD114 billion a year between 2024 and 2030 just to achieve the first two (of six) targets.[34] In a 2020 report by UNICEF, sanitation accounted for an important part – 60 % – of the USD114 billion annual costs.[35] A key argument supporting investment in adaptation of sanitation infrastructure is the demonstration of the added costs of disaster recovery. For instance, sanitation infrastructure in Bangladesh that is vulnerable to flooding, in 2021 flash flooding and erratic rainfall cost the Bangladesh government around USD430 million[36] but would have cost only USD 90 million if climate resilient sanitation had been in place.

A 2022 study found that only 6% of global climate finance was directed to adaptation, mostly in middle-income countries,[37] with low-income countries only receiving 8% of the total funding. Within adaptation funding, 38% is focused on water and sanitation; however, this includes efforts focused on wider water resources management, and less than 2% of this funding is focused on basic sanitation systems, despite the impacts climate change has on sanitation.In addition, this finance also came mostly as debt finance, despite the need for grants and concessional funding for sanitation: of the $10.5bn reported in adaptation finance from 2019 to 2023 by the Asian Development Bank (ADB), 93% was provided as loans.[38]

The provision of climate financing for adaptation through loans has potential to be problematic given many LMICs make only a small contribution to climate change, but are then faced with added debt burdens.[39] In addition, some climate finance is double-counted as aid.[40] These shortcomings of the global financing mechanisms critically need to be addressed, and sanitation prioritised as an adaptation option. As the bulk of climate finance is currently allocated to mitigation, it could also make sense to explore this area. In addition, it may be possible to align win-win approaches that address adaptation of sanitation services to climate change through active management with reducing or capturing methane emissions.[41]

Three financing sources are highlighted below for their potential to support adaptation actions in urban sanitation: domestic public finance, international sources of climate finance and innovative sources of climate finance. One issue faced to date in climate financing for sanitation and water has been the requirement for large-scale funding that favours large-scale infrastructure investments (which may not reach the most unserved, vulnerable communities), rather than systems strengthening approaches and smaller investments that are also needed to address adaptation challenges.[42]

5.2. Domestic public finance

Domestic public finance is the most prominent source for sanitation services. Water, sanitation and hygiene have largely been funded through public funds[43] and, given the nature of sanitation as a public service, this is likely to remain a key funding source for climate resilient sanitation.[44] The share of funding through public-private partnerships (PPPs) has been small compared to other sectors, such as transport and energy. The government finances sanitation in countries such as Ghana through ring-fenced subsidies; in India through direct budgetary allocations, taxes, subsidies, market mechanisms to leverage private finance, and by facilitating and supplementing climate funds; and in Senegal through significant national government transfers to city level. However, many national budgets do not (yet) consider the climatic impacts on sanitation.

5.3. International sources of finance and climate finance

International sources of finance and climate finance include multilateral climate funds, such as GCF and GEF and multilateral development banks including the ADB, World Bank, JICA and DFID. Key sources are described below in terms of their relevance to sanitation.

Green Climate Fund (GCF): There has been progress recently to add guidance on climate resilient sanitation to GCF funding guidelines. However, it is important to consider the demand side and how governments will make use of this funding: there is a need for more knowledge and capacity on climate resilient sanitation, and incentives for actions (potentially through NDCs, as mentioned in the section on institutions above). In Fiji, a GCF project includes a focus on increasing sewerage coverage and reliability of wastewater treatment processes, upgrading pumping stations, networks and treatment facilities to handle extreme events and minimise bypass incidents.[45]

Global Environment Facility (GEF): The GEF provides grants for projects that address global environmental issues, including climate change, biodiversity, and water/sanitation. The GEF, the largest contributor of global financial flows in India, funded 97 projects with USD 816.47 million and additional significant co-financing; however the grant component is limited to 12%. Multilateral development banks, such as the World Bank and the ADB, contributed to over 50% of the total GEF-funded projects in India.[46]

Least Developed Countries Fund (LDCF): This fund was established to support a work programme to assist Least Developed Country Parties to carry out the preparation and implementation of national adaptation programmes of action. The LDCF is managed by the GEF. This fund specifically targets the most vulnerable nations and can include financing water, sanitation and hygiene projects that address immediate and urgent climate adaptation needs. This includes improving water supply systems, constructing resilient sanitation facilities and enhancing hygiene practices to protect communities from climate-induced water scarcity and health risks.

Adaptation Fund: The Adaptation Fund was established in 2001 under the Kyoto Protocol, to support developing countries in strengthening their capacity to better cope with the impacts of climate change. This is funded by a share of proceeds from Clean Development Mechanism projects and voluntary contributions. The Adaptation Fund finances projects such as flood-resistant water supply systems, climate-resilient sanitation infrastructure and initiatives that promote sustainable water management practices.

5.4. Innovative sources of climate finance

Innovative sources for climate funding include carbon credits, green bonds, blended finance, and loss and damage funds. To date many of these have been explored in the context of emissions and mitigation rather than adaptation. These are explained further below.

Carbon credits: Carbon credits[47] have been explored by the Millennium Water Alliance and the Container Based Sanitation Alliance[48] and show potential to monetise the climate impact of sanitation, even if this is limited at present to actions recognised in carbon methodologies (which are mostly concerned with methane capture). While carbon financing holds promise, significant efforts are still needed to create the enabling conditions and frameworks that can effectively channel this source of climate finance towards climate-resilient sanitation infrastructure and services.

Blended finance: There are emerging opportunities for blended finance[49] to mobilise private and commercial finance for the sanitation sector across the value chain, noting that many blended finance efforts provide only a minor share of private investment in water and sanitation[50] and they require mature management arrangements and oversight,[51] which may not suit many contexts.

Green bonds: Green bonds are a popular sustainable finance instrument in emerging markets. In Colombia they have been used in the wastewater sector as a capital market instrument to improve environmental sustainability, access and resilience of sewerage systems.[52] Several Indian states and municipalities have issued green bonds to finance water supply and sanitation infrastructure that contributes to climate change mitigation and adaptation.

For example, the Pune Municipal Corporation issued a US$ 26 million green bond in 2019 to fund wastewater treatment plants and water distribution networks.

Loss and Damage Fund: On the first day of COP28, a landmark agreement was made through the establishment of the Loss and Damage Fund to support LMICs especially vulnerable to climate change to deal with its effects. Ensuring that the scope of the Loss and Damage Fund explicitly covers climate change-induced impacts on sanitation infrastructure, services and livelihoods will be a key priority for sanitation advocates. This could include funding for the repair, rehabilitation or replacement of damaged sanitation facilities, as well as the restoration of sanitation services after climate-related disasters.

5.5. Short-term priorities

- **Ensure that climate finance for sanitation is distributed equitably,** with a focus on reaching the most vulnerable, exposed and underserved communities, as there is a risk that current financing mechanisms may favour large-scale infrastructure efforts and may not be targeted to these groups.
- **Continue to make existing financing by the public sector, national programmes, and multilateral development banks more climate-responsive.** This involves aligning financial resources and investments with climate change objectives and integrating climate considerations into the design, implementation and evaluation of all development projects and programmes.
- **Maintain a strong emphasis on public finance for sanitation as a public service, a public health service and an environmental service and, at the same time, strategically utilise public finance to catalyse and mobilise private sector investment** in climate-related projects through mechanisms such as blended finance and green bonds.

