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The Global Sanitation Crisis

Pathways to Urgent Action

OVERVIEW

A Product of The World Bank's
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Front cover photo (large): A toilet facility located at a school in rural India (Credit: World Bank). Copyright protected.

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Preface

This World Bank report, *The Global Sanitation Crisis: Pathways to Urgent Action*, highlights the benefits of investing in resilient urban sanitation systems for people, economic growth, and the planet.

The report presents a suite of policy, institutional, regulatory, and financing (PIRF) recommendations, and outlines actions that cities and countries can take to accelerate progress toward universal access to resilient, safely managed sanitation. It contributes to the World Bank’s strategic objective of accelerating access to water, sanitation and hygiene by supporting two pillars of the World Bank’s Water Strategy: *Water for People* and *Water for Planet*.

By leveraging existing evidence, case studies, and expert opinions the report first underlines the essential role of resilient safely managed sanitation in fostering healthy communities, ensuring a sustainable environment, and promoting economic development, thus supporting the World Bank’s mission to create a world free of poverty and boost shared prosperity on a livable planet. Second, it highlights the complex interplay between urban sanitation and climate change. Third, it rethinks approaches to urban sanitation to additionally contribute to urban water security and city resilience. Fourth, it outlines key policy, institutional, regulatory, and financing directions for accelerating universal access to urban climate-resilient sanitation (CRS). Finally, it presents pathways for countries and cities to follow when prioritizing interventions to accelerate universal access to resilient safely managed sanitation services and to foster climate action in the sanitation sector.

Recognizing the diversity of service providers in low- and middle-income countries (LMICs), the report acknowledges the distinct roles and capacities of both utilities and smaller-scale dispersed providers. It emphasizes the need for utilities and city authorities to take greater responsibility for sanitation in contexts where this is not yet the case while also supporting the contributions of smaller providers.

The insights and policy recommendations presented in the report aim to guide decision makers and practitioners in accelerating universal access to resilient sanitation services. Interventions to address climate impacts on sanitation systems should be tailored to context-specific realities, risks, and resources. Some contexts may prioritize coping with disrupted services and reducing the resulting health and environmental risks, while others may focus on building adaptive capacity by modifying technologies, practices, and/or capacity through broader systems transformation (GCF 2024).

There is a critical need for coordinated action to accelerate the transition to CRS, particularly in rapidly growing cities within LMICs. Cities worldwide have already begun rethinking their approaches to urban sanitation as they race to climate-proof their sanitation systems and related services. Growing pressures on sanitation systems present opportunities to embrace integrative urban water cycle management, thereby enhancing urban water resilience which in turn contributes to greater city resilience and livability—and ultimately delivers positive impacts for people, shared prosperity and the planet.

The sector must act now to drive a fundamental shift from the vicious cycle of inadequate sanitation that is vulnerable to climate change-related hazards and contributes to GHG emissions, to a virtuous cycle of climate-resilient, mitigation-positive sanitation services for all.

Acknowledgments

VI

This report, *The Global Sanitation Crisis: Pathways to Urgent Action*, was prepared by a World Bank team led by Sanyu Lutalo, Nishtha Mehta, and Gustavo Saltiel, with core team members Sean Nelson, Leonie Hyde-Smith, Martin Gambrill, and Pavel Luengas Sierra. The team greatly appreciates the strategic guidance and direction provided for the report from Saroj Kumar Jha (Global Director for Water), Yogita Mumssen (Practice Manager, Water Global Solutions Unit), and Yitbarek Tessema (Global Lead for Water Supply and Sanitation). The team also extends its gratitude to Dina Umali-Deininger (Regional Director, Planet for South Asia Region) and the Management team of the World Bank Water Global Practice for their valuable advice.

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Abbreviations

CBS	Container-Based Sanitation
CRS	Climate-Resilient Sanitation
CRUS	Climate-Resilient Urban Sanitation
CSO	Combined Sewer Overflow
CWIS	Citywide Inclusive Sanitation
FSM	Fecal Sludge Management
FSTP	Fecal Sludge Treatment Plant
GCF	Green Climate Fund
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GWSP	Global Water Security and Sanitation Partnership
HIC	High-Income Country
IFC	International Finance Corporation
LCA	Life Cycle Assessment
LIC	Low-Income Country
LMIC	Low- and Middle-Income Country
MIC	Middle-Income Country
NBS	Nature-Based Solution(s)
O&M	Operations and Maintenance
PIRF	Policy, Institutions, Regulations, and Financing
SCADA	Supervisory Control and Data Acquisition
SDGs	Sustainable Development Goals
SuDS	Sustainable Drainage Systems
UMIC	Upper-Middle-Income Country
UNICEF	United Nations Children’s Fund
WASH	Water, Sanitation, and Hygiene
WHO	World Health Organization
WSS	Water Supply and Sanitation
WSUP	Water and Sanitation for Urban Populations
WWTP	Wastewater Treatment Plant



Photo: A sanitation facility in the Dominican Republic is badly damaged by Hurricane Maria in 2017 and is rendered unusable (Credit, World Bank).

Overview

Sanitation is fundamental to multiple dimensions of sustainable and inclusive socioeconomic development, and supports the World Bank's mission to end extreme poverty and boost shared prosperity on a livable planet.

Key Takeaways

1. **There is a global sanitation crisis, exacerbated by climate-induced threats, such as droughts, floods and extreme weather.**

Globally, urban sanitation is alarmingly off-track in meeting SDG 6, with the world needing to accelerate progress fivefold to achieve universal, safely managed urban sanitation by 2030. Achieving universal access to sanitation in Africa by 2030 will require a 23-fold increase in the current rate of progress for safely managed sanitation and a 13-fold increase for basic sanitation (WHO/UNICEF, 2022). The urban sanitation crisis is being critically exacerbated by climate change, intensifying the challenges faced by vulnerable populations, particularly in urban areas of LMICs.

2. **Globally, up to one-third of urban populations in low- and middle-income countries (LMICs) are burdened by a 'triple threat'—poverty, climate risk, and inadequate access to sanitation services (Box ES.1).**

Approximately 919 million people, or 26 percent of these urban populations, face poverty, water stress, and limited sanitation access, while about 1.1 billion people, or 32 percent, are vulnerable to poverty, flooding, and insufficient sanitation. Without urgent interventions to tackle these challenges and enhance resilience, these communities will continue to suffer increasing losses from extreme weather events. The financial, social, and economic repercussions can perpetuate a vicious cycle of poverty, displacement, and infrastructure damage.

3. **Why sanitation matters for people, the planet and prosperity.**

Urban sanitation has profound impacts on human capital (people), economies (prosperity), and the local and global environment (planet). See Box ES.2 for a summary of key takeaways.

4. **Importance of Climate-Resilient Sanitation (CRS).**

CRS is essential for achieving and sustaining universal access to safely managed sanitation services and for driving climate adaptation and mitigation efforts in the sanitation sector. CRS anticipates, responds to, recovers from, and transforms sanitation systems while prioritizing universal access to safely managed sanitation services, paying special attention to vulnerable populations, and to reducing emissions.

5. **Rethinking urban sanitation for enhanced water security and city resilience.**

Without reimagining the role of sanitation, cities will continue to face challenges of too much, too little, and/or too polluted water. Urban water crises are prompting cities worldwide to rethink how they structure and deliver sanitation services. CRS brings an opportunity to improve urban water resilience and contribute to livable and resilient cities.

6. **Citywide Inclusive Sanitation (CWIS) approaches as a basis for accelerating resilient service provision.**

CWIS provides a robust foundation for achieving CRS. CRS requires a systems approach which recognizes that sanitation cannot be viewed in isolation but must be considered as an integral component of city systems and societal functioning. This means moving beyond climate-proofing infrastructure to addressing structural inequities in service provision and adopting a CWIS approach that promotes access to safely managed sanitation across the entire service chain. Sanitation systems are intimately linked to other urban services, necessitating a shift in how cities plan, design, and operate complementary infrastructure. Comprehensive systems-thinking enables cities to develop sanitation services that are resilient, regenerative, and focused on resource recovery.

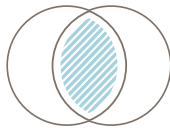
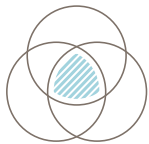
7. **Adopting circular economy thinking to enhance resilient sanitation service provision promote resource recovery and reuse, and support economic activities and jobs.**

Integrating circular economy approaches into sanitation systems offers transformative benefits for people, prosperity, and the planet. These approaches include extracting value from all stages of the sanitation service chain, increasing water resource use efficiency and reuse, and preventing environmental degradation. They can create jobs and yield significant economic and financial benefits by increasing revenues from resource recovery and reducing operation and maintenance (O&M) costs.

Understanding the triple burden faced by billions around the world

Without urgent measures to reduce climate impacts and build resilience, populations will continue to face escalat-

ing losses from extreme weather events, leading to a cycle of poverty, displacement, and infrastructure damage.



2

Globally, up to one third of urban populations in LMICs are afflicted by the 'triple burden'—poverty, low access to sanitation services, and climate risk.

Regionally, almost all urban populations in LMICs face at least one of the three burdens, and many face two.

Incidence of the triple burden varies significantly by country.

The World Bank has introduced a new indicator to measure the population at high risk of climate hazards.

Urban populations who simultaneously face a combination of low access to sanitation, climate risk (either water stress or flooding), and poverty, are especially vulnerable. About 919 million people of low- and middle-income urban populations are exposed to poverty, water stress, and low access to sanitation, and about 1.1 billion people are exposed to poverty, flooding, and low access to sanitation.