5.6. Long-term priorities

- **Improve the capacity of local governments, utilities, and service providers to access and effectively utilise existing climate finance mechanisms,** such as GCF, especially through concessional instruments. This could include developing a system to track and monitor climate-related expenditures within national and sub-national budgets. Such monitoring supports better transparency and accountability in climate finance and helps prioritise climate-responsive investments.
- **Advocate to increase the proportion of climate financing directed to adaptation.** At present, adaptation receives only a marginal portion of the climate finance flows. National, regional and city governments and utilities/service providers need to incorporate adaptation in their budgetary and programmatic frameworks, integrate climate risks in decision making processes and build capacities across policy and sectors to mainstream adaptation.
- **Green bonds may offer potential for cities to finance sustainable projects, but several key challenges persist.** These include lack of awareness, limited creditworthiness and difficulties developing bankable green initiatives, necessitating capacity building, credit enhancement mechanisms and technical assistance.

Figure 4: Container based sanitation services use low or no water which makes them well suited to providing services in water scare areas such are the areas surrounding Lima in Peru pictured here (Image source: Sanima).

Section endnotes

34 https://www.worldbank.org/en/topic/water/publication/the-costs-of-meeting-the-2030-sustainable-development-goal-targets-on-drinking-water-sanitation-and-hygiene

35 Global and Regional Costs of Achieving Universal Access to Sanitation to Meet SDG Target 6.2 (2020): https://www.unicef.org/media/85111/file/Wash-Reports-CostOfSanitation.pdf

36 https://washmatters.wateraid.org/publications/mission-critical-invest-water-sanitation-hygiene-healthy-green-recovery

37 Climate financing flows for water, 2022 https://washmatters.wateraid.org/sites/g/files/jkxoof256/files/2022-11/Climate%20finance%20for%20WASH%20-%20November%202022_0.pdf

38 Unaccountable adaptation The ADB's overstated claims on climate adaptation finance: https://oxfamilibrary.openrepository.com/bitstream/handle/10546/621602/bp-unaccountable-adaptation-020524-en.pdf

39 https://www.ircwash.org/blog/pledges-loss-damage-fund-cop28

40 https://www.care-international.org/news/double-counted-climate-finance-means-poorest-pay-price

41 https://www.globalwaters.org/resources/assets/managing-climate-impact-human-waste-study-understand-impact-methane-emissions

42 https://www.waterforwomenfund.org/en/news/climate-finance-for-wash-in-asia-pacific.aspx

43 https://www.worldbank.org/en/topic/water/publication/funding-a-water-secure-future

44 Carrard, N., Willetts, J., Kome, A. et al. (2024) Sustainable cost recovery principles can drive equitable, ongoing funding of critical urban sanitation services. *npj Clean Water* 7, 105. https://doi.org/10.1038/s41545-024-00399-2

45 https://www.greenclimate.fund/document/fiji-urban-water-supply-and-wastewater-management-project

46 Srinivasan, M., Ghoge, K., Haldar, S., Bazaz, A. B., and Revi, A. (2023, November 27). Climate finance in India 2023. Indian Institute for Human Settlements.

47 https://mwawater.org/learning-paper-carbon-credits-for-water-sanitation-and-hygiene-wash-interventions/ , https://cbsa.global/carboncredits

48 https://mwawater.org/learning-to-action-mwas-liquid-assets-event-explores-carbon-credits-in-water-security/; https://cbsa.global/carboncredits

49 Blended Finance Cases Across the Sanitation Service Chain: Cases from India: https://cwas.org.in/cwas-resources/blended-finance-cases-across-the-sanitation-service-chain-cases-from-india

50 https://www.worldwatercouncil.org/sites/default/files/World_Water_Forum_09/WWC-Successful-Blended-Finance-Projects_WEB_EN.pdf (2022).

51 https://www.adb.org/publications/long-term-financing-for-city-wide-inclusive-sanitation, https://doi.org/10.56506/YVXB6984 (2023).

52 https://greenfinancelac.org/resources/publications/green-bonds-issuance-in-the-water-and-sanitation-sector-in-colombia/

6.

Climate resilient urban sanitation infrastructure and service provision

6.1. Adaptation strategies and trends

Adaptation strategies and trends in sanitation infrastructure and service provision have changed over the last decade or more. Initial work focused on sanitation infrastructure, looking to draw conclusions about which infrastructure types were more 'resilient' than others, including drawing comparisons between onsite sanitation and sewerage.[53] More recent thinking on climate resilience in sanitation is focused on the importance of context – which influences levels of exposure to different climate hazards and varied adaptive capacities of the actors involved in using and managing the system – in determining resilience. So, whilst sanitation technologies such as pit latrines, septic tanks and sewers respond differently to climate stress, such as increased or decreased rainfall, it is not possible or appropriate to describe one as resilient and the other as not. Exposure is an important dimension, and risks are high, for example, for rural communities and small towns located in climate hot-spots (e.g. monsoon flooding, cyclone-prone areas and flash flooding areas), and also for coastal areas, given wastewater infrastructure is often located on the coast, exposed to storm surges and sea-level rise.

Climate adaptation for sanitation infrastructure requires designs that remain functional (as possible) under diverse conditions and service delivery functions that are uninterrupted (as feasible) under climate events and trends. A key aspect is that resilience is required along the whole sanitation chain, whether for onsite systems or offsite sewerage systems, hence including containment, conveyance, treatment and reuse or disposal. During climate events, it is possible that parts of the service chain will be disturbed (e.g. emptying services stopped due to impassable roads, or the shutdown of a flooded faecal sludge or wastewater treatment plant) and it may require extended time to restart operations, adding to operation and maintenance costs and, possibly, to capital costs.

Design adaptations of onsite sanitation containment technologies: Containment systems, such as pit latrines and septic tanks, in areas exposed to climate events are at risk of damage, particularly from flooding and subsequent spillage of faecal matter in the wider environment, with serious public health implications. To overcome this, many countries have taken steps to develop climate-resilient design of sanitation infrastructure and mainstream their adoption in different programmes. For example, in Indonesia, local governments in some locations have adopted special designs for flooding, including biofilter tanks with closeable outlets with non-return valves and the use of submersible pumps and sealed prefabricated tanks.[54] In Bangladesh, UNICEF has mainstreamed climate change in their programming through three interlinked strategies:[55] (i) creating demand for climate-resilient sanitation in the CATS/CLTS (Community Approaches to Sanitation/Community-Led Total Sanitation) programme; (ii) promoting and expanding supply and installation of climate-resilient sanitation designs and products through sanitation marketing (the 'SanMark' Approach); and (iii) providing climate-resilient sanitation services with a focus on constructing flood-resilient latrines in vulnerable areas. The SanMark approach identifies latrine options suitable for different climatic zones and supports latrine producers to provide these options. Some 529,000 climate-resilient structures were supported by the programme during 2021 (see Figure 5).