When the climate risk considered is water stress, South Asia is home to the highest percentage of the urban population facing the triple burden, at 57 percent, followed by Central Asia at 28 percent, the Middle East and North Africa at 26 percent, Sub-Saharan Africa at 20 percent, and Latin America and the Caribbean at 12 percent. When the climate risk is flooding, patterns are similar, but in South Asia, the percentage of the population facing the triple burden increases to 72 percent (Figure ES.1).

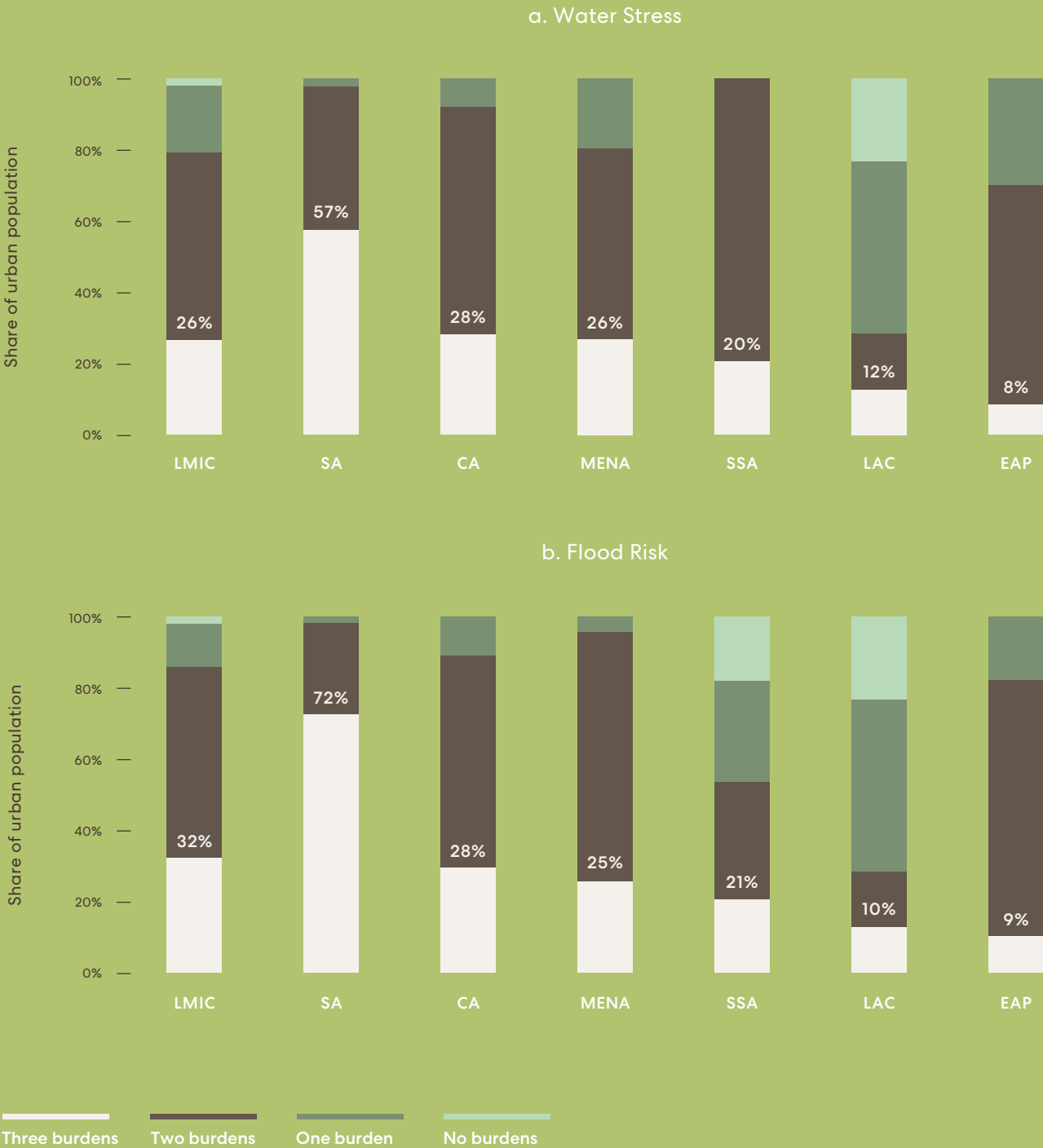
When the climate risk is water stress, of the 71 LMICs with information on poverty, sanitation, and climate risk, 35 of them have at least some urban residents facing the three burdens simultaneously. In 16 countries, more than half of the urban population faces the triple burden; in nine of these countries, all of the urban population faces the triple burden. When the climate risk is flooding, of the 51 LMICs studied, at least some people in urban areas face the three burdens simultaneously. In 33 countries more than half of the population faces the triple burden; in 13 of these countries, the entire urban population faces the triple burden.

This new indicator includes individuals exposed to hazards who are already vulnerable, meaning they are likely to suffer significant losses and lack coping capacity and the ability to recover. Based on this indicator, Sub-Saharan Africa has the highest proportion of people at high risk, with nearly all highly vulnerable people being exposed to extreme weather. South Asia, however, has the largest total number of people at high risk, representing 32 percent of its population.¹

¹ World Bank calculations using World Bank Group Scorecard Indicator data (percent of people at high risk from climate-related hazards) (<https://scorecard.worldbank.org/>) (Hill et al. forthcoming—cited in World Bank 2024).

Figure ES.1

The number of burdens faced by urban populations in LMICs across six regions



Sources: World Bank, 2025 (Methodology in Annex 2) using (a) information from AQUEDUCT 4 (World Resources Institute) for water stress and from Rentschler, Salhab, and Jafino (2022) for flood risk; (b) poverty data at the state and province level from the Global Subnational Atlas of Poverty (GSAP, Geospatial Poverty Portal, World Bank); and (c) access to improved sanitation data from Deshpande et al. (2020).

Note: Data limitations preclude providing estimates for Europe and Central Asia as district-level sanitation estimates only cover Central Asia. SA = South Asia; CA = Central Asia; MENA = Middle East and North Africa; SSA = Sub-Saharan Africa; LAC = Latin American and the Caribbean; EAP = East Asia and the Pacific.

Summary of key takeaways on why sanitation matters for people, the planet and shared prosperity



For People

• Human capital outcomes

Inadequate sanitation not only exacerbates the spread of diseases but also traps individuals in a cycle of poor health, limited education, and diminished economic opportunities, particularly for women and girls.

• The triple burden

About one-third of urban populations in low- and middle-income countries face simultaneous challenges of poverty, climate risks, and low access to sanitation services—the ‘triple burden.’² Approximately 919 million urban residents are exposed to poverty, low access to sanitation, and water stress, while about 1.1 billion people face poverty, inadequate sanitation, and flooding risk in urban areas.



For the Planet

• Sanitation and environmental sustainability

Minimizing environmental impacts through robust and sustainable sanitation practices prevents water pollution and reduces GHG emissions. This includes treating wastewater and fecal sludge while promoting processes that transform waste into valuable resources, thereby contributing to environmental sustainability, natural resource conservation, and planetary health.

• Sanitation and the planetary boundaries

Sanitation intersects with seven of the nine planetary boundaries, including six that have already been breached (see Table ES.1). These boundaries represent the thresholds within which humanity can safely operate without inflicting irreversible harm on Earth’s ecosystems and climate. Implementing regenerative actions, such as reducing pollution from untreated wastewater discharge, reusing nutrients and wastewater, and enhancing energy efficiency, can help restore humanity to a safe operating space.



For Shared Prosperity

• Sanitation and the economy

Investments in water supply and sanitation (WSS) generate substantial economic return. For example, in Africa, every dollar invested in WSS yields a return of at least seven dollars. Adequate funding in this sector has the potential to boost Africa’s gross domestic product (GDP) by over 5 percent, translating to an annual economic gain of approximately US\$200 billion (Economist Impact and SWA 2023).

• Sanitation and jobs

Each US\$1 million invested in water and sanitation infrastructure generates approximately 40 jobs in lower-middle-income and low-income countries (Moszoro 2024, adapted by the World Bank).

² ‘Poverty’ is defined as the share of population with a per person income per day lower than the US\$6.85 poverty line (2017 PPP) in 2019; ‘climate risk’ is defined as either water stress or flooding; and ‘limited access to sanitation’ is defined as access to sewerage or septic tanks. A standardized approach to classify all districts (municipalities) in the world as urban, or not urban, was followed. An urban district is categorized as facing the Triple Burden if: (1) its water stress is 10 percent or higher, or its flood risk is 14 percent or higher; and (2) its poverty is 33 percent or higher; and (3) its access to sewerage or septic tanks is 75 percent or lower.

8. The need for a robust enabling environment.

To ensure the success of CRS, a robust enabling environment is crucial. This includes tailored policy, institutional, regulatory, and financing solutions adapted to the local context and coordinated across levels of government. Strong political leadership is essential to transform policy changes and interventions into practical actions. Effective implementation relies on clear accountability mechanisms and partnerships among key stakeholders and across government.

9. Costs of resilient sanitation services are substantial but significantly lower than the costs of inaction.

Sanitation is the sector most off-track for meeting the SDG 6 targets, a trend that is growing as the world rapidly and informally urbanizes. Revised cost estimates for extending services to the unserved have risen to US\$1.4 trillion for 2017-2030, averaging US\$105 billion annually (Hutton and Varughese 2020), with additional investments required for making sanitation systems resilient against climate change-induced hazards and disasters. Yet, investments have been underprioritized.

10. While public sector ownership and leadership in the funding arrangements for urban CRS will remain critical, a blend of public and private financing—together with leveraging of climate and other green funding opportunities—will be required to accelerate universal access to resilient sanitation services.