In Bangladesh there are also various design options (elevated pit latrines, floating latrines) in use in high flood-prone areas, promoted by various development partners. The Bangladesh Government has compiled a compendium of such technologies, incorporating technical design drawings and the relevant bills of quantities, with technical support from International Training Network–Bangladesh University of Engineering and Technology (ITN-BUET), which can be used as ready reference material for practitioners.[56]

Figure 5: (left) Flooded pit latrine in Rangpur, Bangladesh in 2019. (right) Elevated latrine in Satkhira, Bangladesh in 2021. (Image source: UNICEF[57])

There is also evidence of designing onsite treatment facilities at high elevations in emergency/humanitarian areas (such as in Bangladesh's Rohingya refugee camps). In these areas, flash floods are quite common with risk of inundation. It is well understood that reducing risks requires prior planning and investment in both structural and non-structural measures, consistent with accepted principles of disaster risk reduction. The Department of Public Health and Engineering (DPHE) CWIS-FSM [citywide inclusive sanitation–faecal sludge management] Support Cell screens for climate resilience during planning of sanitation infrastructure. Some form of preliminary climate screening is a regular part of the development planning process of all national projects in Bangladesh.

New tools for sanitation technology designers based on resilient design features: Considering the diverse hazards caused by climate events requires systematic consideration of each potential hazard, and how sanitation technologies can be designed to withstand or adapt to accommodate these hazards. UTS's[58] ClimateFIRST[59] tool is an excel-based tool that supports step-wise consideration of a wide range of hazards and provides 25 design features that can support resilience,[60] based on groups of design features that respectively help with: (i) avoiding exposure to hazards; (ii) withstanding exposure to hazards; (iii) enabling flexibility; (iv) containing failures; (v) limiting the consequences of complete failure; (vi) facilitating fast recovery; and (vii) providing benefits beyond resilience.[61]

Adaptations in design of wastewater and faecal sludge treatment plants: It is generally preferable for wastewater treatment plants to be built at the lowermost contour in both inland settings and coastal areas so as to reduce pumping costs. However, this leaves such infrastructure susceptible to floods and sea level rise. Similar issues can be faced in nature-based components of wastewater treatment plans, such as sludge drying beds or constructed wetlands, which will become non-functional if they are not appropriately designed and constructed with relevant protections. CWAS[62] has been working with the state of Maharashtra to provide it with technical support to implement sanitation for an urban population of around 60 million.[63] Climate risks across the state vary, from heavy rain, cyclones, flooding and monsoons to semi-arid and arid conditions. Faecal sludge facilities have been constructed with protective sheds or covers (see Figure 6), solar energy for pumping reduces emissions and promotion of wastewater reuse for plantations create carbon sinks.[64]

Adaptation actions by operators and service providers: Resilient sanitation requires adaptability to uncertain conditions, and with this comes the need for continual learning and corresponding adjustments to changing conditions.[65] Improved monitoring, warning and response mechanisms can support service providers to prepare and adapt. Wastewater flow monitoring, for example, could trigger an alert to repair pumps or to warn the public of sewer overflows.[66]

Faecal sludge emptying services are also impacted by climate events, pointing to the need for multiple service providers, and multiple routes between households and treatment plants to allow for services to continue to be provided in the case of extreme weather events that impact service providers directly or road infrastructure.[67]

Adaptations related to users and water cycle management: As users are part of the sanitation chain, they have an important role to play in climate resilient sanitation, described further in the section on user engagement below. Similarly, many adaptation actions related to infrastructure and service involve strong integration with the wider water cycle, also described further below.

6.2. Maladaptations

Maladaptation in infrastructure and service delivery can result from inaction in addressing climate risks for existing sanitation technologies and service delivery arrangements, or they may result from unintentional consequences of adaptation actions. Examples of negative consequences of inaction are many and include return to open defecation when non-resilient sanitation facilities are damaged, disrupted or inaccessible (e.g. due to flooding), and people taking advantage of the flowing water during floods to release the faecal matter stored in pits and tanks using a bypass line, essentially spreading faecal contamination in the open environment. Also, based on interviews and focus group discussions conducted in cities of Maharashtra, it was found that people with newly constructed toilets sometimes do not use the facility out of fear of the septic tanks filling up fast, which would require them to pay an emergency emptying fee, hence they resort to open defecation. Conversely, in Bangladesh when climate change causes a shortage of rainfall and households are affected by water scarcity, reduced flushing and handwashing is observed, affecting the usability of the toilets and hygiene behaviour.

6.3. Short-term priorities

— **Integration of climate risks and threats to sanitation planning for the entire chain:** This requires assessing technology performance against climatic and other variables associated with current and future threats

Figure 6: Covered sludge drying bed at Satara faecal sludge treatment plant, Maharashtra 2024 (Image source: CWAS)

based on local conditions. There is a need to enhance the climate screening and assessment of development planning proposals at national and subnational levels and enhance monitoring of projects with respect to climate change resilience. This could include identifying high-risk vulnerabilities and mapping adaptation strategies for urban sanitation systems, as well as conducting comprehensive risk assessments of urban sanitation infrastructure to identify vulnerabilities to water cycle changes.

— **Conduct infrastructure upgrades that will reduce costs of damage:** Implement quick fixes and low-cost upgrades to existing sanitation infrastructure to enhance resilience to climate impacts, such as improving drainage systems, reinforcing infrastructure against floods and installing backup power sources.

— **Training and capacity building for service providers, operators and sanitation workers:** Practical training for relevant sanitation actors including government officials on climate-resilient sanitation practices is an important measure and could include training on emergency response, disaster preparedness and the use of sustainable, resilient sanitation technologies.

6.4. Long-term priorities

— **Investing in research and innovation to develop new technologies, practices and approaches for climate-resilient sanitation.** This could include harnessing advances in renewable energy, off-grid sanitation systems and digital solutions to improve the functioning and monitoring of sanitation infrastructure and services. There is also need for options to retrofit existing sanitation containment systems to facilitate on-going services during extreme events such as flooding.

— **Supporting synergies between adaptation and mitigation in sanitation service development** will support win-win solutions that address public health and environmental imperatives of resilient services at the same time as minimising emissions.

Section endnotes

53 Howard G, Charles K, Pond K, Brookshaw A, Hossian R, and Bartram J. 2010. Securing 2020 vision for 2030: climate change and ensuring resilience in water and sanitation services. *Journal of Water and Climate* 1(1):2–16. https://doi.org/10.2166/wcc.2010.105b

54 Willetts et al. (2022) Co-developing evidence-informed adaptation actions for resilient citywide sanitation: Local government response to climate change in Indonesia. *Environment and Planning B: Urban Analytics and City Science* 49: 8. DOI: 10.1177/23998083221098740

55 Integrating Climate Resilience into Sanitation Programming in Bangladesh, UNICEF WASH Field Note FN/14/2022. https://clearinghouse.unicef.org/download-ch-media/e758b831-2c8e-41a0-ae4b-2122eddfd6d1

56 https://itn.buet.ac.bd/web/resources/national-compendium-of-water-sanitation-and-hygiene-wash-technologies-for-disaster-response/

57 Integrating Climate Resilience into Sanitation Programming in Bangladesh, UNICEF WASH Field Note FN/14/2022. https://clearinghouse.unicef.org/download-ch-media/e758b831-2c8e-41a0-ae4b-2122eddfd6d1

58 University of Technology Sydney.

59 https://www.uts.edu.au/isf/explore-research/projects/climate-resilient-urban-sanitation/climatefirst-outputs

60 See Cunningham et al., 2024 Designing for climate change: twenty-five design features to improve sanitation technology resilience in low- and middle- income countries https://link.springer.com/article/10.1007/s11027-024-10177-7

61 https://www.uts.edu.au/isf/explore-research/projects/climate-resilient-urban-sanitation/climatefirst-outputs

62 Center for Water and Sanitation, CRDF, CEPT University: https://cwas.org.in/

63 https://cwas.org.in/theme/sanitation/state-sanitation

64 https://majhivasundhara.in/en

65 https://www.uts.edu.au/sites/default/files/2020-11/ISF-UTS%20and%20SNV_2019_Considering%20Climate%20Change%20in%20Urban%20Sanitation.pdf

66 Ibid.

67 https://www.uts.edu.au/sites/default/files/2020-11/ISF-UTS%20and%20SNV_2019_Considering%20Climate%20Change%20in%20Urban%20Sanitation.pdf

7.