Emerging opportunities for new funding and financing mechanisms, such as green and climate finance and private investments, as well as the sale of new products created from sanitation 'waste' streams, can help bridge the funding gap. To effectively leverage such innovative financing, cities and utilities should achieve basic financial sustainability through sound revenue management, transparent budgeting, and efficient expenditure control.

11. Implementation pathways for accelerating access to safely managed sanitation in a changing climate.

Implementation pathways will vary between countries and cities depending on existing levels of access to sanitation, income levels, and related factors such as the availability of funding and financing, institutional capacity and readiness, and synergies with development and economic goals. These pathways require coordinated action across policy, institutional, regulatory, financing, and incentive frameworks.

12. Moving from vicious to virtuous.

The sector must act now to drive a fundamental shift from the vicious cycle of inadequate sanitation that is vulnerable to climate change-related hazards and contributes to GHG emissions, to a virtuous cycle of climate-resilient, mitigation-positive sanitation services for all.

The Links Between Sanitation, Climate, and Development

Sanitation is fundamental to achieving sustainable and inclusive socio-economic development and directly supports the World Bank’s mission of ending extreme poverty and boosting shared prosperity on a livable planet.

6 The role of safely managed sanitation in reducing public health risks, tackling environmental pollution, and improving quality of life in LMICs is indisputable. Urban sanitation is a public good, whose absence affects everyone in a given urban community, regardless of their socioeconomic status. Safe sanitation is an important aspect of well-being that also boosts human capital, positively impacts a country’s GDP and contributes positively to the environment. Sanitation services also help address gender inequalities and reduce vulnerability, especially during pandemics and natural disasters. Sanitation underpins SDG 6 and has strong synergies with the SDGs related to cities, climate change, health, education, gender and inclusion, poverty, nutrition, and the environment.

Climate-related hazards are exacerbating the sanitation crisis in many countries.

Globally, 3.5 billion people—nearly two out of five people across the world—lack access to safely managed sanitation. Billions are trapped in a vicious cycle of inadequate sanitation, poverty, and increasing risks from climate-induced hazards such as increased flooding, water scarcity, rising sea levels, and changing temperatures, which put additional pressure on already strained sanitation systems leading to health and environmental impacts and major productivity and economic losses. At the current rate of progress, the world will not achieve the SDG 6 goal of universal access to safely managed sanitation by 2030.

At the same time, inadequate sanitation systems contribute to greenhouse gas (GHG) emissions across the service chain by emitting methane (CH₄), carbon dioxide (CO₂), and nitrous oxide (N₂O).

These GHG emissions arise directly and indirectly (Johnson et al. 2022):

Directly	Indirectly
From the decomposition of organic matter found in excreta at the household level through to wastewater and fecal sludge treatment and disposal processes.	From the energy (fossil fuels) used to operate systems, including pumping, transportation, and treatment and embedded carbon in sanitation infrastructure.

The reduction of GHG emissions should be a key consideration when selecting sanitation technologies and services, along with other factors that influence the long-term sustainability of sanitation systems. These include cultural acceptability, capital and operational costs, and technical feasibility within local environmental conditions, such as water availability, soil type, topography, and population density. Equity should guide decisions to ensure all communities, and especially the most vulnerable, benefit from resilient solutions.

Climate-resilient sanitation approaches are needed to deliver universal access to safely managed sanitation along the entire sanitation service chain (Figures ES.2 and ES.3).

Climate-resilient sanitation services anticipate, respond to, cope with, recover from, adapt to or transform from climate-related events, trends, and disturbances while striving to achieve and maintain universal access to safely managed services, even in the face of an unstable climate, paying special attention to the most exposed vulnerable groups and, where possible and appropriate, minimizing emissions.

The nexus of climate events and poor sanitation is occurring in the context of vastly increasing populations and disproportionately affects poor and already vulnerable communities, especially in urban areas within LMICs.

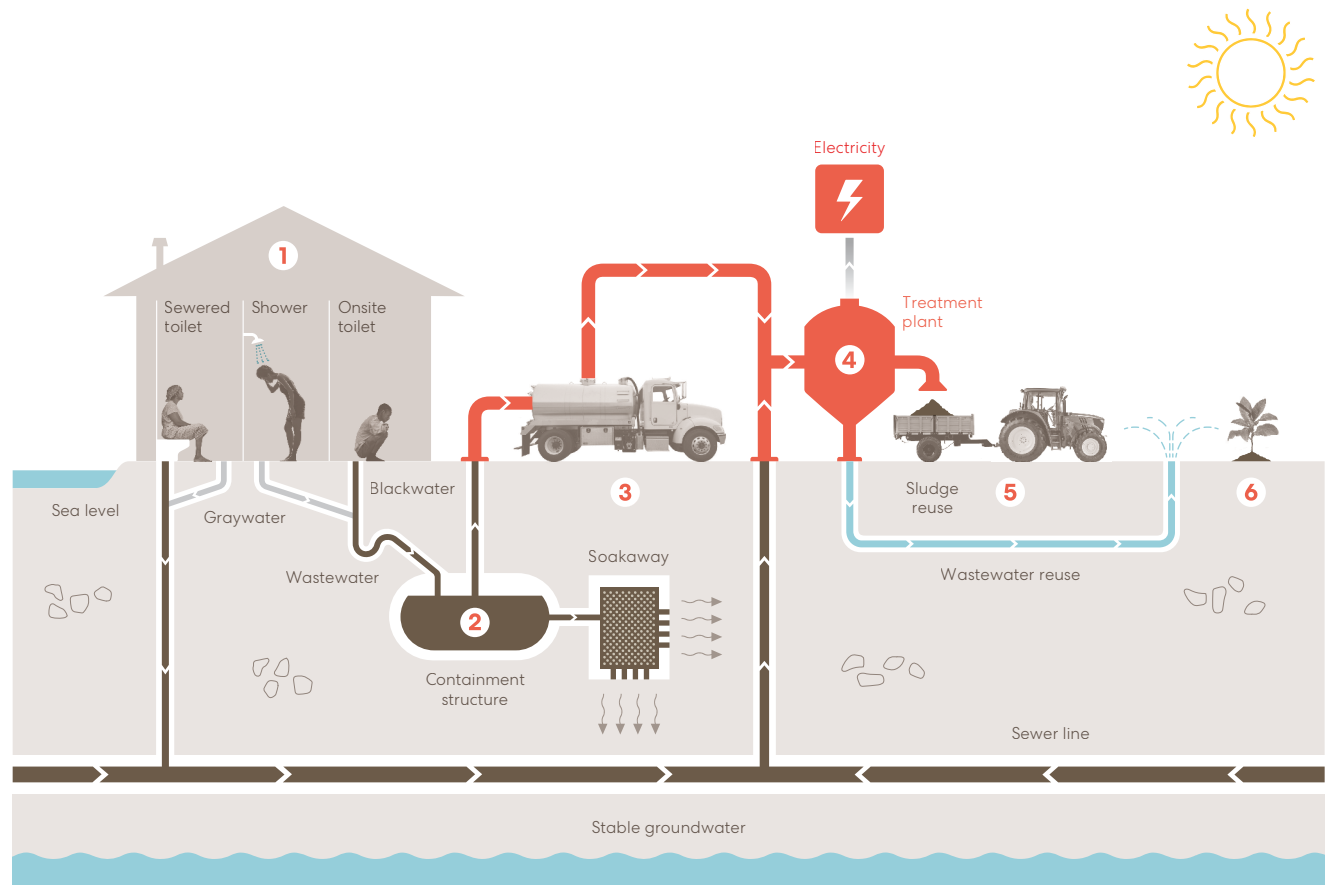
Urban areas, which occupy only 5 percent of all land globally, are currently home to about 58 percent of the world's population. Globally the urban population is rapidly increasing. By 2050, nearly 7 in 10 people are projected to live in cities (Mukim and Roberts 2023). Notably, unregulated urban expansion—especially in hazard-prone areas such as floodplains—is outpacing safer urban development (Rentschler et al. 2023). Many poor urban populations, already lacking access to adequate sanitation, reside in these high-risk areas, compounding their vulnerability to climate hazards.

Climate-related hazards are exacerbating the sanitation crisis in many countries.

About 919 million people in urban areas are exposed to poverty, low access to sanitation, and water stress, and about 1.1 billion urban residents—which is more than the combined total population of the Americas—are exposed to poverty, low access to sanitation, and flooding. This convergence amplifies existing vulnerabilities and necessitates urgent interventions, demanding robust disaster management in the face of escalating climate impacts. As cities battle with the consequences of too much, too little, and too polluted water, resilient sanitation systems will be necessary to build and maintain urban water security, and city livability and resilience. By investing in smart and resilient urban sanitation now, countries can turn the vicious cycle of unsafe, vulnerable sanitation systems into a virtuous one, where sanitation services withstand extreme climate and related disasters, protect human health, boost economic growth, reduce pollution and GHG emissions, and transform cities.

Figure ES.2

Climate-resilient sanitation service chain



1.

Waste Capture

Access to, and use of, a functioning and hygienic sewerage toilet or onsite toilet

2.

Containment and Absorption

Fecal sludge/septage and graywater are safely contained in an underground structure; effluent is discharged into a drain field/soakaway and absorbed into the surrounding soil.

3.

Emptying and Transport

Fecal sludge/septage is hygienically removed and safely transported for treatment. Alternatively, a sewer line conveys wastewater directly to the treatment plant.

4.

Wastewater/Septage Treatment

Organic material, pathogens and nutrients in the waste are removed/reduced at the treatment facility.

5.

Safe Reuse or Disposal

Resource recovery and disposal.

6.