Climate resilience and water cycle integration

7.1. Overview of impacts and trends in urban water cycle management

Climate change is significantly impacting the urban water cycle, creating new challenges for urban water cycle management in cities worldwide.[68] More extreme weather events put unprecedented stress on urban water and sanitation systems, traditionally designed based on historical climate patterns. Impacts on the urban water cycle are particularly pronounced due to high population densities, high freshwater demands and high concentrations of impervious surfaces. These all lead to increased vulnerabilities, flooding risks, reduced groundwater recharge and increased urban heat islands that alter local precipitation patterns, particularly in LMIC contexts.[69]

The conventional approach to urban water management comprises safe and secure water supply, and public health, environmental and flood risk protection through the use of sewerage and drainage systems,[70] which are ideally managed as separate systems but are often conveyed in combined systems in old cities or in mixed stormwater and wastewater ad hoc systems in informal urban settings. Mostly based on large-scale centralised systems, designed for stability and predictability, these solutions are increasingly requiring additional flexibility to adapt to the growing variability in water availability and extreme weather events. Moreover, the sole reliance on large-scale, end-of-pipe solutions for stormwater and wastewater management is becoming unsustainable, both environmentally and economically,[71] and increasing proportions of wastewater are being discharged untreated from combined sewer networks during times of increased stormwater flow.[72]

The climate impacts on sanitation systems due to alterations in the water cycle are significant. Such impacts may take various forms including:[73] (i) water scarcity may lead to insufficient water for safely managed sanitation services based on sewers or on pour-flush toilets; (ii) increased strain on existing infrastructure (e.g. combined sewer overflows contaminating water sources); (iii) damage to sanitation facilities due to extreme weather events (e.g. floods, storms and sea level rise can physically damage sanitation infrastructure); and (iv) decreased functionality of existing systems (e.g. overflow and runoff from containment structures leading to environmental contamination and public health risks).

7.2. Adaptation strategies

Reducing negative interactions of sanitation and other parts of urban water systems under climate change, and increasing positive interactions: Water supply, sanitation and stormwater are one interconnected system. None of the parts should be viewed in isolation and they need to be managed as part of the system, and all are impacted by climate change. The three parts can interact with each other negatively, for example through the contamination of drinking water by poor sanitation and inadequate stormwater management, which can be exacerbated by climate change. They can also interact positively, with wastewater and stormwater potentially providing a viable water supply.[74] [75] In addition, all water sources (freshwater supply, rainwater, rivers, sea, and wastewater) are interconnected with each other and other urban systems (parks, roads, energy, drainage systems, solid waste, etc.) so that efficiencies and synergies can arise from a coordinated approach to their planning and delivery, including in support of broader climate resilience.

Sanitation within a new water paradigm: To address the resilience challenges outlined above with large-scale centralised systems and failing onsite sanitation systems in dense urban areas, and in line with broader trends

to focus on circularity, there is a growing call for a paradigm shift towards urban water systems that embody key characteristics of resilient socio-ecological systems, such as connectivity, diversity, redundancy and feedback loops.[76] This new approach emphasises integration across water supply, sanitation and stormwater management.[77] It promotes the diversification of water sources, including the use of rainwater, stormwater and recycled wastewater, to build resilience against supply disruptions and shortages.[78] The new approach encourages use of blue-green infrastructure solutions, including 'sponge cities'[79] and water-sensitive urban design, sustainable urban drainage systems, wastewater reuse at different scales, nutrient recycling and maximising co-benefits from sanitation such as energy production and faecal sludge reuse, including looking at the potential for separating wastewater into its constituent components (blackwater, greywater and urine) and considering separate treatment and more efficient and targeted reuse. This said, besides sponge cities and water sensitive urban design, these approaches are largely still at the level of policy and academic discussion and require practical guidance and experiences to be taken up at scale.

Redesign to holistically manage sanitation, stormwater and managed aquifer recharge: In South Africa, following the Cape Town Day Zero crisis in 2016–2018, a new water strategy for the city was developed[80] that highlights five major commitments towards the vision of a water sensitive city. These commitments include safe water and sanitation access to all, wise water use, the provision of sufficient reliable water from diverse sources, shared benefits from regional water resources and the creation of a water sensitive city. They provide a starting point for the integration of climate resilience and the broad processes of urban sanitation – that not only includes the provision of toilets and wastewater treatment, but the holistic management of all aspects of environmental sanitation and water resources. The city is also assessing the feasibility of a decentralised, hybrid approach to stormwater management linked to water supply for the City of Cape Town – through the low-cost retrofitting of existing stormwater detention ponds to operate as Managed Aquifer Recharge (MAR) systems that function as flood control mechanisms, as well as water supply systems, water treatment facilities, and also provide amenity and biodiversity functions.

Wastewater reuse as an important water source in the face of water scarcity: There are many examples from around the world already of wastewater reuse and recovery,[81] including wastewater reuse as industrial water, for agriculture, for aquifer recharge and for direct potable use. In South Africa and Namibia, there are already efforts on direct potable reuse of wastewater.[82] In India, the use of treated wastewater as an alternative resource of water, is seen as one of the most important answers to the country's urban water crisis (see Figure 7). The Indian government promotes 100% treatment of sewage in all cities with reuse of treated wastewater. Indian megacities, including Bengaluru and Chennai, have resorted to the implementation of wastewater reuse at scale, with the former taking a decentralised treatment and reuse approach, while the latter has opted for centralised treatment and a groundwater and surface water rejuvenation approach.[83]

Multisectoral planning including sanitation, water and solid waste management: In Brazil, municipal governments are obliged to produce multisectoral and holistic combined master plans for water supply, sanitation, solid waste management and stormwater management as one integrated system – collectively known as 'environmental sanitation' – providing a useful basis of delivering wider access to these services.[84] The Federal Integrated Water Sector Project (Interaguas) in cooperation with the World Bank through a USD 107.4 million loan aims to create an effective integrated planning system across Brazil's water and sanitation sector. The project is jointly coordinated by the Ministries of Environment, National Integration, Cities, and the National Water Agency. It addresses water resources management, irrigation, disaster risk management, water supply and sanitation in an integrated manner.

Targeting sanitation impacts on riverine and coastal environments to reduce compounding climate risks: When untreated wastewater enters rivers and coastal environments, the additional nitrogen and phosphorus as well as pathogens create eutrophication and public health risks for users of those waters. In particular, seagrasses and mangroves, which play important roles in carbon sequestration, are impacted,[85] and their ability to protect coastlines from storms may be reduced.[86] As such, targeting efforts to address inadequate sanitation in such locations is an important adaptation strategy.