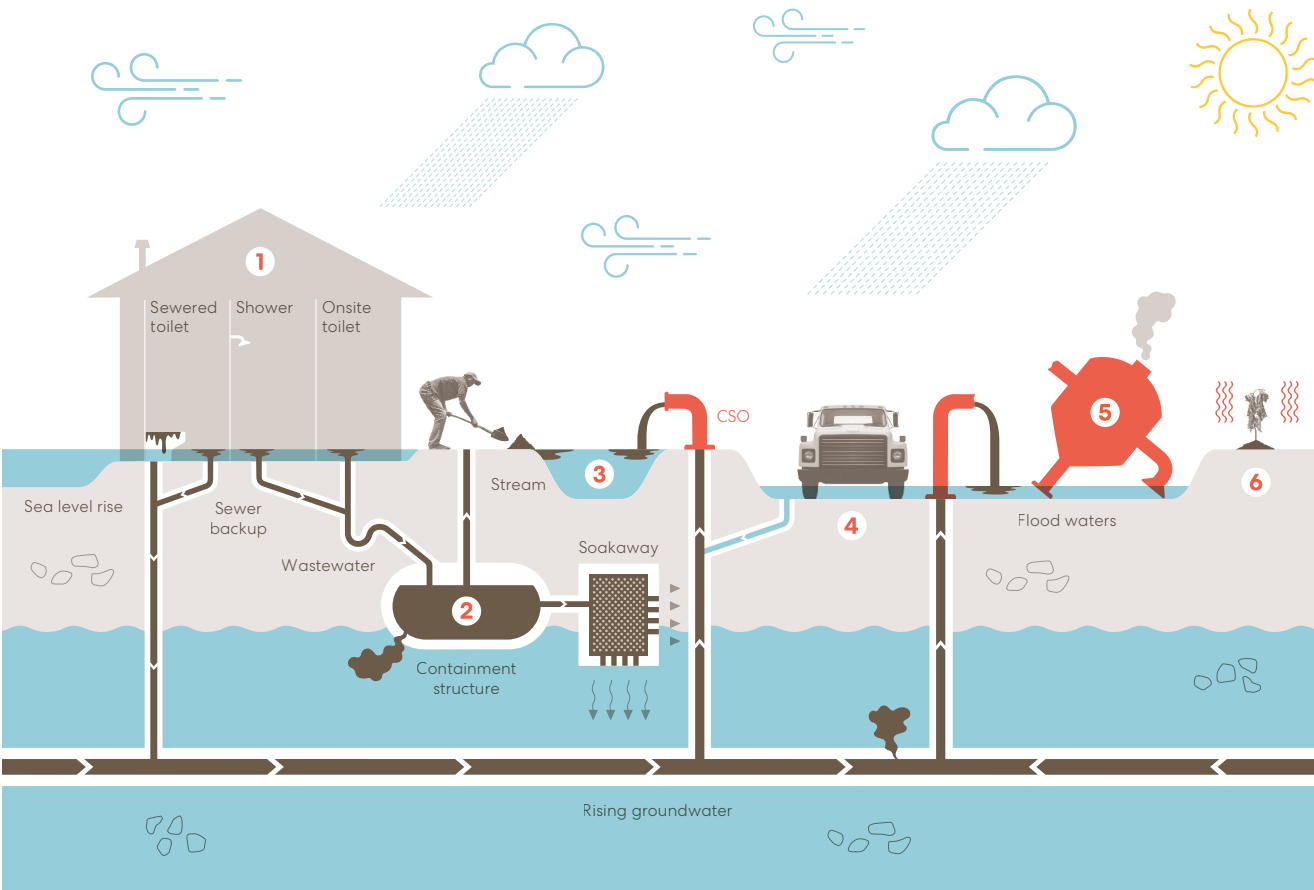
Positive Outcomes

When waste is used safely and responsibly, valuable water, nutrients, and energy can be returned to the circular economy.

Source: Original figure for this publication, World Bank 2025.

Figure ES.3

Non-climate-resilient sanitation service chain



1.

Unsafe/Lost Access

Toilets are inaccessible and/or malfunction due to physical damage or failure from flooding or drought.

2.

Unsafe Containment

Leaking containment structures and inappropriate onsite infiltration systems deteriorate further with floods and rising groundwater/sea levels; unsafe emptying/discharge from onsite structures occurs, especially before/during rain events.

3.

Unsafe Conveyance

Rising flood waters affect equipment critical to the safe removal of wastewater, including sewers and pumping stations; combined sewer overflows (CSOs) discharge untreated wastewater during increased/intense rainfall events.

4.

Unsafe Transport

Rising flood waters affect roads and equipment critical to the safe removal of fecal waste, including vacuum tankers.

5.

Inadequate/Unsafe Treatment

Treatment plants, damaged by flood waters or storms, breakdown, allowing untreated/partially treated waste to be discharged and GHGs to escape.

6.

No Resource Recovery or Reuse

Resource recovery, and reuse of water, sludge, nutrients and energy are no longer possible.

Source: Original figure for this publication, World Bank 2025.

A Conceptual Framework for Climate-Resilient Sanitation

The report introduces a novel conceptual framework for achieving CRS, illustrating how sanitation services can be made more resilient to climate-related events through the adaptation and transformation of infrastructure, service delivery approaches, organizations, and behaviors.

The framework (Figure ES.4) emphasizes strengthening the capacities of sanitation systems to climate-induced impacts. These capacities involve the following:

Absorptive Capacity

Directly coping with and withstanding the immediate climate impacts on sanitation services using existing resources and social networks to minimize damage and provide basic needs.

Adaptive Capacity

Incrementally adapting services to reduce the likelihood of harmful outcomes resulting from climate-related hazards.

Transformative Capacity

Rethinking and reconfiguring sanitation services to enhance their resilience to future climate shocks and to contribute to broader resilience in urban water cycles and communities.

Enhancing the absorptive, adaptive and transformative capacities of sanitation systems leads to several positive outcomes.

These outcomes include the following:

- A. Improved human capital outcomes, such as reduced health risks from water- and excreta-related diseases following extreme weather events.
- B. Improved social outcomes, such as increased school attendance, particularly among girls
- C. Improved natural capital outcomes, such as reduced pollution of freshwater sources and marine ecosystems.
- D. Improved economic outcomes, including leveraging circular economy approaches for more efficient urban water management, enhanced city livability, benefits from resource recovery and jobs, and increased economic activities, such as, tourism, when cities and their water bodies are cleaned up.

These outcomes collectively contribute to positive impacts on people, prosperity, and the planet. If “adaptation is development in a more hostile climate” (Stern, 2009), climate-resilient sanitation can be understood as the provision of safely managed sanitation under increasingly uncertain and extreme climate conditions. Achieving these outcomes requires strengthened sanitation governance and increased financing to support a systems-wide approach to transformative adaptation and resilience. It also calls for rethinking urban sanitation through systems-thinking that promotes inclusive service delivery, urban water security, and climate resilience. Scaling up capacity building and skills development, alongside the adoption of innovative technologies and practices, is crucial to fostering adaptive, resilient, and sustainable sanitation systems.

Figure ES.4

Conceptual framework illustrating the links between safely managed, climate-resilient sanitation services and people, prosperity, and the planet



Why Climate-Resilient Sanitation Matters for People

Ensuring equitable access to reliable and safe sanitation services for all, including marginalized groups, reduces health disparities and enhances social welfare, especially under adverse climate conditions. A commitment to inclusivity addresses existing vulnerabilities while ensuring sanitation improvements reach all segments of society, enhancing human and social capital.

Inadequate sanitation not only spreads diseases more quickly but it also traps already vulnerable urban populations in a cycle of poor health, limited education, especially for girls, and fewer economic opportunities (Figure ES.5).

Extreme weather events make urban sanitation challenges worse, hitting vulnerable people the hardest. Unsafe sanitation is responsible for almost 40 percent of all disease mortality from inadequate water, sanitation, and hygiene (WASH) services. In many LMICs, urban migration to crowded and unsanitary informal settlements diminishes access to adequate WASH services and quality health care (Ezeh et al. 2017; Shetty 2011). Floods and droughts increase pathogen transmission; for instance, flooding can cause wastewater systems to overflow, spreading pathogens from untreated sewage, including noroviruses, hepatitis, hantavirus, and Cryptosporidium, contaminating water and food supplies (Mora et al. 2022).

In 2022, one in five people around the world (or 1.7 billion people) drank water that was contaminated with human waste.

People consuming water with human waste are exposed to diseases such as cholera and dysentery, along with typhoid, intestinal worm infections, and polio. These diseases and infections contribute to increased morbidity and stunting in children, burdening them with lifelong disadvantages. Climate change has intensified cholera upsurges by compounding triggers such as poverty and

conflict. In 2022, 44 countries reported cholera cases—a 25 percent increase from 2021—with more deadly outbreaks and the highest fatality rates in over a decade (WHO 2024).

Inadequate sanitation in schools can severely affect children and their prospects.