7.3. Maladaptations

Inadequate policy frameworks to support integration: The absence of a robust policy framework that incorporates an 'environmental sanitation' approach provides an environment in which disruption of services due to negative interactions between different services and can heighten climate risks. For example, solid waste serves as a primary contributor to flooding due to blockages of stormwater drains and of sewers.

Sanitation systems that increasingly contaminate water sources and water supplies, particularly with the onset of unpredictable climate events: Poorly designed, sited, constructed and managed sanitation systems can and do contaminate water systems, even in the absence of a changing climate. And, impacts can be exacerbated through siloed approaches to urban sanitation that do not consider water-related climate events can lead to public health and environmental challenges. For example, in Bangladesh, Lusaka and Indonesia, the extensive construction of pit latrines near water tube wells (or boreholes), particularly in high-density settlements, such as informal settlements or refugee camps, poses a substantial health risk by contaminating the water on which these populations rely, particularly in the face of increasing extreme rainfall events that can further mobilise the pathogens in excreta and spread them to surface water and groundwater bodies. This is also an issue in coastal areas, as rising sea levels can lead to increased groundwater levels, which can compromise the effectiveness of containment systems and their soak pits. These systems rely on a certain separation from the water table for the partial treatment of wastewater. When groundwater levels rise, the separation is reduced, leading to a potential increase in the contamination of groundwater with untreated or partially treated wastewater.

Combined sewers and their failure in extreme climate events: Combined sewers were designed to only be used occasionally during excessive storm events; however, with climate change increasing the frequency of such events, their use in some contexts represents a maladaptation that increases the risk of public health hazards and environmental pollution. During heavy rainfall events, these systems can become overwhelmed, leading to sewer overflows and the contamination of water bodies with untreated sewage. Instead, stormwater retention, buffering and infiltration is needed, as well as implementation of separate sewers.

Limited consideration of water scarcity impacts on sanitation: The lack of integrated water management that considers both water scarcity and sanitation systems together can result in failures of the latter systems during drought conditions. Prolonged droughts reduce surface water flows and the ability of receiving water bodies to dilute and absorb effluent from wastewater treatment plants. Drought can also lead to flush toilets and sewers no longer functioning or functioning poorly.

Figure 7: In the town of Sinnar, Maharastra, India, wastewater and faecal sludge have been treated and reused for ecosystem restoration.

7.4. Short-term priorities

- **Enhance institutional coordination between sanitation and other urban water and waste services.** Establish cross-departmental coordination mechanisms to improve communication and collaboration among water supply, sanitation, solid waste and stormwater management sectors. Implement platforms to facilitate coordinated decision-making and transversal policy responses to climate-related challenges.
- **Incorporate climate impacts on the full water cycle into urban sanitation design and planning.** Revise urban sanitation policies and standards to account for projected changes in precipitation patterns, temperature, storm events and sea level rise. Integrate climate resilience criteria into new sanitation infrastructure projects and retrofitting plans, with consideration of interactions with other parts of the water cycle.
- **Increase water use efficiency in sanitation systems. Implement water-saving technologies and practices in sanitation systems, such as low-flow or urine diverting toilets in new developments.** Where appropriate, promote greywater separation and reuse and rainwater harvesting to reduce demand on freshwater resources
- **Improve treatment capabilities for enhanced adaptation. Upgrade or modify wastewater treatment facilities in line with relevant context-specific climate risks.** This may include use of existing technologies which can absorb considerable changes in influent volumes and organic loading (e.g. waste stabilisation ponds, aerated lagoons etc.) or adding buffering and storage capacity, and may also include advanced technologies capable of nutrient removal and micropollutants.

7.5. Long-term priorities

- **Move towards decentralisation and greater integration of sanitation infrastructure to promote resilience.** Develop and implement distributed sanitation systems that can enhance opportunities for beneficial interconnections between sanitation, wastewater, stormwater and water supply given climate change pressures on each of these systems.
- **Embrace sanitation within climate and water sensitive urban planning approaches.** Adopt and integrate sanitation solutions with broader Water Sensitive Urban Design (WSUD), Sustainable Urban Drainage Systems (SUDS), Sponge Cities, and Blue-Green Infrastructure (BGI) principles into urban planning for the local context.
- **Consider reuse and recovery of water and nutrients from wastewater and faecal sludge.** Implement systems for the safe and efficient recovery and reuse of treated wastewater and its constituent parts (greywater, blackwater and urine) and faecal sludge for municipal, industrial or agricultural reuse, particularly in water-scarce areas.
- **Build institutional capacities and coordination for long-term planning.** Strengthen the institutional framework to support integrated urban water, sanitation, solid waste and stormwater management, ensuring effective coordination among services. Develop comprehensive long-term plans and policies that incorporate climate resilience, and adaptive management strategies for these services.

Section endnotes

68 https://doi.org/10.1016/B978-0-323-91838-1.00002-6

69 https://doi.org/10.1016/j.cosust.2013.10.005

70 https://doi.org/10.2166/wst.2009.029

71 https://doi.org/10.1016/j.progress.2013.09.001

72 https://www.unesco.org/en/wwap/wwdr/2017

73 UTS-ISF (2022) Urban sanitation and climate change: A public service at risk. https://opus.lib.uts.edu.au/handle/10453/161557

74 Jacobsen, Michael, Michael Webster, and Kalanithy Vairavamoorthy, eds. *The future of water in African cities: why waste water?* World Bank Publications, 2012.

75 https://doi.org/10.1146/annurev-environ-030620-042304

76 Biggs, R., Schlüter, M., Biggs, D., Bohensky, E. L., BurnSilver, S., Cundill, G., et al. (2012) Toward principles for enhancing the resilience of ecosystem services. *Annual Review of Environmental Resources,* 37, 421–448.

77 https://doi.org/10.1371/journal.pwat.0000180

78 https://doi.org/10.1139/er-2020-0090

79 https://research.monash.edu/en/publications/objectives-and-indexes-for-implementation-of-sponge-cities-a-case

80 https://resource.capetown.gov.za/documentcentre/Documents/City%20strategies,%20plans%20and%20frameworks/Cape%20Town%20Water%20Strategy.pdf

81 https://cgspace.cgiar.org/items/f4c65371-fbba-41f4-aa40-07bee47d2044

82 https://www.nature.com/articles/s41545-020-0069-3

83 Binz, C., Sedlak, D., O'Callaghan, P., Truffer, B., Nesi, M., Morgenroth, E., et al. Mainstreaming Decentralized Urban Water Management Solutions for Sustainable Cities. Synthesis Report on an international expert workshop, Eawag, June 2023. (Eawag, Dübendorf, Switzerland., 2024).

84 https://doi.org/10.2166/wp.2014.119

85 https://doi.org/10.1016/j.ecoser.2012.07.005

86 https://doi.org/10.1890/14-1853.1

8.