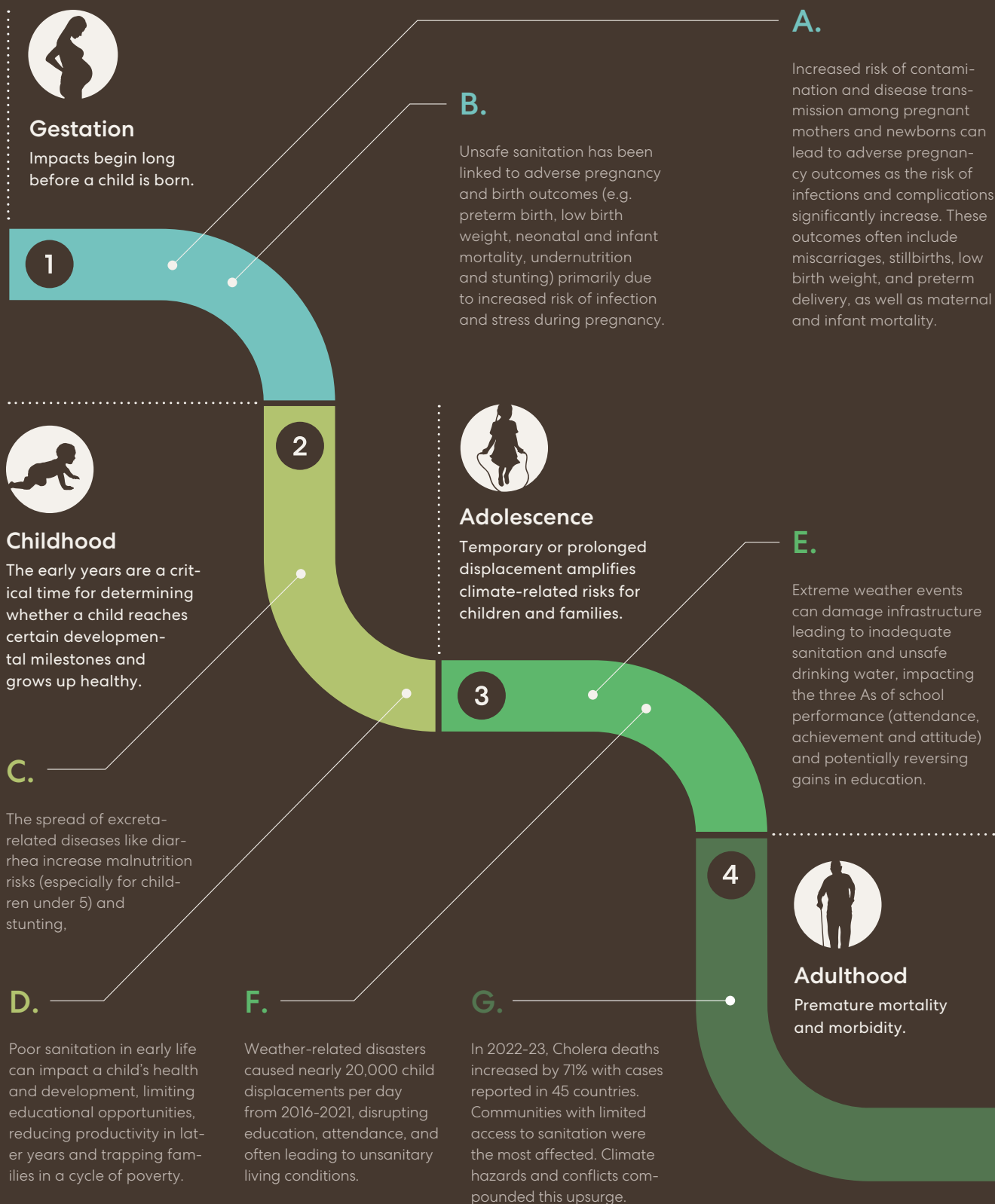
It has been proven to impact the ‘three As’ of school performance: attendance, achievement and attitude; and yet an estimated 367 million children globally attend schools without toilets. Adolescent girls are especially affected, often dropping out of school due to lack of safe sanitation facilities. The increased occurrence of climate hazards destabilizes agricultural production, which can contribute to poor nutrition and childhood stunting (Grace et al. 2012; McMichael 2013) and increase vulnerability to illness (Mora et al. 2022).

High levels of community-wide sanitation coverage with adequate excreta management, along the full sanitation service chain are, like herd immunity in vaccines, central to preventing disease transmission.

Therefore, even small reductions in coverage from, for example, climate change, can significantly affect public health. This underscores the importance for sanitation interventions to prioritize public health outcomes by integrating health risk assessments into technology, infrastructure, and service planning. Inadequate onsite sanitation systems and lack of suitable O&M of systems—particularly in dense flood-prone areas of LMICs—pose severe risks of disease transmission (Mertens et al. 2023).

Figure ES.5

Climate-driven sanitation impacts on health and human capital across four life stages



Source: Authors, (Concept adapted from Andrés et al. [2018], updated for the sanitation sector).

Why Climate-Resilient Sanitation Matters for the Planet

Adequate sanitation infrastructure is key to maintaining the delicate balance of the Earth’s environmental systems.

Sanitation intersects with seven of the nine planetary boundaries, including six that have already been breached (Table ES.1). These boundaries refer to the limits within which humanity can safely operate without causing irreversible damage to the Earth’s ecosystems and climate. The sanitation sector affects freshwater change, climate change, biogeochemical flows, land system change, novel entities, biosphere integrity, and ocean acidification..

Minimizing environmental impacts through robust and sustainable sanitation practices prevents water pollution and reduces GHG emissions.

This includes treating wastewater and fecal sludge while promoting processes that transform waste into valuable resources, thereby contributing to environmental sustainability, natural resource conservation, and planetary health. The pollutants and high nutrient loads found in untreated and inadequately treated wastewater negatively impact ecosystems. Freshwater biodiversity is estimated to have declined by 83 percent since 1970 (WWF 2022), in part from wastewater pollution. Phosphorus and nitrogen are essential nutrients for plant and algal growth; however, high residual loads of these nutrients, associated with poorly treated wastewater, cause excessive aquatic plant growth and algal blooms that decrease oxygen in receiving waters, killing fish and other aquatic life (Corcoran et al. 2010), in turn affecting economic activities such as fisheries and tourism.

Investments in resilient systems can curb GHG emissions.

These emissions include harmful gases such as methane from wastewater and fecal sludge treatment plants as well as carbon dioxide associated with the energy consumed by wastewater pumping stations and treatment systems. Growing research suggests GHG emissions from sanitation systems are underestimated (Lambiasi et al. 2024). Without climate-resilient practices, projections show a 60 percent increase in methane emissions from sanitation systems in Sub-Saharan Africa, with potentially even higher increases in India (USAID 2023). In contrast, providing sanitation in major urban areas to prevent untreated discharges of human waste to the environment could reduce global methane emissions by up to 10 percent (De Foy et al. 2023).

Table ES.1

How sanitation and the planetary boundaries intersect

Boundaries	Impacts of Sanitation on Boundary	Regenerative Actions
 Freshwater Change	Declining water quality reduces the availability of clean water sources. High volumes of untreated wastewater and fecal sludge can contribute to marine and freshwater pollution. Water-based sanitation systems increase the strain on global freshwater resources. A significant proportion of global wastewater is discharged without being adequately treated, making it a major source of nutrient and organic pollution in marine and freshwater environments.	Wastewater treatment, source separation, and safe reuse all reduce the contamination and pollution of freshwater and marine systems, while also reducing the demand for new water sources.
 Biogeochemical Flows	Untreated or inadequately treated wastewater contributes significant amounts of nitrogen (N) and phosphorus (P) into aquatic ecosystems, causing eutrophication. This nutrient overload leads to algae growth, followed by oxygen depletion (dead zones) that can no longer support aquatic life.	Cities can recover nutrients (N and P) from wastewater and sludge by adopting appropriate wastewater treatment or source separation systems. Recovered nutrients can be used in agriculture, reducing the demand for synthetic fertilizers and improving food security. Phosphorus can be crystallized from urine and used as fertilizer. Digestate from anaerobic digestion can improve soil health as a soil amendment.
 Land System Change	Unsafe and unregulated irrigation using polluted wastewater, particularly containing heavy metals and chemicals, degrades agricultural land, including by increasing soil salinity. This degradation may lead to further conversion of forests as new agriculture land is sought.	Implementing wastewater treatment and safe reuse practices, along with appropriate regulatory frameworks, helps protect agricultural land from degradation.
 Biosphere Integrity	Discharging untreated or poorly treated wastewater into aquatic ecosystems degrades habitats, reducing biodiversity. Key species and microorganisms are threatened by nutrient and organic pollution and the introduction of harmful pathogens and chemicals.	Implementing source separation systems—which separate stormwater from wastewater, graywater from blackwater, and/or urine from blackwater—promotes the control of elements to be discharged and those to be treated and recycled. Installing green infrastructure such as rain gardens, bioswales, and wetlands can buffer stormwater and naturally filter nutrients and contaminants from urban runoff, preventing them from entering sewers and/or water bodies directly, where they contribute to eutrophication.

(Table ES.1 continued)

Boundaries	Impacts of Sanitation on Boundary	Regenerative Actions
 Climate Change	Sanitation systems contribute to global warming through GHG emissions, including direct emissions from treatment processes, operational emissions, and embedded carbon.	Circular economy approaches in sanitation can improve energy efficiency. Wastewater sludge can be processed through anaerobic digestion to produce and capture biogas, preventing its emission to the environment and providing a renewable energy source, which reduces reliance on fossil fuels.
 Novel Entities	Untreated and inadequately treated wastewater introduces novel entities such as pharmaceuticals, heavy metals, and industrial chemicals into ecosystems, further disrupting water quality and biological systems.	Appropriate levels of wastewater treatment and reduction of untreated wastewater discharges, such as through CSOs, prevent these contaminants from entering natural systems. Source separation systems can further aid the separation of different waste streams and the entities within them and facilitate their appropriate treatment.
 Ocean Acidification	Oceans acidify due to increased atmospheric CO ₂ absorption and the underwater decomposition of organic matter. Coastal cities contribute to ocean acidification through CO ₂ emissions from fossil fuel combustion and nutrient inputs from sewage and fertilizers, which can lead to localized acidification.	Reducing untreated wastewater discharge such as through CSOs helps prevent excess nutrients from reaching marine ecosystems. Cities can also adopt nutrient recovery from wastewater and sludge by implementing appropriate wastewater treatment or source separation systems.