User engagement and inclusive resilient services

8.1. Adaptation strategies and trends

Engaging users and building their awareness and capacity to cope, adapt and respond to climate hazards is an important aspect of climate resilient sanitation, as they play a key role in selecting and managing the toilet interface, and for onsite services, and the containment system.[87] In addition, since disadvantaged and marginalised groups are more vulnerable to impacts of climate on sanitation services, both due to lower service levels and higher exposure to environmental contamination, they should be a key focus in adaptation strategies.[88] Efforts to raise awareness as well as provide disaster response and support are needed.[89] Resources are available to support user and community engagement as regards rural sanitation[90] and urban sanitation,[91] with examples of key approaches are described below.

Raising climate awareness at the community level: Engaging communities about climate change impacts on sanitation and promoting sustainable practices can help foster resilience at the grassroots level. This includes promoting proper waste disposal, sanitation, hygiene and water conservation practices. Engagement can be achieved through a range of different communication strategies at the community level, including working closely with community organisations (e.g. rights-holder groups such as women's groups, disabled people's organisations etc.), learning about existing community coping strategies and promoting local ownership through effective risk communication. In Kenya on the shores of Lake Victoria, community awareness of increased diarrhoeal illness during extreme weather events (e.g. flooding) has led to community members increasing their use of rainwater harvesting and relocating their latrines to higher ground. Households with more resources have taken anticipatory actions, such as saving money for latrine reconstruction or design of flood-proof latrines.[92] In Indonesia, local governments raised awareness amongst community members on the need for water-tight containment in flood-prone areas, the need to increase water storage and practice water conservation to facilitate water availability for toilet-flushing during droughts, and to avoid disposing garbage in rivers which exacerbated flooding.[93]

Participatory vulnerability assessment: In Bangladesh, WaterAid undertook a participatory Ward Vulnerability Assessment[94] through a variety of tools such as seasonal calendars, participatory mapping, institutional mapping and problem prioritisation exercises. Using these tools, diverse stakeholders were engaged, including vulnerable populations and local government authorities. The use of these tools demonstrates how human activities combine with ongoing climate hazards to make people more vulnerable to shocks and stresses, and that floods, cyclonic storms and river erosion inundate sanitation facilities, weaken and damage latrine infrastructure, and can even submerge latrines. The tools also showed that women faced discomfort with toilet access during floods and that women and girls are forced to use saline water for menstrual hygiene management, which caused rashes, burns, frequent urinary tract infections and blisters.[95]

Early warning systems and rapid response measures: Establishment of early warning systems can provide community members with prior knowledge of climate events and is being implemented by some local governments in Indonesia.[96] Equally, community members can play roles in rapid response to climate events, supporting sanitation services to be swiftly restored to functionality.

Diverse community input to climate resilient design: Understanding user preferences in sanitation technology and design is important for any sanitation solution, and matters for climate resilient design. Inclusive processes can also ensure that climate resilient sanitation is designed to meet diverse needs. For example, in Brazil, a participatory approach to design, construction and management of

Figure 8: Community Engagement in Laos (Image source: USAID).

condominial sewers has been implemented over a period of more than 30 years.[97] In India multiple groups have been involved in sanitation design, including people with disabilities and women. Protecting privacy and dignity of women users, including during times of disaster is a strong imperative. Use of local construction materials (where sufficiently robust and resilient) can also enable community members to make their own repairs to sanitation systems.

Contribution to community resilience: Resilient sanitation systems protect people and their environment from pollution and disease outbreaks and ensure privacy and dignity. These represent important elements of wider community resilience.[98] Governments, development partners and donors should prioritise participation of communities, particularly groups who are vulnerable, and strengthen local capacity. Engaging all community groups in adaptation policy design and implementation will ensure adaptation actions respond to their needs and are sustainable and resilient.

8.2. Maladaptations

Maladaptation is possible through a mismatch of technologies and user behaviours. Where innovative or new sanitation technologies are used, challenges arise in user awareness and required behaviour changes. Such issues are further compounded by climate change, placing an additional strain on sanitation services and users alike. It is important not to view user engagement for inclusive sanitation services in isolation but to recognise how climate change impacts technologies, services and user behaviours. Neglecting any of these aspects may lead to increased susceptibility of infrastructure and services due to maladapted services and user behaviours, which may be challenging to address once they have occurred. By prioritising community and user involvement and implementing resilient sanitation practices, the groundwork can be laid for 'inclusive climate resilient sanitation'.

Key common failures and maladaptations in community and user engagement in sanitation and climate resilient sanitation include disconnected planning cultures, unsustainable user behaviours, unrepresentative user engagement and lack of community empowerment.

Absence of users in climate resilient sanitation planning: A disconnected planning culture means communities are not involved in planning and sanitation service delivery processes, leaving users unaware and disconnected. This

can lead to a lack of community ownership and engagement and huge inertia when their support is required to achieve resilience.[99]

Unsustainable user behaviour: Unsustainable user behaviour includes high water consumption for flushing, as well as improper disposal of menstrual hygiene products and other solid waste into sanitation facilities, which can overload or block the system and compromise its climate resilience. Addressing these behaviours from the earliest possible time is essential.[100]

Unrepresentative user engagement: Strategies that engage only a narrow subset of users, rather than a diverse and representative group of stakeholders, can fail to capture the varied needs and vulnerabilities within a community, undermining the effectiveness of climate adaptation efforts.[101]

Insufficient investment in capacity building and empowerment: Finally, insufficient investment in building the capacity of both service providers and community members on how to operate and maintain sanitation systems, as well as their involvement in monitoring, early warning and disaster response, can limit the long-term sustainability and resilience of these services. Selecting diverse and representative stakeholders is thus essential for designing user accepted interventions for climate resilience.[102]

8.3. Short-term priorities

— **Participatory vulnerability assessment and mapping:** As part of short-term planning, conducting rapid assessments and mapping vulnerable areas where sanitation systems are prone to climate-related risks, such as flooding, drought or extreme temperatures is recommended. For instance, the coastal belt of Bangladesh was designated as high risk to climate vulnerability, but there remains a need to document and assess the current state of temporary latrine facilities and requirements of safely managed sanitation. Similar needs exist in many other countries, cities and regions. Such assessments require participation to ensure lived experiences of impacts, coping mechanisms and potential adaptations are brought to light and so can inform planning.

— **Prioritising equity and inclusion:** As climate change tends to impact vulnerable groups living in exposed areas, governments, development partners and donors should strengthen participation of such groups. Engage all community groups in adaptation policy design and implementation to ensure that adaptation actions respond to diverse needs, including those of specific groups, such as people with disabilities, from ethnic minority groups or other dimensions of potential disadvantage.

— **User-led infrastructure disaster preparedness and resilience:** Infrastructure should be selected based on user preferences and designed to balance users' abilities to participate in monitoring, early warning and disaster response. This is particularly important for onsite systems, where users are responsible for the toilet interface and containment units.

8.4. Long-term priorities

— **Transformational adaptation:** Transformational adaptation involves fundamental changes to restructure power relations and address systemic inequalities that leave marginalised and disadvantaged groups the most impacted by climate events, including with respect to sanitation. Governments, development partners and donors should increase their allocation of climate and other finance to sanitation for such groups and to protect them from undue exposure to environmental contamination, thereby guaranteeing the sustainability of sanitation services and enhancing climate resilience. This entails shifting away from a sole focus on infrastructure to a focus on the long-term performance of all elements and actors within the sanitation service chain, addressing the way each of these is impacted by climate change.