Source: Original to this publication. Based on Arup 2021 and Carrard and Willetts 2017.

Why Climate-Resilient Sanitation Matters for Shared Prosperity

Investing in climate-resilient sanitation is a catalyst for shared prosperity. Expanding safely managed sanitation services and maintaining their functionality during climate disruptions supports economic growth and productivity. CRS systems contribute to economic growth and stability by creating jobs, preventing or mitigating economic losses associated with sanitation failures, promoting resource recovery initiatives that provide economic benefits to communities, and supporting economic activities, such as tourism, by improving amenity and livability in cities.

The economic costs of poor sanitation can last a lifetime.

Research shows that in India, for example, adults born in regions with a high disease burden earned significantly lower wages later in life. The cost of inadequate sanitation is substantial, with losses exceeding 2 percent of gross domestic product (GDP) in East Asia, the Pacific, and Sub-Saharan Africa and 4 percent in South Asia (Hutton and Chase 2016).

Investing in resilient sanitation systems has a positive impact on prosperity.

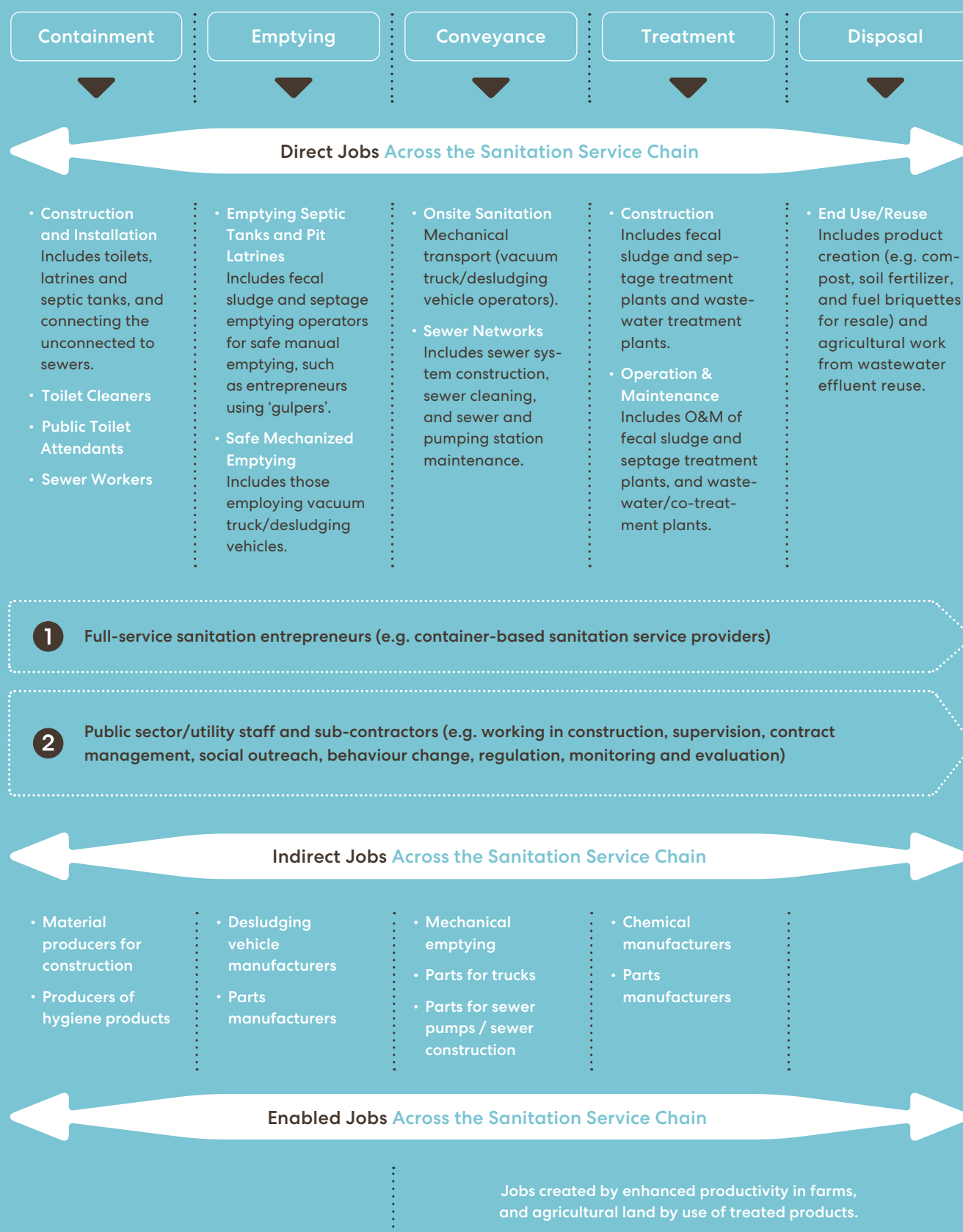
Downstream impacts of environmental pollution are estimated to reduce GDP growth by up to one-third (Damania et al. 2019). Conversely, improving climate-resilient sanitation can fuel prosperity. CRS infrastructure for example limits drought and flood damage, helping protect future earnings of children. Investment in WSS yields significant returns; every dollar spent in Africa returns seven; adequate funding in WSS could result in a 5 percent return on GDP, amounting to an annual US\$200 million in Africa alone (Economist Impact and SWA 2023).

Jobs can be directly created through building, adapting, retrofitting, managing, and maintaining sanitation systems in response to climate change.

Each US\$1 million invested in water and sanitation infrastructure generates approximately 40 jobs in lower middle-income and low-income countries (Moszoro, 2024; adapted by the World Bank). Employment in the water and sanitation sector has traditionally focused on jobs related to capital works, including the building of large-scale wastewater infrastructure. Citywide Inclusive Sanitation, however, emphasizes the service delivery aspects of sanitation and considers employment across the full sanitation service chain, for both sewered and onsite sanitation systems, regardless of whether they are labor-intensive or technology-intensive, and thus encompasses a range of profiles from highly skilled to low-skilled jobs (Table ES.2). Furthermore, safely managed and more resilient sanitation systems can enable circular economy approaches that reuse products from treated wastewater and fecal sludge, thereby creating further direct and indirect employment opportunities.

Table ES.2

Sanitation and jobs across the sanitation service chain



Turning Climate Risks Into Opportunities Using a Systems-Wide Approach

Around the world, cities facing water and sanitation insecurity are increasingly rethinking their approaches, driven by circular economy principles that close resource loops and promote access to safely managed sanitation and urban water resilience.

Urban CRS requires integrated planning that recognizes the interdependencies between water supply, sanitation (both sewerred and non-sewerred), stormwater management, solid waste management, and other basic urban services such as transport, electricity, and urban planning. CRS is not just about managing risks but also capitalizing on opportunities (Table ES.3). When sanitation is considered alongside interconnected urban services, it offers significant opportunities to drive broader systems change and enhance climate resilience.

Circular economy approaches present transformative solutions for addressing global environmental challenges and advancing sustainable development.

Integrating circular economy principles into sanitation systems offers opportunities to minimize waste, maximize water use efficiency, diversify urban water sources, enhances water security and resilience, restore ecosystems, recycle nutrients and soil conditioners, generate energy, and create potential income streams (Delgado et al. 2021). Wastewater and fecal sludge can serve as sources of water, energy, nutrients and other valuable materials—these, together with transitioning from combined to separate sewer systems and reducing urban runoff through nature-based solutions, are strategic approaches to mitigate flood and drought risks.

Anchoring climate-resilient sanitation planning within a Citywide Inclusive Sanitation (CWIS) framework presents a strong opportunity for transformative adaptation towards more equitable urban sanitation systems.

CRS requires a systems approach that recognizes that sanitation cannot be viewed in isolation but must be considered as an integral component of city systems and societal functioning. This means moving beyond climate-proofing infrastructure to instead addressing structural inequities in service provision and adopting a CWIS approach that promotes access to safely managed sanitation across the entire service chain. Sanitation systems are intimately linked to other urban services, necessitating a shift in how cities plan, design and operate complementary infrastructure. Comprehensive systems-thinking enables cities to develop sanitation services that are resilient, regenerative, and focused on resource recovery.

To ensure the success of climate-resilient sanitation, a robust enabling environment is crucial.

This includes tailored policy, institutional, regulatory, and financing solutions that are adapted to the local context and coordinated across levels of government. Strong political leadership is essential to transform theoretical changes and interventions into practical actions. Effective implementation relies on clear accountability mechanisms and partnerships among key stakeholders across governments.

Table ES.3

Summary of multifaceted co-benefits of investing in climate-resilient sanitation

Benefit	Explanation	Benefit	Explanation
1. Contributes to urban water resilience and city resilience	Climate-resilient sanitation allows the rethinking of how urban sanitation systems are designed and delivered such that they contribute to situations of too much and, especially, too little and too polluted urban water, thus contributing to urban water resilience and, through it, city resilience.	4. Increases climate resilience capacity and climate-resilient outcomes	- Increases the resilience of beneficiaries, communities, and local areas. - Reduces the risk of sanitation systems failing. - Prevents negative spill overs from sanitation into other sectors.
2. Contributes to water quality	CRS reduces pollutant exposure to water resources used for potable, irrigation and environmental ends.	5. Reduces local pollution and a healthier environment	- Reduces pollution loads in local water systems and landscapes, making water safer to drink and otherwise use effectively. - Lower organic and nutrient loads in water reduces the risk of algal blooms and oxygen dead zones that kill aquatic life. - Pollution control protects key ecosystems and biodiversity.
3. Enables economic growth, job creation, and increased prosperity	- Provides better public health outcomes. - Increases people's ability to be economically productive. - CRS facilities for girls in school help ensure they can obtain a full education. - A healthier environment leads to healthier marine life and fisheries. - The safe reuse of products from the sanitation service chain contributes to the local economy, including effluent and sludge reuse. - Reduces the costs for loss and damage of sanitation infrastructure as well as costs of negative environmental and public health outcomes after climate hazard induces sanitation failures. - Reduces costs of fines for service providers for non-compliance with environmental legislation.	6. Promotes circular economy reuse of resources	Allows for circularity and reuse principles to be followed, including electricity and heat generation, effluent reuse in irrigation, industry and elsewhere, and the recovery of other resources from treated wastewater and sludge.
		7. Reduces GHG emissions	Reduces GHG emissions from unmanaged or untreated wastewater and fecal sludge, while providing opportunities for biogas capture, energy efficiency, and renewable energy investments.
		8. Improves public health	Reduces the risk of early childhood stunting and chronic and acute disease transmission, including cholera outbreaks.

The costs of achieving universal coverage and incorporating climate resilience into sanitation systems are substantial but significantly lower than the costs of inaction.

Safely managed urban sanitation is the most expensive and most challenging of the WASH sub-sectors. Sanitation is the sector most off-track for meeting the SDG 6 targets, a trend that is growing as the world rapidly and informally urbanizes. Revised cost estimates for extending services to the unserved have risen to US\$1.4 trillion for 2017-2030, averaging US\$105 billion annually (Hutton and Varughese 2020), an increase of US\$36 billion per year (Hutton and Varughese, 2016) with additional costs required for making them resilient against climate change-induced hazards and disasters (Hutton and Varughese 202).

The fundamental nature of sanitation as a public good justifies substantial public financing and subsidies.

Unlike water supply, which primarily benefits individual households, sanitation generates extensive public benefits that extend far beyond the immediate user. This means consumers are generally willing to pay for water services irrespective of income level because of their essential role in daily life, health and productivity. Safely managed sanitation prevents disease transmission, protecting entire communities from health risks and reducing the burden on public health systems. It safeguards environmental quality by preventing contamination of water resources and ecosystems, while protecting biodiversity and enhancing climate resilience. The economic benefits are equally significant—reduced healthcare costs, increased productivity, improved school attendance, city livability and enhanced tourism potential all contribute to broader prosperity. These positive externalities mean that the social returns from sanitation investments substantially exceed private returns, creating a strong economic rationale for public sector financial support.

While public-sector ownership and leadership in the funding arrangements for climate-resilient urban sanitation are critical, a blend of public and private financing—together with leveraging climate and other green funding opportunities—is required to accelerate universal access to resilient sanitation services.

Emerging opportunities for new funding and financing mechanisms, such as climate and green finance, private investments, and the sale of new products created from sanitation 'waste' streams, can help bridge the funding gap. To effectively leverage such innovative financing, cities and utilities should achieve basic financial sustainability through sound revenue management, transparent budgeting, and efficient expenditure control.

Guiding Policy Objectives and Actions

The following recommendations are intended to guide governments, service providers, and development partners in their quest to accelerate universal, climate-resilient urban sanitation, building upon CWIS and the principles of a circular economy.

Policy interventions will differ according to local geography and socioeconomic context but, in all cases, should address the combined challenges of access to climate-resilient sanitation services for all, and the resilience of sanitation systems to extreme climate risks while contributing to urban water security and broader city resilience.

Policy Objective 1

Improve sanitation governance and increase financing to support a systems-wide approach to transformative adaptation and climate resilience.

Actions

1. Adopt flexible planning, financing, management, and regulatory frameworks to support adaptation and mitigation efforts of service providers.
2. Integrate circular economy approaches into sanitation policy, institutional, and regulatory frameworks.
3. Prepare service providers and governments for multiple revenue streams and to incentivize private-sector engagement in service delivery and resource recovery.
4. Incorporate costs of climate-resilient sanitation into project financing mechanisms to balance financial viability with affordability.
5. Incorporate sanitation within existing climate commitments across all levels of government.

Policy Objective 2

Rethink urban sanitation and implement systems-thinking that emphasizes inclusive sanitation services, urban water security, and climate resilience.

Actions

1. Focus on the provision of effective, universal sanitation services, integrating existing principles of CWIS with climate resilience.
2. Integrate sanitation with wider urban services and development processes.
3. Prioritize activities that emphasize adaptation while seizing opportunities for mitigation.

Policy Objective 3

Enhance capacity building and skills development and adopt innovative technologies and practices, to create adaptive, resilient, and sustainable sanitation systems.

Actions

1. Develop capacity, knowledge, skills, and mechanisms for innovative and sustainable adaptation and mitigation in the sanitation and related sectors.
2. Enhance data collection and monitoring capacity to promote evidence-based CRS services and financing, leveraging emerging innovative tools and technologies.
3. Strengthen local government and utility capacity to drive innovation for resilient sanitation systems, focused on reducing climate-induced failures and mitigating GHG emissions.

Implementation Pathways

Implementation pathways will vary between countries and cities depending on existing levels of access to sanitation, income levels, and related factors such as the availability of funding and financing, institutional capacity and readiness, and synergies with development and economic goals.

Cities with very low access to basic and/or safely managed sanitation services and weaker absorptive and adaptive capacities, as seen in many low-income countries, might prioritize interventions that maximize development benefits, regardless of whether they qualify as adaptation or mitigation. For example, to reduce exposure and vulnerability to climate risks and to build overall community resilience, these countries can focus on expanding access to basic sanitation services while simultaneously planning for, and progressively investing in, safely managed sanitation. Such cities can also incorporate resilience into new sanitation systems from the outset, which is often more cost-effective than retrofitting systems later (World Bank 2024).

Cities with higher, though often not universal, access to safely managed sanitation, as seen in many middle-income countries, might need to balance achieving universal coverage with strengthening wider system resilience to climate change while reducing GHG emissions. Cities that face lower resource constraints and have achieved universal access to safely managed sanitation, as is the case in many high-income countries, might prioritize adapting and transforming existing systems and services to withstand climate impacts while driving technological innovation to reduce climate-induced infrastructure failures and mitigate GHG emissions.

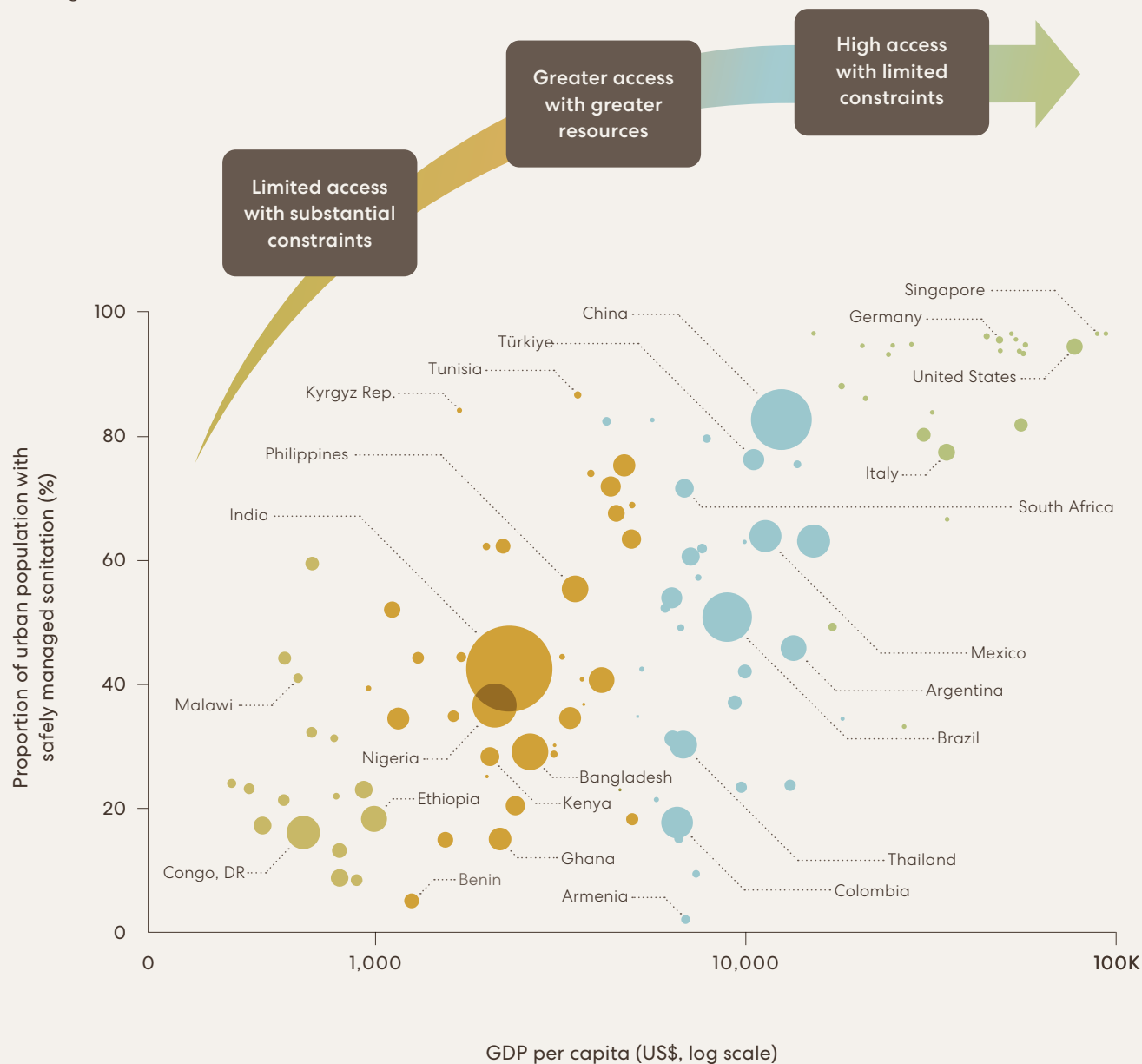
Prioritizing efforts is an important part of the implementation process that will vary according to the local context.