Section endnotes

87 This is not to detract from the important role of design standards and regulations in ensuring certain levels of design, construction and servicing of onsite systems.

88 https://www.uts.edu.au/sites/default/files/2020-11/ISF-UTS%20and%20SNV_2019_Considering%20Climate%20Change%20in%20Urban%20Sanitation.pdf

89 UTS-ISF (2022) Urban sanitation and climate change: A public service at risk. https://opus.lib.uts.edu.au/handle/10453/161557

90 https://www.uts.edu.au/sites/default/files/2021-08/Frontiers17_ClimateChange_FINAL%2Blinks.pdf

91 UTS-ISF (2022) Urban sanitation and climate change: A public service at risk. https://opus.lib.uts.edu.au/handle/10453/161557

92 Marcus, H., Muga, R., Hodgins, S. (2023) Climate adaptation and WASH behavior change in the Lake Victoria Basin. *Journal of Water, Sanitation and Hygiene for Development* 13 (3): 174–186. https://doi.org/10.2166/washdev.2023.165

93 https://journals.sagepub.com/doi/full/10.1177/23998083221098740

94 https://opendocs.ids.ac.uk/opendocs/bitstream/handle/20.500.12413/18193/SLH%20learning-brief-17_FINAL.pdf?sequence=7&isAllowed=y

95 https://sanitationlearninghub.org/resource/a-participatory-assessment-for-climate-induced-wash-vulnerabilities-in-bangladesh/

96 https://journals.sagepub.com/doi/full/10.1177/23998083221098740

97 https://documents1.worldbank.org/curated/pt/505601468226737476/pdf/344420rev0BR0Condominial0water.pdf

98 UTS-ISF and UNICEF (2024, in press) Contribution of water, sanitation and hygiene to community resilience to climate change.

99 https://www.susana.org/_resources/documents/default/3-4343-7-1624432507.pdf

100 https://www.unicef.org/indonesia/media/14421/file/Climate%20Resilient%20Urban%20Sanitation%20in%20Indonesia:%20Hazards,%20Impacts%20and%20Responses%20in%20Four%20Cities.pdf

101 https://www.uts.edu.au/sites/default/files/2020-11/ISF-UTS%20and%20SNV_2019_Considering%20Climate%20Change%20in%20Urban%20Sanitation.pdf

102 https://journals.ametsoc.org/view/journals/wcas/15/2/WCAS-D-22-0112.1.xml

9.

Addressing health risks in delivery of climate resilient services

Climate trends and events increase potential health risks related to sanitation, both due to climate change influences on sanitation systems and on pathogens and their spread. A growing body of evidence suggests that climate change impacts, particularly heavy rainfall and high temperatures, may increase the incidence of water- and excreta-related diseases generally, and diarrhoeal diseases in particular, as well as vector-borne diseases transmitted by mosquitos that breed in dirty or stagnant water.[103] Floods and storms are commonly associated with wastewater overflows from sewers and onsite 'containment' structures and transmission of pathogens, such as norovirus and *Cryptosporidium*.[104] In addition, more than half of the known human pathogenic diseases can be aggravated by climate change.[105] A recent update to the burden of disease associated with water, sanitation and hygiene notes as many as 1.4 million preventable deaths occur globally each year, but does not yet consider how climate change may impact these figures.[106] Furthermore, climate risks affect sanitation users unequally, with both exposure to climate hazards and capacity to respond varying greatly across individuals and social groups.[107]

Climate change-related health consequences from sanitation systems generally fit within two overarching categories: (i) increased risk of disease or illness from exposure to pathogens and hazardous substances through increased environmental contamination, changes to water-related and excreta-related pathways, and/or (ii) increased risk of disease or illness, including stress, fear and exposure to violence and/or protests due to inadequate sanitation when systems are destroyed or damaged by climate events.[108] In addition, sanitation workers may experience additional risks depending on their work context and the associated level of occupational health and safety, including working during or after climate events, or in relation to heat exposure.[109]

9.1. Adaptation strategies, actions and trends

Adaptation efforts described in other parts of this paper would already be expected to reduce health risks as they support climate-resilient sanitation services to function well. In this section therefore, we focus on specific adaptation efforts that aim to assess, address and/or monitor health risks associated with sanitation systems and services in the context of climate change.

Vulnerability adaptation assessments with a public health focus can draw attention to the links between climate, sanitation and health. In Indonesia, regular drought and flooding events triggered the undertaking of vulnerability adaptation assessments to explore climate change impacts on public health, particularly on diarrhoea and stunting. Community health promotion, focused on desludging of containment systems, is promoted before the rainy season to enhance preparedness. Sanitary inspections also include climate information for householders. Programmes have a robust evaluation mechanism (including data gathering methods) in order to inform the consideration of further adaptation options and community behaviour mapping. Accounting for specific vulnerabilities in certain population groups is an important aspect to vulnerability adaptation assessments, and can draw on the many existing social vulnerability indices, as is combining sanitation-related data with other data from demographic and health surveys (e.g. Demographic Health Survey (DHS) or Multi-Indicator Cluster Surveys (MICS)).

Adaptation through strengthened involvement of the health workforce in sanitation: Health authorities play an important role to ensure sanitation investments improve public health, as noted in WHO's sanitation and health guidelines.[110] To play this role, the health sector needs contingency plans for deployment of health personnel

during climate-related disasters, as well as national strategies that address climate change risks to health, including through sanitation, and communicate and raise awareness of the links between climate, sanitation and health.[111] In particular, strategies that build local level capacity amongst environmental health professionals is an important way to strengthen climate and health awareness amongst users.[112]

Acting on visible health risks, particularly for vulnerable and marginalised groups, as an impetus for adaptation actions: Peru, a country with a high rate of diarrhoea, major seasonal flooding and widespread open defecation leading to faecal contamination of soil and water sources commonly used for drinking,[113] was targeted by UNICEF to construct raised flood-resilient, fully lined and sealed latrines above the level of regular floodwaters.[114] In Indonesia, an area with illegal dumping of faecal matter into rivers was targeted under the USAID-funded initiative to work with cities to introduce an affordable, scheduled desludging service. These efforts were expected to reduce the risk of disease outbreaks during and as a result of flood events.[115]

Addressing resurgence of cholera through a multisectoral response: The risk of disease outbreaks during flooding events is usually high and is made worse by inadequate water and sanitation and poor access to health services. One example is the outbreak of cholera in East Africa during the 2015–2016 El Niño event.[116] Outbreaks, especially in LMICs, often occur seasonally but are amplified during periods of above normal rainfall in areas of poor sanitation. Cholera outbreaks globally have been linked to extreme climatic events like El Niño and flooding.[117] The Global Task Force on Cholera Control is a partnership of more than 50 institutions and follows a framework that includes sanitation and water among the responses.[118] In line with this, health ministers and national representatives from cholera-affected countries, including Bangladesh, Lebanon, Malawi, Mozambique, Nepal and Zimbabwe, are actively working on a coordinated multisectoral approach that includes the sanitation sector, particularly given the compounding effects of climate-related impacts and other factors.[119]

Sanitation Safety Planning (SSP) as a risk-based planning, management and monitoring tool that integrates climate resilience considerations. The use of SSP has the potential to bring together actors from varied sectors to identify health risks and agree on improvements and monitoring approaches, including expertise in climate data and related expected hydrological changes. It provides a systematic assessment to identify and prioritise the most critical health risks at each stage of the sanitation chain, including consideration of potential future climate events. SSP investment plans can be used to target investments to match with the highest risks and the most effective control measures. In particular, for emergency response operations during a disease outbreak, SSP investment plans can be used to direct funding to sustainable sanitation investments. Since climate is a driver of interactions across the water cycle, its use in combination with water safety planning is an important direction going forward.