Figures ES.6 presents broad groupings of countries with different levels of access to safely managed sanitation, and income to help identify priority action pathways for progressive achievement of universal safely managed and resilient sanitation services. Table ES.4 presents some priority implementation actions for accelerating CRS in different city contexts.

Figure ES.6

Priority action pathways reflecting the relation of GDP with deficits in safely managed urban sanitation

- Low-Income Countries
- Lower-Middle-Income Countries
- Upper-Middle-Income Countries
- High-Income Countries



Source. World Bank estimations using information for safely managed access from WHO, UNICEF, JMP; and for GDP per capita information from the World Development Indicators (World Bank). For all sources, information corresponds to 2022 or its closest year.

Note. The size of the bubbles denotes the total number of people in urban areas without access to safely managed sanitation (millions).

Photo: Girls at Sabuhene Primary School in Tanzania wash their hands near school toilets. Provision of adequate hygiene, including soap and water are critical for achieving the full benefits of sanitation (Credit, World Bank).



Table ES.4

Proposed priority implementation actions for accelerating universal CRS in different city contexts

Context	Cities with limited access to safely managed sanitation facing climate challenges and resource constraints.	Cities with greater access to safely managed sanitation facing climate challenges with more robust resources.	Cities with high access to safely managed sanitation facing increasing climate challenges.
Goals	Accelerate universal resilient urban sanitation services for people and prosperity on a livable planet		
Focus	Providing universal sanitation services while reducing exposure and vulnerability of populations to climate risks.	Providing universal services while increasing climate resilience of sanitation systems, reducing pollution, working toward greater circularity, and achieving opportunistic reductions in GHG emissions.	Driving innovation for resilient circular sanitation systems, focused on environmental protection, reducing climate-induced failures, and mitigating GHG emissions.
Climate Preparedness and Risk-informed Sanitation Planning	Conduct climate-risk assessment, modeling, and prioritization, informed by stakeholder and public consultation (for example, by following the WHO Sanitation Safety Planning approach [WHO 2022]).		
	Assess viability of resource recovery: safe wastewater and sludge reuse across all sanitation systems, including opportunities to separate wastewater/blackwater/graywater/urine for their tailored reuse.		
	Integrate utility sanitation planning within citywide services planning, including water supply, stormwater management, solid waste management, transport, electricity, housing, land use, and agriculture.		
	- Align a range of short-, medium-, and longer-term planned investments with urban migration and peri-urban growth. - Incorporate resilience into new sanitation systems from the outset, avoiding costly retrofitting.	- Plan for urban stormwater management to minimize discharge to combined sewers. - Evaluate transitioning from combined to separate sewers and to source separation systems. - Assess reuse opportunities with neighboring agriculture and other end-uses.	
	Assess opportunities for the role of source-separating systems as part of the drive to universal access (for example, CBS, Urine Diversion Dry Toilets (UDDTs)).	Leverage opportunities from source-separating and decentralized systems for resource recovery and pollution reduction.	
Technical Modifications to New and Existing Infrastructure	Enable non-conventional sewered services (for example, simplified sewerage, source separation).		
	Promote SuDS/NBS/sponge city approaches to reduce urban runoff and recharge groundwater.		
	Maximize existing infrastructure and service chains by... - Formalizing and rationalizing existing FSM services. - Connecting households to existing sewers. - Implementing sustainable wastewater and fecal sludge treatment. - Retrofitting climate resilience into existing sanitation systems. - Implementing climate-resilient systems in new urban developments.		

Context	Cities with limited access to safely managed sanitation facing climate challenges and resource constraints.	Cities with greater access to safely managed sanitation facing climate challenges with more robust resources.	Cities with high access to safely managed sanitation facing increasing climate challenges.
Technical Modifications to New and Existing Infrastructure	Support safe FSM, including ensuring groundwater protection from septic tanks and their disconnection from stormwater drains; support health and safety of sanitation workers.		
	Convert septic tanks to sewers in areas affected by sea level rise.		
	Maintain access and service during climate-induced impacts through...		
	- Investment in stormwater drainage (including SuDS) and flood risk management, - Risk-informed site selection and flood prevention of treatment facilities. - Risk-informed modifications to new infrastructure and during infrastructure overhauls, including raised latrines/containment, robust and resilient latrines/containment, low-water or no-water toilets, sealable and removable containment, simplified/decentralized sewers, and corrosion-resistant designs. - Modular and decentralized systems, including modular FSTPs/WWTPs, and decentralized/clustered FSTPs/WWTPs.	- Use of tailored mixes of gray, blue, and green systems, enhanced with predictive flood modeling. - Integration of flood, drought, and pollution. resilience into infrastructure design, including source separation and treatment, additional retention and treatment of sewer overflows, and corrosion-resistant design. - Promotion of SuDS, NBS, and sponge city approaches to manage urban runoff and recharge groundwater. - Modular and decentralized systems, including modular WWTPs and decentralized/clustered WWTPs.	
Active Management of Sewered and Non-sewered Sanitation Systems	Prioritize low-energy wastewater and fecal sludge treatment systems with biogas capture and effluent reuse.	Recover biogas at community/clustered and centralized scales for climate mitigation and income generation.	Assess mitigation potential for treatment facilities, promoting energy efficiency and reuse of treated wastewater, biogas, and heat; incentivize low-GHG collection and treatment processes.
	Integrate LCAs into asset management practices and decision-making for sewerage and non-sewered systems.		
	Train utility staff, local authorities, and sanitation workers in emergency response to climate impacts.		
	Adopt SCADA-type system monitoring and AI-powered diagnostics.		
Active Management of Sewered and Non-sewered Sanitation Systems	Ensure active O&M for sewerage and non-sewered services, including...		
	- Regular, scheduled, or more frequent (and pre-rainy season) emptying of onsite systems. - Pre-rainy season clearance of stormwater drains and sewers. - Preventive maintenance of sewers and drainage systems.	Preventive maintenance of sewers and drainage systems.	
	Improve the use of data, mapping, and monitoring to...		
	Incorporate findings into planning and design, including detailed sanitation system mapping in cities with fragmented services, and real-time ongoing review of satellite to identify newly settled areas of city.	Help incubate start-ups for high quality data collection, analysis, and data visualization	

Conclusion

The findings in this report underscore the critical need for coordinated action to accelerate the transition to universal climate-resilient sanitation, particularly in rapidly growing cities within LMICs.

The costs of inaction—in terms of public health, environmental degradation and economic impacts—far outweigh the investments required to build resilient urban sanitation systems.

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Many cities worldwide have already begun rethinking their approaches to urban sanitation as they race to strengthen the climate resilience of their sanitation systems and services. Growing pressures on sanitation systems present opportunities to embrace integrative urban water cycle management, thereby enhancing urban water resilience which in turn contributes to increased water security, greater city resilience and livability—and ultimately delivers positive impacts for people, shared prosperity and the planet.

The report outlines a comprehensive set of policy actions and implementation pathways aimed at accelerating universal access to resilient sanitation services in cities with varying levels of sanitation access and resources. Achieving these goals will require sustained commitment from governments, utilities, development partners, and communities, in collaboration with the private sector.

By fostering a supportive enabling environment, unlocking funding, and integrating climate-resilient urban sanitation within broader urban development frameworks, a climate-resilient future that protects public health, safeguards the environment, and supports sustainable development is achievable. The sector must drive a fundamental shift from the vicious cycle of inadequate sanitation that is vulnerable to climate change and also contributing to it, to a virtuous cycle of climate-resilient, mitigation-positive sanitation services for all. The time to act is now.

Photo 1: Biogas storage from anaerobic domestic sewage treatment at Atuba Sul WWTP, Curitiba, Brazil. Clean energy from methane and biomass (dried sludge and wood chips) is used to generate heat for a full scale sustainable thermal drying and combustion sewage sludge system (Credit: Sanepar).

Photo 2: Seedlings, like the one shown here, are planted in newly constructed wetlands adjacent to decentralised treatment plants that are designed to serve more remote communities (Credit: Juliet Willets).

Photo 3: In Machakos, Kenya, exhaustor trucks are key for the safe removal and disposal of septage and fecal sludge from septic tanks and pit latrines (Credit: Waterfund, Kenya).

Photo 4: Sludge from a recycling program developed by Sanepar that serves small and medium-sized farmers is used as fertilizer. In the last 12 years, more than 300,000 tons of sludge have been recycled (Credit: Sanepar).

Photo 5: A City contractor installs a simplified inspection chamber for a condominal sewer system in Brasília, Brazil (Credit: CAESB).

Photo 6: School children in Filimule Primary School in Katavi, Tanzania, using recently built toilets provided under the Sustainable Rural Water Supply and Sanitation Program (Credit: World Bank).

Photo 7: Nature-Based Solution (constructed wetlands) for sewage sludge treatment at the Santa Helena wastewater treatment plant in Santa Helena, Brazil (Credit: Sanepar).

Photo 8: A treatment plant in Philipsburg, Sint Maarten (Credit: Martin Gambrell).



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