9.2. Failures and maladaptations

Maladaptations can result from non-action as well as from unintended consequences of adaptation actions. In the sanitation sector in relation to health, there are examples of both.

If the sanitation sector does not act proactively on the many strategies described earlier in this paper, it is likely that maladaptations, of which there are many, will result. In the case of Indonesia, floods spurred households to wash out their latrine pits and septic tanks. This involved households opening the pit or tank during flooding to allow their contents to be washed out, posing a significant health risk.[120] In Cambodia it was shown that increasing climate vulnerability and poverty was associated with increasing toilet abandonment and that toilet dysfunction occurred more frequently in flood-prone regions during the rainy season.[121] Another example of maladaptation due to non-action is the return to open defecation and its associated health risks if back-up or alternative facilities are not made available to populations experiencing disruptions to their sanitation systems.[122]

Maladaptation as an unintended consequence of an adaptation strategy is relevant to actions related to wastewater reuse. Wastewater reuse, for agriculture in particular, and also to subsurface storage, is a key adaptation response to water scarcity arising from climate change. However,

such practices can also pose significant health risks since, although reuse guidelines exist in most countries, their implementation and monitoring are often weak. In addition, climate change impacts resulting in extreme droughts and floods may alter the dilution of treated wastewater intended for reuse, and therefore careful monitoring is advisable.

9.3. Short-term priorities

— **Improved evidence base and awareness of public health risks of non-climate resilient sanitation.** In the short-term, there needs to be an improved understanding of public health risks arising from climate change impacts on sanitation. For example, the vulnerable geographic regions at risk of cholera will expand due to an increase in temperature. Inundation of pit latrines and other containment structures will be prevalent among communities in low-lying areas and where rainfall intensity increases.

— **Targeting climate resilient sanitation investment in recurrent sanitation related disease hotspots.** There is an urgent need to use health data to better target high risk areas, such as cholera hotspots, where outbreaks and costly responses predictably recur due to root cause failures in sanitation systems. Furthermore, sanitation investment in hotspots should be based on a better analysis of transmission pathways for the pathogen in that setting using systematic risk assessment methods such as SSP.

9.4. Long-term priorities

— **Address socio-economic dimension of public health risks:** The socio-economic dimension of public health risks requires attention. Higher income communities enjoy a higher guarantee of safety, in sharp contrast to poor communities in the same city. The long-term priorities includes bridging the gap between the disproportionate risks and impacts faced by different sectors of a given city or country.

— **Shift research design to be future-focused and inform adaptation planning,** by incorporating known factors on climatic conditions and water- and excreta-related disease associations and outcomes into future projections that take account of evolving social and environmental processes, rather than simplified forward projections.[123]

Figure 9: With small, sealed waste containers that are frequently collected, container-based services minimize the risk of waste release into the environment—even during flooding—and are more likely to be able to continue to operate during adverse conditions (Image source: SOIL).

Section endnotes

103 https://doi.org/10.1007/s40572-018-0199-7

104 https://www.nature.com/articles/s41558-022-01426-1

105 Ibid.

106 https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(23)00458-0/fulltext

107 OHCHR, Office of the United Nations High Commissioner for Human Rights (OHCHR), n.d. Climate change and the human rights to water and sanitation position paper. Geneva: OHCHR.

108 https://cdn.who.int/media/docs/default-source/wash-documents/sanitation/climate-sanitation-and-health.pdf

109 Ibid.

110 https://www.who.int/publications/i/item/9789241514705

111 https://cdn.who.int/media/docs/default-source/wash-documents/sanitation/climate-sanitation-and-health.pdf

112 Ibid.

113 UNICEF: WASH CLIMATE RESILIENCE: A Compendium of Case Studies.

114 Ibid.

115 USAID Technical Brief: Climate-resilient, low-emissions water security and sanitation.

116 Moore, Sean M., et al. (2017) El Niño and the shifting geography of cholera in Africa. *Proceedings of the National Academy of Sciences* 114(17):4436–4441.

117 Rodó, X., et al. (2002) ENSO and cholera: a nonstationary link related to climate change? *Proceedings of the National Academy of Sciences* 99(20):12901–12906.

118 https://www.gtfcc.org/about-gtfcc/#framework-for-action

119 https://www.gtfcc.org/news/global-leaders-call-for-commitment-to-end-the-global-cholera-emergency/

120 https://www.uts.edu.au/sites/default/files/2022-06/UTS-UI-UNICEF-2021_Climate%20resilient%20Sanitation%20in%20Indonesia%20-%20Final%20report.pdf

121 https://doi.org/10.1007/s10668-024-04881-2

122 https://www.uts.edu.au/sites/default/files/2022-06/UTS-UI-UNICEF-2021_Climate%20resilient%20Sanitation%20in%20Indonesia%20-%20Final%20report.pdf

123 See https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6119235/

10.

Conclusion

With the recent agreement on the Global Goal for Adaptation in 2023 and its explicit incorporation of climate resilient sanitation services as part of the first thematic target, there is opportunity to take adaptation actions further.

Concerted action across the six areas described in this paper can provide the means to turn ideas into action, and address the significant risks and impacts that are already occurring across multiple regions today.

Strengthened integration of climate change into sanitation policies, planning and regulations is a cornerstone to enable proactive response to climate change impacts on sanitation services. From this can flow adjustments in infrastructure, technologies, service delivery arrangements and the capacity of service providers to adapt to new and uncertain events and trends. Such adjustments are particularly needed to ensure those people most exposed and most impacted are given attention, supported by sound involvement of users in building resilience. Configurations that integrate sanitation into the broader urban water cycle can be an explicit strategy to build resilience and deliver co-benefits beyond public health, which should remain at the core of all efforts to improve resilience of sanitation services.

The short-term and long-term priorities laid out in this discussion paper, identified by participants at the IWA Development congress in December 2023 and the CEPT Climate Change and WASH event in February 2024 provide a direction to follow and important investment priorities for governments and development partners.

About the IWA Inclusive Urban Sanitation Initiative

The initiative responds to a huge and growing public need – safe sanitation in combination with access to safe drinking water and hygiene underpins good health. The aim of this initiative is reshaping the global urban sanitation agenda by focusing on inclusive sanitation service goals and the service systems required to achieve them – rather than the traditional singular focus on expanding sewer networks and treatment works. This forms part of IWA's larger agenda to promote inclusive, resilient, water-wise, and sanitation-secure cities. This initiative is being progressed through a dedicated campaign #SanitAction to garner support and collaborative action.

About the Inclusive Urban Sanitation Discussion Papers

The initiative aims to produce a series of publications – books, position papers, and discussion papers. The discussion papers present analyses and findings from research and/or reports of projects, and programmes of the sanitation sector to instigate discussion among the sanitation community.

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